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Assessment of Productivity at Drilling Workstation – A Methodology

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ABSTRACT
This is an approach for formulation of productivity assessment in the process of tractor trolley axle drilling. The productivity assessment is helpful in calculating the productivity and positive - negative findings of various factors that are carried out during axle drilling process. The assessment through direct observations (DO) and methodology is proposed for the process of tractor trolley axle drilling in MIDC Wardha. This productivity assessment leads in improving the performance of system by suggesting or modifying the inputs for improving output. The complete assessment of productivity in axle drilling process is main objective of this paper.
Keywords : Axle Drilling, Formulation of Productivity, Man-Machine System, Productivity, Productivity Assessment.

I. INTRODUCTION

Productivity is a vital indicator of economic performance of an economic system. Productivity is not an end in itself. In fact, it is a mechanism for improving the material quality of life. Productivity is fundamental to progress throughout the world. It is at the heart of economic growth and development, improvements in standards of living and quality of life [10].

The process of axle drilling in MIDC Wardha is a man-machine system. The tractor trolley axle drilling process which is considered for study is a complex phenomenon. The productivity assessment through direct observations (DO), interventions and follow-up studies is undertaken for the process of tractor trolley axle drilling at MIDC Wardha and the assessment methodology is proposed for determining the productivity. This assessment will prove helpful in suggesting or modifying the inputs which in turn will lead in increasing the output (productivity).

1.2 TRACTOR AXLE DRILLING PROCESS

Enterprise selected for study is a medium scale industry in Sevagram MIDC at Wardha in Maharashtra. The industry is involved in axle drilling for various types of tractors.. Drilling process of axle is targeted for Mahindra tractor as it is having the highest production rate as its requirement is more. Fig1 shows the block diagram of tractor axle machining process.

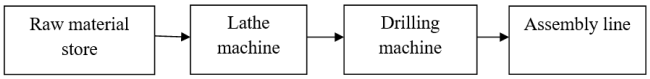

Fig1: Block Diagram of Tractor Axle machining Process

II. LITERATURE REVIEW

Case study research was conducted with a view to assess the impact of five factors such as man, machine, material, money, and safety on productivity. Total Productivity Model (TPM) has been used as the

theoretical base of the research model. Skilled workers, improper utilization of materials, inefficient inventory control, ineffective safety package etc., are identified as critical obstacles to productivity improvement, M. M. A. Khan et.al. Many firms, especially from manufacturing industries, find it difficult to measure their service productivity and as a consequence, they have troubles in applying the right measures to improve it. This is especially true for those services that are knowledge intensive and therefore hard to standardize, Flavius Sturm et.al. The increased productivity due to an improved indoor climate is at least 10 to 100 times greater than the operational and maintenance costs, R. Kosonen et.al. Subjective assessment (through questionnaire), direct observation method, and archival data leads in improving productivity and quality, increasing revenue and reducing rejection cost of the manual component insertion (MCI) lines in a printed circuit assembly (PCA) factory, Paul H.P. Yeow et.al. Productivity is a measure of the rate at which outputs of goods and services are produced per unit of input (labour, capital, raw materials, etc), Dean Parham. Responding to competitive pressures and financial realities long familiar to other functional managers and academics, corporate shareholders, senior managers, and the Marketing Science Institute had identified marketing metrics and marketing performance measures as top research priorities, Neil A. Morgan et.al. Direct observation assessment showed that physical and biological degradations were more severe than chemical degradation in all the land uses, B. A. Senjobi et.al. The Productivity Assessment tool identifies 6 key performance measures that many successful companies balance in their quest for benchmark productivity improvements. Each tab contains a handful of key questions that will enable participants to better understand where they stand versus common focus areas and the current best practices of high performance productivity leaders, Dustin Smith et.al.

1.4 AIM

Assessment of productivity of axle drilling process of a tractor-trolley.

1.5 OBJECTIVES

1. To calculate the productivity.
2. To predict the breakeven point.
3. To estimate the profit of organization.
4. To define the wages of workers.
5. For positive and negative findings in production process.
6. Guide to management.

III. MATERIALS AND METHODS

Productivity

Productivity is a measure of the rate at which outputs of goods and services are produced per unit of input (labour, capital, raw materials, etc). It is calculated as the ratio of the amount of outputs produced to some measure of the amount of inputs used.

Productivity measures are used at the level of firms, industries and entire economies. Depending on the context and the selection of input and output measures, productivity calculations can have different interpretations.

Improving productivity means economizing on the use of inputs — for example, adopting efficient production processes that minimize waste. Equally, improving productivity means yielding more output — for example, using resources in activities or with technologies that generate more output [6].

1.6.2 Types / Measurement of productivity

1) Partial Productivity = total output / individual input
   a) Labour productivity = total labour output / labour input (hrs)
      (Number of employees or hours of work)
   b) Capital productivity = total output / capital input
      (Buildings, machinery and equipment, etc)
   c) Material productivity = total output / material input
   d) Energy productivity = total output / energy input
2) Total productivity measure (TPM) = total tangible output / total tangible input
3) Total factor productivity measure (TFP) = net output / (labour + capital input) [14].

IV. PRODUCTIVITY ASSESSMENT

Productivity assessment is an evaluation technique which includes various steps for complete evaluation, analysis, and calculations of productivity. It also helps in positive and negative findings in production process. Interventions and follow-up studies are later carried out for productivity solutions to increase the productivity (output) and performance [2].

Types / Process / Methods involved in Productivity Assessment

The methods involved in productivity assessment are as follows-

1) Subjective assessment (SA):

SA is divided into two categories as follows-

a) Preliminary questionnaire:

A preliminary questionnaire is designed by a team of experts in ergonomics. It consists of questions on work sequence and arrangement, workstation design, work environment, workgroup communications, material handling and defects, reject percentage, and occupational health and safety (OHS) problems. Interviews are conducted with operators using the preliminary questionnaire to find out problems related to poor productivity and quality (P&Q), loss of revenue, and high rejection cost.

b) Finalized questionnaire:

It consists of questions related to the problems highlighted in the preliminary questionnaire. Likert's 5-point scale is used in the questionnaire to assess the level of agreement on the problems faced.

2) Other methods:

The problems with higher ratings were investigated through direct observations (DO) of the production lines and with the use of archival operation records and customer feedback data. To investigate some cases, live experiments are conducted. DO is done using videotape recordings.

3) Interventions and follow-up studies:

Root-causes are found and appropriate interventions are made to overcome the problems. The interventions are implemented separately for each of the problems to ensure a clear relationship between the cause and effect, i.e. between each intervention and its effects on the problem [4].

V. METHODOLOGY

The productivity assessment of axle drilling process of a tractor trolley is done through a direct observation (DO). The DO of the axle drilling process is done using videotape recordings. A video camera was used to record operator's work in the drill line. A half-hour recording was made of each of the operators. The videotape recordings were analyzed by playing them in slow motion to investigate a particular problem (e.g. operators idling while waiting for axles, too much counting of components, insufficient time for drill, obstructions during drilling, etc.). The recordings were also played in fast motion to search for the occurrence of a particular incidence

(e.g. line stoppage, incomplete work order, trainee operators (TOS) making mistakes, etc.). Number of axles drilled per hour i.e., the productivity per hour is calculated by taking the recordings of two different operators working on axle drilling operation (using a stop watch).

Fig 2: Axle with two drill holes.

Table 1: Axles drilled per hour by operator 1 and operator 2

Description	Operator 1	Operator 2
Drill hole dia 7 mm (depth 70 mm through)	44 sec	48 sec
Drill hole dia 19 mm (depth 14 mm)	28 sec	30 sec
Time required for marking, changing speed of machine, and adjusting operator position	17 sec	21 sec
Total time	1.29 min	1.39 min
Each axle consists of 2 holes of 7 mm dia and 2 holes of 19 mm dia.	1.29 x 2 = 2.58 min	1.39 x 2 = 2.78 min
Number of axle drilled per hr	2.58/60 = 23.26 axles = 23 axles/hr	2.78/60 = 21.58 axles = 21 axles/hr

VI. DISCUSSION

In this way, we can easily determine the productivity in tractor trolley axle drilling process. Table 1 shows the complete productivity assessment. The methodology proposed shows the result in terms of axle drilled per hour by operator 1 and operator 2. Operator 1 is able to produce output by drilling 23 axles per hour and the operator 2 is able to produce output by drilling 21 axles per hour.

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