IMPLEMENTATION OF MAYNARD OPERATION SEQUENCE TECHNIQUE (MOST) TO IMPROVE PRODUCTIVITY AND WORKFLOW – A CASE STUDY

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Abstract: Profit gain is the main goal of a manufacturing industry. The successes of industry depend on its productivity. This productivity suffers due to the lack of established standard time for activities carried out by operators, the non-value added activities involved and the unproductive methods, material expenditures, and imbalance in the material flow. This study is conducted through application of Maynard Operation Sequence Technique (MOST) in the sewing section of a garment industry is taken into consideration with the aim of identifying the non-value added activities and minimizing the bottlenecks to improve productivity and reduce product cycle time, production cost per product. Present method reduced the total activity time from 139 seconds to 109 seconds and improved daily productivity from 600 pieces to 1600 pieces.

***Keywords*- Maynard Operation Sequence Technique (MOST), Bottleneck, Takt time, Improvement of Productivity.**

I. INTRODUCTION

Non-value added activities are an important factor for any kind of manufacturing industry. Non-value added activities are those that do not append a value to the product but the authority has to pay. The productivity of a manufacture company hampers by the bottlenecks workstation. As result the bottleneck workstations and non-value added activities act as a vital fact to gain the company's goal. So it is very essential to identify and eliminate the bottleneck and non-value added activities. There are various tools and techniques known as lean tools to identify and eliminate non-value added activities. Among of them "Maynard Operation Sequence Technique (MOST)" is one of the most common tools. The MOST can be defined as a way of analyzing the operations or sub-operations performing through several methods, steps and sequences, etc. in terms of time. In other words, it is a predetermined motion time method that aims to define the standard time of performing the work**.**At first, in 1960s H.B. Maynard and Company In introduced MOST but in the basic form of MOST had started from 1967s in industrial application. Finally, in 1970 the Basic MOST was modified and named as Clerical MOST to perform the administrative and clerical work in the company. Bangladesh is well enriched in garments industry. This industry plays a vital role for the economic development of the country. So it is very important to increase productivity by smooth workflow. For this research study a garment industry was selected which located in Dhaka, Bangladesh and this industry produces a lot of garments product and export them. During this study a particular operation area i.e sewing section of T-shirt fabrication was considered to implement the MOST. Like most of the other, the operator of this section works as a conventional way. Due to this a lot of non-value added motion of the workers are exist. The Maynard Operations Sequence Technique (MOST) is implemented for increasing the productivity by identifying bottleneck, standard time and excess motion of the sewing section.

II. LITERATURE REVIEW

The implementation of MOST in different industries proved its significant contribution to enhance the productivity. M. Jadhav*et al* (2017) implemented MOST in Mahindra CIE automotive industry and increased productivity through reducing product and labor cost [1]. A.A.karad et al (2016) improved the productivity of an auto company by MOST. They saved takt time 1.90 min and also saved annual investment 18 lakh [2]. Sunil Londhe (2016), in his study ' Review On Work Measurement By Maynard

Operation Sequencing Technique', The designing, scheduling, estimation of prices and analysis of performance are used as Work measuring tools for management choices. [3].Ankit P. Vekariya (2015) implemented MOST in Manufacturing Process of Diesel Engine and carried out a decision that, to increase productivity and determine standard time for any enterprise Work study is most effective tool.[4]. Jamil et al. (2013) integrated MOST with the Ergonomics study, this integration helps to optimize the standard times of the process activities and reduce the fatigue of the workers simultaneously. As a result, the workforces gained a better working environment while they performed their activities with a comfort manner consequently the rate of productivity also increased.[5]. Yadhav in his study optimize the Manpower through implementing MOST. In his study, it was found that MOST enables a better picture of working procedures and thus leads to the elimination of Nonvalue-added operations. It was observed that the work content utilization factor was very less and a considerable amount of manpower remained unutilized. He suggested balancing workload by assigning more work and improving productivity by using MOST.[6]. Belokar et al (2012) implemented MOST to increase the efficiency and the cost-effectiveness of the work and reduce worker's fatigue through identification and minimization of the Non- Value Added (NVA) activities. As a result of their study, the authors managed to save 18% of the working time and define a new set of reduced standard time.[7]. Similarly, Gupta and Chandrawat (2012) applied the basic MOST in a small Indian industry and showed possible and significant improvement in the productivity. [8]. Abdullah and Bahiyah(2011), in their study, Labor Utilization and Man to Machine Ratio study at a Semiconductor facility, attempted to improve productivity and reduce operational cost in MNC semiconductor industry using Maynard Operation Sequence technique (MOST).[9]. Mahajan (2011), examined the reduction in tool changeover time by the implementation of Single Minute Exchange of Dies (SMED) through MOST for Legrand (India) Pvt. Ltd, Jalgaon. He reviewed MOST technique and compared it with traditional time study application method.. He concluded that by application of other MOST methods tool changeover time can be further reduced into single digit minutes.[10]. Productivity Improvement through Application of MOST in Switchgear Company was studied by Sir Deshmukh et al (2009). Predetermined Motion Time systems (PMTS) have become attractive and a useful evaluation tool for manpower utilization and productivity improvement [11].

III. METHODOLOGY

By analyzing the undertaken case of sewing section in a garment, several problems have been identified including the improper capacity planning. The non-value added activities were increased and affected the whole assembly line due to the absence of pre-defined standard time, working methods, unplanned working distance, and animbalance in the material flow etc.. Hence, the competitive advantages in the undertaken sewing line can be brought into thesystem by the proper use and selection of body motion, balancing workflow and optimizing layout body motion of the operator. Hence, to increase the line efficiency as well as the production rate of the undertaken case study, the MOST technique is implemented for identifying the bottlenecks and NVA added activities of the production line as well as setting time standard. The basic MOST technique constitutes with the general move, control move and tool use process. In sewing section for sewing cloth, only general moves exist. For that reason, we studied only with the general move or motion of the sewing operator.

3.1. General Move:

In the General Move Sequence Model the studied object moves freely in the air. In brief, the General Move model follows the Sequence of GET, PUT, and RETURN i.e. |A B G|, |A B P|, and |A|. Where, A = action distance, B = Body motion, G = Gain control, P = Placement. Each of these parameters A, B, G, and P has its own index value which is determined from the MOST Data Card. The General Move Sequence Model is
A B G A B P A

Action Distance (A):

This parameter is used to analyze all spatial movement or actions of the fingers, hands, and/or feet. The index value of action distance using in this paper is described in table -1.

Body Motion (B):

This parameter is used to analyze either vertical motions of the body or the actions necessary to overcome an obstruction or impairment to body movement. In sewing section to sewing, there is no use of body motion. For sequence maintaining, we only use B0 as body motion index value.

Gain Control (G):

This parameter is used to analyze all manual motions employed to obtain complete manual control of objects and to subsequently relinquish that control. The using index value of thegain control is given table-1.

Placement (P):

This parameter is used to analyze actions at the final stage of an object's displacement to align, orient, and/or engage the object with another object(s) before control of the object is relinquished. The using placement index value is given table-1.

Table-1: Parameters Index Value.

Parameter	Index value	When using
A	A0	This is any displacement of the fingers, hands, and/or feet a distance of 2 inches or less.
	A1	Actions that are confined to an area described by the arc of the outstretched arm pivoted about the shoulder.
	A3	The trunk of the body is shifted or displaced by walking, stepping to the side, or turning the body around using 1 or 2 steps.
B	B0	No motion of body
G	G0	No requiring of controlling the object.
	G1	Gain control of an object by grasping it as long as no difficulty is encountered.
	G3	While one hand is grasping an object, the other hand must wait before it can grasp the other object.
P	P0	This is "placement" in which no placement occurs. The object is picked up and
	P1	The object is placed in appropriate locations with no apparent aligning or adjusting motions.

3.2 Time Unit used in MOST:

The time measurement unit (TMU) is used as a time unit for MOST analysis, which is converted to the minute by using the following Table-2

Table -2: Unit Conversion Table

1 TMU	=	0.00001 hour	1 hour	=	100000 TMU
1 TMU	=	0.0006 minute	1 minute	=	1667 TMU
1 TMU	=	0.036 second	1 second	=	27.8TMU

3.3 Procedures of MOST calculation:

A typical MOST work sequence code would look like this:
A_{10} B_6 G_3 A_6 P_3 A_0

Step – 1 adds up all the subscript numbers
10+6+3+6+3+0= 28 (the subscript is the MOST index value)

Step – 2 multiple the sum of the index by 10.
This answer gives the TMU equivalent
28 x 10 = 280 TMU

Step – 3 Convert to time in seconds
280U *0.036 seconds = 10.08 seconds

IV. CASE STUDY

For this study, the sewing section of selected industry consists of eight workstations. To show the process of data extraction in line the MOST analysis, a short explanationthrough sequential workstation 1 to workstation 8 is shown in table-2.

Table-2: data extraction process

SL	Method description	Index value	Move
1	Pick up cloth	A3 B0 G1 A1 B0 P0	General move
2	Placing the cloth	A0 B0 G3 A3 B0 P1	General move
3	Matching front & back part	A0 B0 G3 A0 B0 P0	General move
4	Matching the cloth	A3 B0 G3 A0 B0 P0	General move

The selected sewing section consists of eight workstations. Time calculated for the existing production section carried out by applying MOST technique. Time calculated for each workstation individually. The elemental activity times as measured for the current workstation as shown in table – 3

Table – 3: Estimated activity time for the current operation in the workstations

WORK STATION - 1			WORKSTATION -2		
Activities	Time in (TMU)	Time in (sec)	Activities	Time in (TMU)	Time in (sec)
Picking & placing the cloth on machine	112	4	Picking &placing the cloth on machine	56	2
Collar joining with body sewing	167	6	Neck support joining with collar	250	9
Placing the cloth to store	56	2			
Total completion time	**335**	**12**	**Total completion time**	**306**	**11**
WORKSTATION - 3			WORKSTATION - 4		
Picking &placing the cloth on machine	83	3	Picking &placing the cloth on machine	56	2
Sleeve hem	196	7	Left sleeve joining with body part	139	5
Placing the cloth to store	28	1	Changing side	56	2
Total completion time	**306**	**11**	Joining right sleeve with body part	140	5
			Placing the cloth to store	28	1
			Total completion time	**419**	**15**
WORKSTATION – 5			WORKSTATION - 6		
Picking &placing the cloth on machine	112	4	Picking &placing the cloth on machine	139	5
Joining right side	444	16	Left sleeve tuck	83	3
Changing side	250	9	Right sleeve tuck	83	3
Left side joining	500	18	Placing the cloth to store	28	1
Placing the cloth to store	28	1	**Total completion time**	**333**	**12**
Total completion time	**1334**	**48**			
WORKSTATION – 7			WORKSTATION- 8		
Picking &placing the cloth on machine	112	4	Picking &placing the cloth on machine	112	4
Top stitch joining	250	9	Body hem	250	11
Placing the cloth to store	56	2	Placing the cloth to store	56	2
Total completion time	**418**	**15**	**Total completion time**	**418**	**15**

In-order to identify the bottleneck workstations of the selected sewing section, the total completion time for each station found from the MOST technique are shown in table – 4.

Table-4: Summary of existing time for Workstations.

Workstation No	Completion in MTU	Completion Time in second
Workstation - 1	335	12
Workstation – 2	306	11
Workstation – 3	306	11
Workstation – 4	419	15
Workstation – 5	1334	48
Workstation – 6	333	12
Workstation - 7	418	15
Workstation - 8	418	15
Total	**3869**	**139**

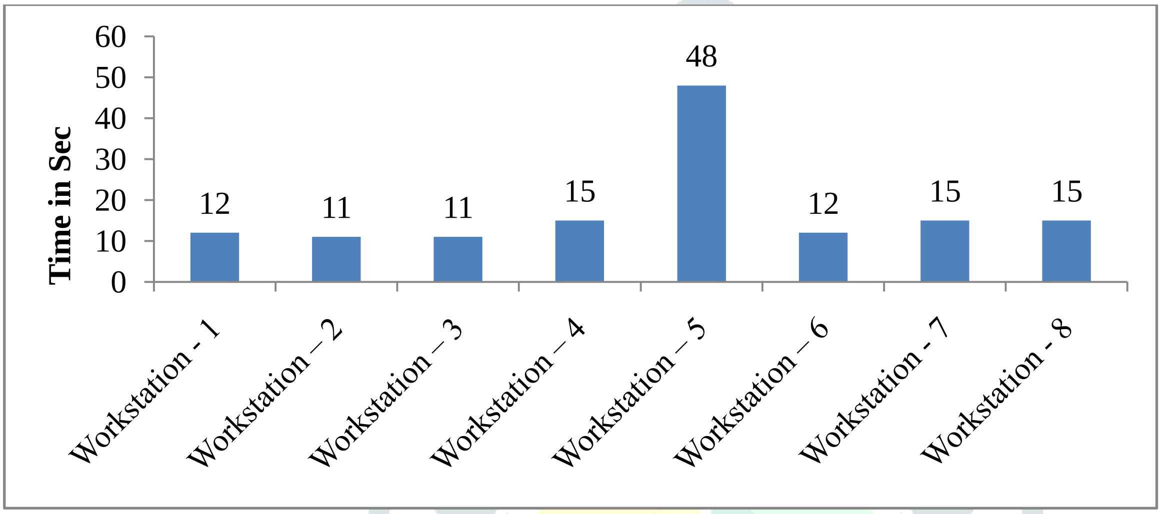


Fig. 1: Existing time for Workstation

As shown in above fig.1, workstation – 5 required maximum time to complete work. So the workstation – 5 is identified as a bottleneck workstation which requiring a cycle time 48 second. To be competitive advantages, at first necessary step is needed to reduce cycle time of bottleneck workstation by incorporation of positive changes. Implementing MOST technique, process flow working procedure (called standard operating procedure (SOP)) and the cycle time of a workstation can be reduced. To reduce the cycle time of bottleneck workstation, replaced the operator with a skilled operator. In this way, production flow smoothly.

Table – 5: Proposed solution for workstation - 5

Activities	Activity time in seconds (By Existing worker)	Activity time in seconds (By new skilled worker)
Picking &placing the cloth on machine	4	2
Joining right side	16	9
Changing side	9	5
Left side joining	1	1
Placing the cloth to store	1	1
Total time in seconds	48	18

Table –6: Proposed change the worker and its effects.

Workstation No	Completion in MTU	Completion Time in second
Workstation - 1	335	12
Workstation – 2	306	11
Workstation – 3	306	11
Workstation – 4	419	15
Workstation – 5	500	18
Workstation – 6	333	12
Workstation - 7	418	15
Workstation - 8	418	15
Total	**3035**	**109**

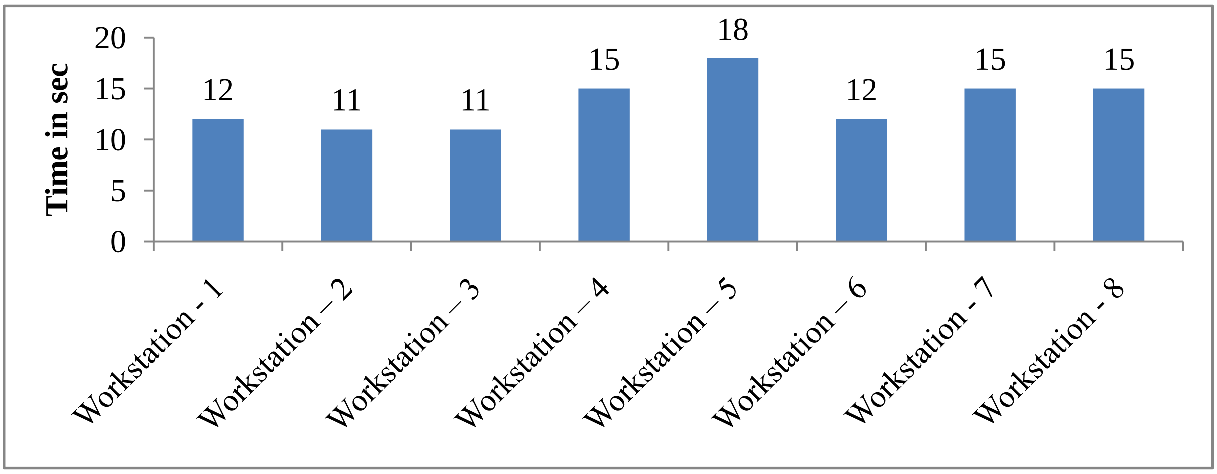


Fig.2: proposed cycle time

As shown in fig.2, changing the operator at workstation – 5 required bottleneck time is minimized. Time minimized for bottleneck workstation- 5 means line is more balanced than before implementing of MOST technique.

V. RESULT AND DISCUSSION

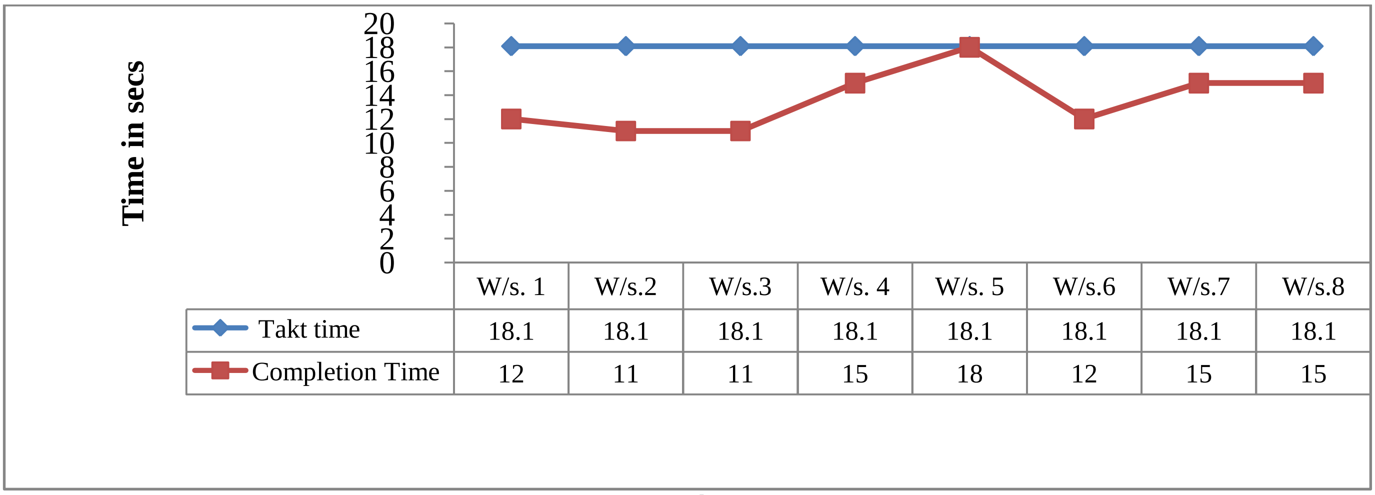
In this study, it was found that before implementation of MOST technique in selected garment industry to complete a basic T – shirt time consumed 139 seconds. But, after implementation of MOST bottleneck time reduced and 109 seconds is needed to complete the same T – shirt.After identifying bottleneck and improving the method of working motion time reduced 40 seconds. To measure the production rate, the Takt time of the selected sewing line is estimated by dividing the total available time with the customer demand. The Takt (cycle time per work station) time and productivity as per demand are shown in table-6.

Table -6: Takt time and daily productivity

Available working time/day (sec)	Before MOST implementation				After MOST implementation				
	Total activity time(sec)	Bottleneck time (sec)	Takt time(sec)	Productivity per day(pc)	Total activity	Bottleneck time (sec)	Takt time(sec)	Productivity per day(pc)	Daily demand(pc)
28800	139	48	18.1	600	109	18	18.1	1600	1590

Here,

Takt time = **Available working time÷ Daily demand**



	W/s. 1	W/s.2	W/s.3	W/s. 4	W/s. 5	W/s.6	W/s.7	W/s.8
Takt time	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1
Completion Time	12	11	11	15	18	12	15	15

Fig.3: Takt time

As the estimated Takt time for the sewing section is as 18.1 sec per piece and daily demand is 1590 pieces which not to be diverted by new practice. So, the new proposed changes in workstation – 5 it is possible to maintain the daily demand as well as improve the productivity.

VI. CONCLUSION:

In this studes, tried our best to find a possible solution for exists problem in the selected garment sewing section by applying MOST technique. It is said that, the Maynard operation sequence technique plays a vital role to identify and eliminate bottleneck workstation and to make a competitive industrial environment. MOST also helps to improve the productivity of a manufacturing company by reducing non-value added activities. By implementing MOST, it is possible to proper utilization of total available time and to save money.

VII. REFERRENCE

[1]. MangeshJadhav, SamadhanMungase, Prof. A. A. Karad (2017), "Productivity Improvement through Maynard Operation Sequence Technique" International Journal of Scientific Research in Science, Engineering and Technology ,volume-3, issue-1, [(3)1: 565-568]

[2] Prof. A. A. Karad1, Mr. Nikhil K. Waychale2, Mr. Nitesh G. Tidke3,(2016), "Productivity Improvement By Maynard Operation Sequence Technique" International Journal of Engineering Research and General Science Volume 4, Issue 2

[3].Sunil Londhe,(2016) 'Review of Work Measurement By MOST', IJATES, Volume 4, Issue 3, March 2016,PP. 563-569.

[4].AniketP. Vekariya,(2015) 'Productivity Improvement Of Manufacturing Process Of Diesel Engine By Time And Motion Study Method (MOST Technique)', IJAERD, Volume 2, Issue 6, PP.577-584.

[5].Jamil, M. G., Saxena, A., and MrVivekAgnihotri, M.,(2013) "Optimization of Productivity by Work Force Management through Ergonomics and Standardization of Process Activities using MOST Analysis-A Case Study", Global Journal of Researches In Engineering, vol.13, no.6,

[6]. Yadav T.K.,(2013) Measurement Time Method for Engine Assembly Line with Help of Maynard Operating Sequencing Technique (MOST), International Journal Of Innovations In Engineering And Technology (IJIET), vol. 2,no.2

[7]. Belokar, R. M., Dhull, Y., Nain, S., and Nain, S.(2012), Optimization of Time by Elimination of Unproductive Activities through 'MOST', International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 1, no. 1, pp. 77-80

[8]. Gupta, M. P. K., and Chandrawat, M. S. S.,(2012),"To improve work force productivity in a medium size manufacturing enterprise by MOST Technique", IOSR Journal of Engineering (IOSRJEN), Vol. 2, no.10, pp. 08-15

[9]. Abdullah Rohana and Bahiyah Aida, 2011, "Labor Utilization and Man to Machine Ratio Study at a Semiconductor Facility", Journal of Engineering and Technology, Vol.2, ISSN 2180-3811, PP.75-84.

[10].MahajanHarshal V.,2010-2011, "A Project Report on Reduction in Tool Changeover Time by SMED through MOST for Legrand (India) Pvt. Ltd", MIDC, Jalgaon, A project report (MBA), Institute of Management and Research, Jalgaon

[11]. SirdeshmukhNeelesh P.C, Puri Y.M, Chopde I.K and Pundlik A.D (2009), "Productivity Improvement through Application of MOST in Switchgear Company", Productivity. Vol.50, No.2, July -September, PP.146-151.