Optimization of Labour Productivity Using MOST Technique

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Abstract

Productivity has now become an everyday watch word. The most practical approach is to attack the work process itself- that is, review and redesign the operations and apply automation and mechanization. In such cases, a productivity audit employing industrial engineering (IE) techniques is used for evaluating the existing manufacturing situation and identifying the potential for increased productivity. MOST (Maynard Operation Sequence Technique) is a good application of work measurement technique that allows a greater variety of work (both repetitive and non-repetitive) for manufacturing, engineering to administrative service activities to be measured quickly with ease and accuracy. This paper demonstrates the application of MOST technique through a case study of process improvement for improving labour productivity. This paper attempts to show the application of the MOST for time study of casting processes at bathroom appliances industry and shows the comparison with the time standard established using Stopwatch method. Statistical t-test is used to show the significance level between stopwatch method and MOST results. Test shows a 95% level of confidence in the result obtained using MOST.

Keywords: Productivity, IE techniques, MOST.

Introduction:

In this customer-focused paradigm of business environment puts tremendous pressures of quality, delivery, dependability, flexibility and cost on the manufacturing organisation. Automatic manufacturing systems (Mathur et al., 2011) offer several advantages and are increasingly being adopted as a strategy to improve the performance of manufacturing organisations and employee satisfaction (Meena and Dangayach, 2012) is important for organization's success and survival. The quest for lower operating costs and improved manufacturing efficiency (Dangayach and Deshmukh, 2001) has forced a large number of manufacturing firms to embark on IE approaches to analyse and optimize their production. A common goal is to establish a continuous improvement process to achieve the same added value with reduced resource utilization (Woamck and Jones, 2003). This paper methods to identify an IE technique (Shoichi Saito, 2004) which needs to be applied on the process. An audit to be done according to three important factors of productivity method, performance, and utilization [abbreviated as MPU] (including planning and control). To be specific, an evaluation is made of that how efficiently all applied resources (input), including personnel, equipment and machinery, and raw materials, are converted into output - finished products. For each factor, IE techniques such as work sampling and time studies are used to evaluate quantitatively and objectively the effectiveness of the applied resources in the existing situation and to determine where and to what degree MPU losses are occurring. The system for such audits is shown in Table 1, of which some additional explanation may be useful.

Table 1: System for surveying the potential for improvement

		Operator	Machine	Material
Method Factor	Actions	• Confirm percentage for basic functions. • Estimate the operator reduction factor.	• Determine actual machine time. • Estimate the potential for reduction of machine time.	• Determine losses caused by product design • Estimate the potential (%) for improvement of yield.
	Techniques	• Work Sampling, • Direct time study, • Pitch diagrams, • Human-machine charts • 4W (what, who, why, where) charts.	• Pitch diagrams, • Sequence charts.	• Design review, • Value-added analysis.

Performance Factor	Actions	• Confirm present performance level. • Estimate performance improvement potential (%).	• Confirm the facility performance. • Estimate the potential (%) for improvement of performance.	• Confirm the quality of material and parts. • Estimate potential for increasing first-pass yield.
	Techniques	• **MOST analysis,** • **Direct time study,** • **Output analysis.**	• Work Sampling, • Material analysis.	• Yield analysis • Analysis of failure causes • Analysis of materials
Utilization Factor	Actions	• Confirm utilization loss. • Estimate the potential (%) for improvement of the utilization factor.	• Confirm utilization loss. • Estimate the potential (%) for improving utilization.	• Confirm utilization loss. • Estimate the potential (%) for improving utilization.
	Techniques	• Analysis of setup procedures, • Investigate the impact of staffing changes, • Work sampling.	• Downtime analysis, • Work sampling, • Analyse space utilization.	• Scrap rate analysis, • Inventory analysis, • Investigate alternative materials.

MOST is a work measurement technique that concentrates on the movement of objects. It is used to analyse work and to determine the normal time that it would take to perform a particular process /operation. MOST is a powerful analytical tool to measure every minute spent on a task. It makes the analysis of work a practical, manageable and cost effective task (Salvendy, 2001). MOST analysis is a complete study of an operation or sub-operation typically consisting of several method steps and corresponding sequence model. MOST is comprised of Work study, method study, and work measurement. In the organization under study, the excess time in operator's activity and fatigue of worker.

Research Methodology:

Research methodology (Kothari, 2004) is a way to systematically study & solve the research problems. A research problem here was to analyse the labour resources used and reduce or minimize them. MOST and stopwatch can be applied for the activities having well defined work methods. The Basic MOST System (Zandin, 1990) is the core of MOST Work Measurement Systems.

The Basic MOST System: The Basic MOST System satisfies the most work measurement situations in the manufacturing arena. Every company very likely has some operations for which Basic MOST is the logical and most practical work measurement tool.

Consequently, only three activity sequences are needed for describing manual work. The BasicMOST work measurement technique therefore comprises the following sequence models:

(A).General Move Sequence—for the spatial movement of an object freely through the air

A B G	A B P	A
Get	Put	Return

Where, A = Action distance

B = Body motion

G = Gain control

P = Placement

These sub-activities are arranged in a sequence model, consisting of a series of parameters organized in a logical sequence. The sequence model defines the event or actions that always take place in a prescribed order when an object is being moved from one location to another.

The common scale of index numbers for all MOST sequence models is 0, 1, 3, 6, 10, 16, 24, 32, 42 and 54. The time value for a sequence model in basic MOST is obtained by simply adding the index numbers for individual sub-activity and multiplying the sum by 10.

(B).Controlled Move Sequence—for the movement of an object when it remains in contact with a surface or is attached to another object during the movement.

The move sequence model is A B G M X I A, in which

A B G	M X I	A
Get	Move or Actuate	Return

Where M = Move Controlled

X = Process Time

I = Alignment

(C).Tool Use Sequence—for the use of common hand tools. However, the Tool Use sequence model does not define a third basic activity --normally it is a combination of General Move and Controlled Move activities. The tool use sequence model is ABG ABP *ABP A, in which

ABG – Get Tool, ABP – Put Tool, * - Use Tool, ABP –Aside Tool, A – Return

The MOST has advantages that only one or two observations are needed to measure the work and rating factors is inbuilt. It is more accurate than other techniques and involves less paper work.

MOST application at Production Line:

The present study makes use of Basic MOST for the estimate of labour activities and worker' fatigue problem and try to reduce them.

The study was carried out in three phases: (i) Time Study, (ii) Basic MOST analysis and (iii) Significance testing.

(i) Time Study: The total activity time consists of operator of traveling due to placement of material and other operating devices far from line were note down by timing device i.e. palmtop mobile device. Time study is a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task by using specified method. This technique is based on measuring the work content of the task when performed by the prescribed method, with the allowance for fatigue and for personal and unavoidable delays. Divide the operation into reasonably small elements, and record these on the Time Study observation sheet multiply it by the rating factor to get normal time.

$$\text{Normal time} = \text{Observed time} \times \text{rating factor} \tag{1}$$

Determine allowances for fatigue and various delays.

Determine standard time of operation by adding allowances in normal time i.e.

$$\text{Standard time} = \frac{[\text{Normal time} \times \text{Fatigue} \times \frac{\text{Frequency of Sub-operation}}{\text{Frequency of Sub-activity}}]}{60} \tag{2}$$

Table 2: Time Study Sheet Working Activity

Sub Activity 1: Starting Operations						
S. No.	**Sub Operations**	**Normal Time**	**Fatigue**	**Frequency of Sub-Operation**	**Frequency of Sub- Activity**	**Standard Time**
1.	Wear / Remove Apron	9.90	1.14	4	1	0.752
2.	Use / Remove Mask	7.50	1.14	6	1	0.855
3.	Switch On / Off Light	9.00	1.14	5	1	0.855
4.	Switch On / Off Fans	10.30	1.14	5	1	0.979
5.	Arrange Table and Tools	28.40	1.15	1	1	0.544
					Total Time:	**3.985**

The above table 2 shows the time study sheet for a sub-activity named 'starting operations' the staring, this table is generated by using palmtop timing device just input of time and workers' rating factor, and the below table 3 shows the summary of all activities held in the casting process. These calculations are done for single line operation, in which total number of workers used is four; all the operations are divided between the workers and so for time study operation the above time is calculated for single workers' activity in that particular operation.

Table 3: Total activity time of Operator's all activities: A Summary

Sub Activity Number	Sub-operation	Time (in minutes)
1	Starting operations (5 sub activities)	3.985
2	Mould Filling (32 sub activities)	13.280
3	Unloading (17 sub activities)	7.042
4	Polishing (15 sub activities)	13.497
5	Demoulding (54 sub activities)	31.913
6	On rack Operation (25 sub activities)	4.888
7	Green Piece Preparation (10 sub activities)	5.854
Total Time: (158 sub activities)		**80.459 minutes**

(ii) Basic Most Analysis:

The activities of workers at each workstation were broken down into distinctly identifiable and measurable sub activities. Each sub activity was further broken down into sub-operation and the sub-operation elements. The elements were then sequence modelled using the parameters and index values. Unit sub-activities have common and the same sequenced set of elements and occur frequently in many activities. MOST estimation sheets, one each for an activity, were developed to sequence model the element using the parameters and index value. Table 4 shows a partial MOST estimation sheet for the activity of operators in starting operation sub activity for the casting process. It explains how operator's sub-activity is broken down into sub-operations and element. The sample calculations, based on parameters and index values, are shown for each element. The operator's activity time (in min.) is calculated by adding the index values and then multiplying the sum by 0.0006 (1 TMU = 0.0006 min.)

$$1 \text{ T.M.U} = 1/28 \text{ of a second} = 0.036 \text{ sec}$$
$$= 0.0006 \text{ min}$$
$$= 0.00001\text{hr}$$

Table 4: MOST Estimation Sheet Existing Working Activity

Sub Activity 1: Starting Operations				
S. No.	**Sub Operations**	**Parameters and Index Values**	**Man**	**Time**
1.	Move 50-55step, Bend & arise,	A101B6G3A10B6P1A0	1	0.756

	get Apron with both hand and wear it and move to shop floor.	(101+6+3+10+6) ×10 = 1260 TMU		
2.	Walk 40-45 step with Mask (bend & arise), Get Mask, Put Mask on Face, (Normal time>7 secs), precisely move 1-2 steps.	A81B6G3M16X16I16A3 (81+6+3+16+16+16+3) ×10 = 1410 TMU	1	0.846
3.	Switch on/off the Lights (Fix Shift Operation)	PTIME = 1400 TMU	1	0.840
4.	Switch on/off Fans (Fix Shift Operation)	PTIME = 1600 TMU	1	0.960
5.	Move 6-9 steps, stand and bend, grasp tools and table with both hand, push and pull table, (Normal time>7 secs) Put tools down precisely & move 5-7 steps for assembly line.	A16B3G1M16X16I16A10 (16+3+1+16+16+16+10) × 10 = 780 TMU	1	0.468
Total Time:				**3.87**

Similar calculations were made for each process and calculated time for each. Table 5 shows the summary of all activities held in the casting process by using MOST.

Table 5: Total activity time for MOST Sheets of Operator's all Sub-activities: A Summary

Sub-operation	Time (in minutes)
Starting operations (5 sub activities)	3.870
Mould Filling (32 sub activities)	13.218
Unloading (17 sub activities)	7.044
Polishing (15 sub activities)	13.428
Demoulding (Automatically by Garoll machine as one activity)	50000TMU = 30.00
On rack Operation (25 sub activities)	4.863
Green Piece Preparation (10 sub activities)	5.850
Total Time: (101 sub activities)	**78.273 minutes**

So total time calculated by each process = 3.870+13.218+7.044+13.428+30+4.863+5.850

= 78.273

Optimize time after applying MOST = 80.459 -78.273

= 2.18 min.

(iii) Significance Testing using SPSS 16.0:

Statically testing will be done for starting operation using SPSS is done for checking the significance of the applied solution in the production line of Casting Process.

Table 6a: Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Time_in_min_Timestudy	.797000	5	.0727619
	Time_in_min_MOST	.774000	5	.0830951

Table 6b: Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Time_in_min_TimeStudy & Time_in_min_MOST	5	.993	.001

Table 6c: Paired Samples Test

		Paired Differences					**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**	**95 % Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	Time_in_min_Timestudy - Time_in_min_MOST	.0230	.03087	.0138094	-.01534	.06134	1.666	4	.171

This testing for 5 % level of significance or 95 % level of confidence.

For (n-1) i.e. 15 d.f.,

$t_{0.025, 15}$ = 2.776 (referred from Banks and Meikes, 1984)

Since $t < t_{0.025}$

i.e. 1.666 < 2.776

Difference between the sample mean is not significant.

Hence the two independent samples come from the same normal population. This shows that applying this study on the process is significant.

The above tables 6(a, b, c) explains how operator's sub-activity significance testing is done. The sample calculations, based on time calculated for time study and MOST analysis is done for other sub activities similarly.

Results and Conclusion:

A brief summary of results of comparison done in the Table 7 which shows how good the application of the MOST at manufacturing site.

Table 7: Comparison between MOST and Stopwatch time values

S.No.	Sub Operation Name	Time Calculated by Time study method(in mins)	Time Calculated by MOST (in mins)	Unit Relative Deviation (in %)
1.	Starting operations	3.985	3.870	-2.88
2.	Mould Filling	13.280	13.218	-0.47
3.	Unloading	7.042	7.044	+0.028
4.	Polishing	13.497	13.428	-0.51
5.	Demoulding	31.913	30.00	-5.99
6.	On rack Operation	4.888	4.863	-0.51
7.	Green Piece Preparation	5.854	5.850	-0.07
	Total	**80.459 minutes**	**78.273 minutes**	**-2.72**

So this table 7 shows the 2.72 % decrement in the time takes place after successful implementation of MOST on casting process at assembly line of the product. Also the labour improvement also takes place from 4 workers to 1 worker, so this shows the MOST is successfully implemented. Time values calculated using MOST gives a confidence level of 95% when compared with the time established using stop watch method. Also the time and effort required in establishing the time values for various operation is very less when compared with the stop watch method. This proves the effectiveness of the MOST in work measurement area.

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