A critical review of the use of labour productivity in industries, material, method, application and challenges

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Abstract:

Poor productivity of construction workers is one of the causes of cost and time over runs in construction projects. This study provides guidelines for necessary steps required to improve labour productivity. The survey was carried out by a questionnaire and responses. The ten most significant factors affecting labour productivity for small, medium and large companies are identified. The whole assembly line suffers due to the absence of established standard time for activities carried out by operators, the non-value added activities involved and the inefficient methods such as manual screwing, unplanned aisle and walking distance, material wastages and imbalance in the material flow. Thus through the process redesign and process flow analysis, material handling and workflow are improved. Consequently, it has been possible to reduce the production cycle time to crater the higher level of demand with shorter task time maintaining the current level of manpower.

Keywords*:* productivity, labour, small, medium and large companies, cost, time, etc.

1. Introduction

Poor safety and insufficient quality. Productivity is the one of the most important factor that affects overall performance of any small or medium or large construction industry. There are number of factors that directly affect the productivity of labour, thus it is important for any organization to study and identify those factors and take an appropriate action for improving the labour productivity. At the micro level, if we improved productivity, ultimately it reduces or decreases the unit cost of project and gives overall best performance of project. There are number of activities involved in the construction industry. Thus the effective use and proper management regarding labour is very important in construction operations without which those activities may not be possible.

1.1 Productivity in Different Segments

Agriculture: If the production of a paddy field is, say ‘X’ tons, and if through using better seeds, better fertilizers and better methods of cultivation, the yield is increased to 1.5 times

'X', then it can be stated that the productivity of that particular piece of paddy field is improved by 50%.

- **Labour productivity**: If a tailor takes 'X' hours to stitch a shirt where as another skilled tailor takes only half of that then the productivity of the former is only 50%.
- **Material**: If an ordinary tailor produces 'X' number of shirts from a particular size of cloth piece whereas another experienced tailor can produce 1.2 times 'X' number of shirts from the same piece of cloth then the productivity of the experience tailor is 1.2 times that of the ordinary tailor.
- **Machining**: Normal output from a machine tool is 10 pieces per hour and after reconditioning of the machine if the output can be increased to 12 pieces per hour by increasing the machining parameters, then it can be stated that the productivity of the machine is improved 20%. Similarly in a punching machine, if in place of producing 9 pieces from a sheet of material, using CAD if 12 pieces can be punched out then it can be stated that productivity has been increased 33%.
- **Process Planning**: If the output can be increased through using a better process plan, say more than one piece being machined simultaneously using a fixture or suggesting alternative raw material to produce more than one finished component in a cycle, then we can state that the productivity is improved based on the increased output.
- **Construction**: At a construction site where contract workers are employed, where wage rate is different for different workers, ratio of the output produced by the worker to the wages he is given represents the productivity.

$$\text{Worker Productivity} = \frac{Value\ of\ the\ output\ produced\ during\ a\ specified\ period}{Wages\ given\ for\ the\ specified\ period} \qquad (1)$$

- **Capital productivity**: It is the ratio of output to the capital employed.

The five most widely used productivity concepts are

1. Labour productivity, based on gross output. This productivity measurement traces the labour requirement per unit of output. It reflects the change in the input coefficient of labour by industry and is useful for the analysis of specific industry labour requirements. Its main advantage as a productivity measure is its ease of measurement and readability; particularly, the gross output measure requires only price indices on gross output. However, since labour productivity is a partial productivity measure, output typically reflects the joint influence of many different factors.

2. Labour productivity, based on value-added. Value-added based labor productivity is useful for the analysis of micro-macro links, such as an individual industry"s contribution to economy-wide labour productivity and economic growth. From a policy perspective, it is

important as a reference statistic in wage bargaining. Its main advantage as a productivity measure is its ease of measurement and readability, though it does require price indices on intermediate inputs, as well as to gross output data. In addition to its limitations as a partial productivity measure, value-added labour productivity have several theoretical and practical drawbacks including the potential for double counting production of benefits and double deflation.

3. Capital-labour MFP, based on value-added. This productivity measurement is useful for the analysis of micro-macro links, such as the industry contribution to economy-wide MFP growth and living standards, as well as, for analysis of structural change. Its main advantage as a productivity measure is the ease of aggregation across industries. The data for this measurement is also directly available from national accounts. The main drawback to the value-added based capital-labour MFP is that it is not a good measure of technology shifts at the industry or firm level. It also suffers the disadvantage of other value-added measures that have been double deflated with a fixed weight Laspeyres quantity index.

4. Capital productivity, based on value-added. Changes in capital productivity denote the degree to which output growth can be achieved with lower welfare costs in the form of foregone consumption. Its main advantage as a productivity measure is its ease of readability but capital productivity suffers the same limitations as other partial productivity measurements.

Fig. 1 Anticipated Value Drivers from Digital Manufacturing Technology Implementations

1.2 Factors that affect in general all

Lack of material, Delay in arrival of materials , Unclear instruction to laborer, Labour strikes, Financial difficulties of the owner, High absenteeism of labor's, No supervision method, Supervisors absenteeism, Lack of equipment and design changes, There is no definite schedule, Poor management, Unproductive time (internal delay, extra break, waiting & relaxation), Lack of skill, Supervision delay, Lack of tools & equipment, Poor instructions, Poor quality of labour, Supervision factor, Material factor, Execution plan factor, Health & safety factors, Labour shortages, Working time factor, Accidents, Organization factors, Improper training, Bad weather, Use of alcohol & drug.

2. Literature Review

MOST presents an alleviation of the tediousness of analysis and reduces the work load of handling a large amount of data while other MTM techniques still suffer from the same problems (Ma et al. 2010, Yadav 2013). Since its introduction in time study analysis, the implementation of MOST in different industries proved its significant contribution to enhance the productivity. 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. Similarly, Gupta and Chandrawat (2012) applied the basic MOST in a small Indian industry. Their work also shows a possible and significant improvement in the productivity. MOST can also be used in combination with some other techniques for a particular purpose. Jiao and Tseng (1999) used MOST together with Cost-related Design Features (CDFs) approach to determine the product cost in electronics manufacturing company. To standardize the process of manufacturing inside two companies, Jamil et al. (2013) integrated MOST with the Ergonomics study, this integration helps to simultaneously optimize the standard times of the process activities and reduce the fatigue of the workers. As a result, the workforces gained a better condition while performing their activities and the rate of productivity also increased. Because of its universality, relatively and ease of use, nowadays, as stated by Gupta and Chandrawat (2012), MOST is used in almost every domain wherein a defined working method exists. In addition, the capability of proceeding with MOST becomes easier, faster and more reliable through computerization of data collection and the analysis procedure. For instance, the work conducted by Cohen et al. (1998) in which the authors developed an automatic speech recognition system, to be implemented with MOST procedures. Through a case study, the authors have shown the usefulness of this system named Talk MOST and how it can present as a great tool that reduce the analysis time and ease the establishment of time standards. In this paper, an assembly line of an automotive company is taken under consideration with the aim of identifying and minimizing the bottlenecks, and improving the productivity by standardizing the work method and time, maximizing the utilization of resources as well as changing the conventional tools. To do so, the MOST technique is implemented for increasing the productivity by identifying the bottlenecks, standard times and NVA activities of the production line. However, due to the suggestion of replacing the conventional resources with the advanced ones, the economic viability of the proposed investment cost also assessed in terms of monthly profit.

3. Need for study

(i) Need for enabling employees to do the work in a more effective way, to reduce learning time, reduce supervision time, reduce waste and spoilage of raw material and produce quality goods and develop their potential.

(ii) Need for reducing grievances and minimizing accident rates.

(iii) Need for maintaining the validity of an organization as a whole and raising the morale of its employees.

4. Research Methodology

Meanwhile, the changes in layout of the different workstations and processing areas are also expected to help improve the scenario in the context of travel distance of operators, avoidance of interruptions in the paths of operators, material or equipment handling, organization of tools and WIP storage areas as well as the smoother delivery of materials from one station to another.

However, in these contexts, the proper work measurement techniques can play a vital role by balancing and increasing the production rate of the studied line through the identification and elimination of the bottlenecks.

5. Result and Discussion

As the improvement to be brought by implementing the suggestions needs investment, it is necessary to assess and justify the proposed modifications from two different perspectives:

(a) The increment of production rate

(b) The amount of investment.

5.1 Asses the increment of production rate

To visualize the improvement in production rate, MOST analysis has been carried out again based on the proposed modifications in the assembly operations. Inside work station-1, based on the proposed modifications, the MOST analysis have shown a total time of 560 TMU has been reduced for the elemental activities 3, 5, 6, and 7 as shown by Table 1. A comparative scenario is evident in Figure 1 for eight activities to be performed workstation. Similarly, for work station 2, it is found from the MOST analysis, a total time of 3260 TMU is possible to be reduced for the activities 3, 4, 5, and 6. On the other hand, the MOST analysis also shows that an approximate total time of 2106 TMU for workstation 3 and 3010 TMU for workstation 4 are possible to be reduced.

Table 1: Elemental task times as estimated for the proposed W/S- 1

No	Elemental Activities	TMU (Current)	TMU (proposed)	Min (proposed)
1	Loosening Mainframe Screw (4 screws)	2200	2200	1.45
2	Place mainframe to work	2650	2650	1.75
3	Sealant Frame	430	370	0.24
4	Channel Rubber Preparation	27	27	0.02
5	Assemble C/Rubber to	910	690	0.46
6	Assemble C/Rubber to	1270	1130	0.75
7	Assemble L/Frame to	1750	1610	1.06
8	Refill Soap Water	28	28	0.02
9	Refill Silicon	86	86	0.06

To assess the improvement in production rate, the take time of the considered assembly line is determined by dividing the total available time with the customer demand. The total available time for production is obtained by deducting the fixed loss from the total working time per day. The fixed loss consists of meal break, allowable downtime, briefing time and cleaning time. Necessary information for calculating the take time is given in Table 1.

Table 2: Information available to work out the take time

Total working	**Fixed loss**	**Available working**	**Total activity**	**Highest operation**	**Daily required**
9.5 hours	1 hour	8.5 hours	25 minutes	7.3 minutes	66 units

$$\textbf{Task time} = \frac{\textbf{Available working time}}{\textbf{Daily required quantity}} = \frac{\textbf{8.5 hours}}{\textbf{66 pieces}} = \textbf{0.13 hr/pc} = \textbf{7.8 min/pc}$$

However, a comparative scenario of overall improvement among the workstations that are achieved by implementing the proposed changes is illustrated in Table 1. By observing of the Table 2, the significance of the proposed changes over the current practice can be realized. The maximum work station time in the current practice is 9.465 minutes which is longer than the task time, whereas the maximum work station time calculated for the proposed modifications is 7.30 min. As the calculated task time for the assembly line is as 7.8 minutes per piece, the customer demand of 66 pieces per day cannot be entertained by the current practice. However, by bringing the proposed changes in assembly lines it is possible to satisfy the demand on time as well as increase the productivity.

5.2 Economic validation of investment

By implementing the proposed ideas, it is likely to bring in more benefits to the company as it cuts the processing time leading to lower the production costs. The processing times for certain assembly operations are estimated by using MOST technique. It is found that some of the operations can be performed within reduced times by incorporating certain tools. As shown in the Table 2, though some investment is necessary to facilitate those resources, the overall production costs are deemed to be lower compared to that of the current level.

5.4 Scope of improvement

For bringing the competitive advantages, attempt is to be made first to reduce the cycle time through incorporation of positive changes within the bottleneck work station. Since work station 2 requires 9.465 minutes to complete all the elementary tasks, it is necessary to reduce this cycle time to a level of the operation having the second longest cycle time (8.748 minutes). As the bottleneck is a dynamic situation, after lowering the cycle time of work station 2 to the level of latter operation, effort can be made to address both the assembly operations for effective reduction in cycle time and so on. By applying the MOST technique, process flow, working procedure (also called standard operation procedure (SOP)) and layout of the plant, it can be easily identified that the work station cycle time can possibly be reduced by modifying the working method and replacing the manual tools as the operators are facing difficulties mostly in performing manual activities, such as fastening and loosening of screws. Hence to increase the productivity, it is necessary for the company to provide the operator with advanced hand tools. The use of these hand tools would not only make the process faster, but also it requires a reduced amount of effort from the operators. As a result, fatigue experienced by the operator would be delayed and enabling them to work for longer hours consistently in terms of quality and rate of production. As presented in Table 7, the current working conditions can be improved by adopting alternative ways of doing the tasks or by using additional tools such as screwdriver and air pressure pump etc.

Apart from the above proposed actions, it is also proposed that the 'Leak test' which is currently done in work station 4 can be transferred to work station 3 to readjust the work station cycle time for betterment of the process flow. However, the unloading of tested rear window is to remain within workstation 4. This modification is expected to lead to a balanced production line with four assembly operations at their respective workstations.

Conclusion

In this research, a possible way of improving the productivity of undertaken by an auto company is presented. The result shows that by replacing some working tools and modifying the methods, it is possible to bring the competitive advantages in terms of satisfying the customer demand, well balancing the process flow as well as ensuring the economic benefits. Thus the incorporation of the MOST to estimate the standard times for various elemental tasks involved in different operations, inclusion of simple tools and jigs to perform a task in shorter time with minimum effort from operators and maneuvering the distribution of activities in different workstations to balance production lines can substantially improve the productivity of an industry from the current level. In future, a research study with the application of the MOST can be explored from a wider perspective through implementation in a single or mixed model assembly lines having large number of work stations.

For an organization to progress, it is very important to identify and understand various factors that influence the growth of the organization. Productivity of workers is the most important factor among them. Every organization shall have a special eye to monitor this performance factor. This study was concerned with identifying the significant factors concerning the same.

Study was conducted in six factories located in different states in the country manufacturing different types of equipment's like rail coaches, lathes, milling machines, machining centres, special purpose machines, grinding machines, defense equipment etc. Therefore it is believed that the findings of the study also represent the population of manufacturing industries as a whole.

The findings of this study revealed that

- There are 16 significant factors affecting the workers' productivity.
- Based on the criticality of these factors, the same can be classified in to different groups.
- Delay in ensuring the availability of right material in right time is the most significant factor affecting the productivity of workers in manufacturing industries.
- Highest proportion of idle time occurring in an organization is due to the fact that labour is available for production but is not engaged in active production due to shortage of material.

Reference

[2] Global Scenario of Automation in Garment Industry; http://fashion2apparel.blogspot.com/2018/02/automation-gar ment-industry.html.

[2] Md. Monirul Islam (Rajib), ATM Adnan (2016). Improving Ready-Made Garment Productivity by Changing Worker Attitude. European Scientific Journal, vol.12, No.4 ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431.

[3] Dhanashree Rajput, Madhuri Kakde, Pranjali Chandurkar, P. P. Raichurkar. Enhancing Efficiency and Productivity of Garment Industry by Using Different Techniques. International Journal on Textile Engineering and Processes Vol. 4, Issue 1.

[4] Dheeraj Nimawat and Ashish Shrivastava, Increasing Productivity through Automation. European Journal of Advances in Engineering and Technology, 2016, 3(2): 45-47, ISSN: 2394 - 658X.

[5] Belokar, R. M., Dhull, Y., Nain, S., and Nain, S., 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, 2012.

[6] Cohen, Y., Bidanda, B., and Billo, R. E., Accelerating the generation of work measurement standards through automatic speech recognition: a laboratory study, International journal of production research, vol.36, no.10, pp.2701-2715, 1998.

[7] Genaidy, A. M., Mital, A., and Obeidat, M., The validity of predetermined motion time systems in setting production standards for industrial tasks, International Journal of Industrial Ergonomics, vol.3, no.3, pp.249-263,1989.

[8] Genaidy, A. M., Agrawal, A., and Mital, A., Computerized predetermined motion-time systems in manufacturing industries, Computers & Industrial Engineering, vol.18, no.4, pp.571-584,1990.

[9] Gupta, M. P. K., and Chandrawat, M. S. S., 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 ,2012.

[10] Jamil, M. G., Saxena, A., and Mr Vivek Agnihotri, M., 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, 2013.

[11] Jiao, J., and Tseng, M. M., A pragmatic approach to product costing based on standard time estimation, International Journal of Operations & Production Management, vol.19, no.7, pp.738-755, 1999.

[12] Ma, L., Zhang, W., Fu, H., Guo, Y., Chablat, D., Bennis, F., and Fugiwara, N., A framework for interactive work design based on motion tracking, simulation, and analysis, Human Factors and Ergonomics in Manufacturing & Service Industries, vol.20, no.4, pp.339-352, 2010.

[13] Yadav T.K., 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, 2013.