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Productivity Enhancement for Spray Painting Process of Wheel Hub

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Abstract:- Productivity is nothing but an economic measure of output per unit of input. Inputs include labour and capital, while output is typically measured in process time and revenues. The aim of the paper is to study productivity of the current production process by systematic analysis and implementation of the enhanced method to increase the productivity. For this the special purpose machine is developed to reduce the time required for the prescribed application of spray painting process with the improved accuracy of painting to the constrained area. The special purpose machine designed is advantageous for the improvement in productivity, increasing accuracy and proper utilization of manpower. Thus, the design and development of Special Purpose Machine is explained and analysed further in this report.

Keywords:- Accuracy Improvement, Fixture, Productivity, SPM, Spray Painting, Wheel Hub.

I. INTRODUCTION

Productivity Analysis is conducted to identify areas for potential productivity improvement projects based on statistical data collected during the analysis. It also pinpoints areas of delays and interruptions that cause loss of productivity.Productivity improvements in the firm generate selection and raise welfare everywhere, with both the selection effect and the positive welfare effect being stronger in the company [1].

The first step in productivity improvement initiative is to understand the current state of the operation. Productivity analysis provides baseline indicators that will also yield data which will be used to determine possible productivity improvement objectives and potential cost savings.

One of the major causes of company's decline is low productivity. Failure to meet targeted productivity can result to higher cost per unit and making your good, services and commodities not competitive enough on the market. Thus machine analysis is discussed further in paper as it is one of the important ways of productivity analysis.

It is required to develop the machine for rotating wheel hub at about 30 to 35 rpm. It should run with minimum friction. The overall cost viz. initial and running cost of machine must be as low as possible with maximum accuracy and precision achieved. Wheel hub should be properly masked on unwanted areas in order to increase the accuracy of painting. At the same time, machine has to reduce the present operation cycle time required for manual painting.

The present method has some flaws and is quite inaccurate as well as time consuming from the quality and productivity point of view. The paper explains the steps involved in development of the new mechanism, which does not possess such kind of defects and will help to increase the productivity of the company. The new mechanism must be designed with maximum efficiency and quality as one of the important priorities, simultaneously the budget has to be taken into consideration.

II. EXPERIMENTAL SETUP AND ARRANGEMENT

The design of SPM is done in order to improve the painting process of wheel hub; by increasing accuracy of painting, decreasing human efforts and in-process time. The SPM developed consists of prime mover, fixture, coupling, bearing, masking and support.

The arrangement of SPM is explained as further. The prime mover consists of a motor and gearbox which is connected to the support rigidly [2]. The drive is transmitted from the prime mover to the fixture with the help of coupling, consisting of shaft and bush. In order to reduce friction, thrust ball bearing is used. The effect of thrust bearing is obtained by providing groove in fixture and supporting plate. The role of friction in our design is to hold and transmit the rotary motion from prime mover to the work-piece [3]. The SPM is designed and developed as per the standard prescribed method [4-6].

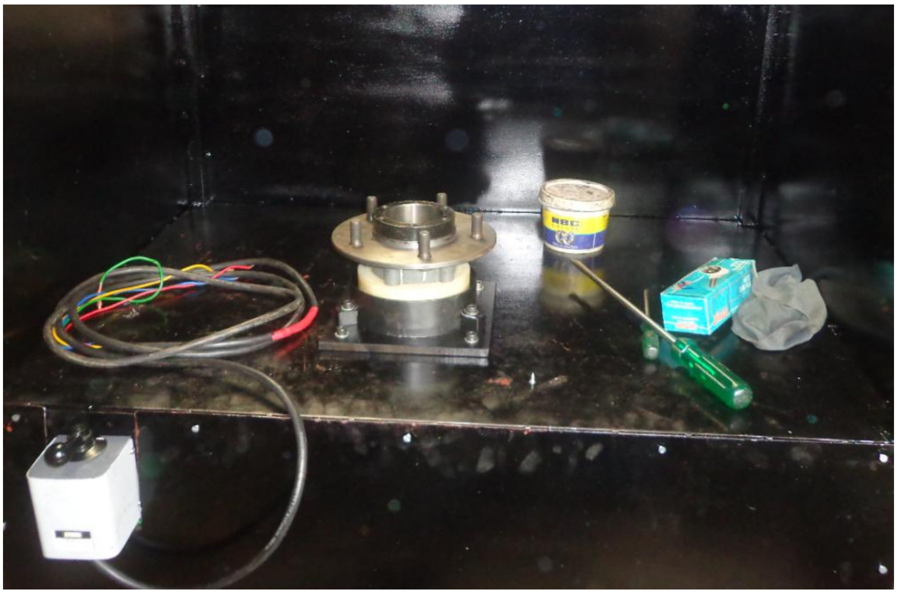

Fig.1: Experimental setup for SPM

Masking is placed over the work--piece at required areas so as to ensure accurate and constrained painting of work-piece. Further aesthetics is also a measure of concern while developing the machine. Essential parts of SPM are black-o-dised (an improved chemical composition for the production of the black oxide coatings) [7] in order to improve resistance to corrosion.

III. MATHEMATICAL MODEL FOR PRODUCTIVITY IMPROVEMENT ANALYSIS

Mathematical modelling for productivity improvement analysis can be given with the help of matrix formation.
In order to form the matrix, parameters are divided into dependent and independent as follows:
Independent Parameters – Human Efforts, Use of Manpower, Initial Cost
Dependent Parameters – Process Time, Production Rate, Overall Cost

Table I: Values Specification

Parameter	High	Moderate	Low	Very Low
Equivalent Value (x, y)	**4**	**3**	**2**	**1**

With reference to the above specific values the matrix analysis is carried out for determining the index of the matrix. This index indicates the productivity of the particular process. For finding the index of the matrix in the analysis the matrix is formulated in following different form;

Matrix of productivity:

		Dependent Parameters		
Independent Parameters		Process Time (y_1)	Production Rate (y_2)	Overall Cost (y_3)
	Human Effort (x_1)	$(x_1 \times y_1) + 1$	$(x_1 \times y_2) + 1$	$(x_1 \times y_3) + 1$
	Manpower (x_2)	$(x_2 \times y_1) + 1$	$(x_2 \times y_2) + 1$	$(x_2 \times y_3) + 1$
	Initial Cost (x_3)	$(x_3 \times y_1) + 1$	$(x_3 \times y_2) + 1$	$(x_3 \times y_3) + 1$

The process analysis is carried out for two different conditions; first analysis is with the parameters without considering the advanced modifications in the production process whereas in second the modifications are considered. The matrix A and B indicated the before and after condition of the improved production process.

Matrix A: Before Improved Process

	(4)	**(2)**	**(3)**
(3)	13	7	10
(2)	9	5	7
(1)	5	3	4

Matrix B: **After Improved Process**

	(2)	(4)	(3)
(2)	**5**	**9**	**7**
(1)	**3**	**5**	**4**
(3)	**7**	**13**	**10**

The matrix analysis is carried out for finding the index of the productivity matrix both in conditions A and B. The index determined is having values of 01 and 20 for matrix A and B respectively. This indicates that as the matrix is a function of both dependent and independent variables.

IV. RESULT AND ANALYSIS

Above matrix shows that, before implementation of modified process i.e. use of SPM, the index of matrix came out to be 1 and after implementation it is increased up to 20. Improvement in productivity is done by implementing various modifications in process cycle and special purpose machine was developed for the same. Various results obtained after the testing of SPM are tabulated as follows:

Table II: Distribution and Analysis of Process Cycle Time

	Old Time(sec)	New Time (sec)
Non-Productive Time	**9**	**11**
Lead Time	**18**	**4**
Overall Time	**27**	**15**

The results obtained are further analysed and compared with the old results in terms of graph as shown below. Thus, it can be observed that overall product cycle time is reduced by significant amount in order to improve the productivity.

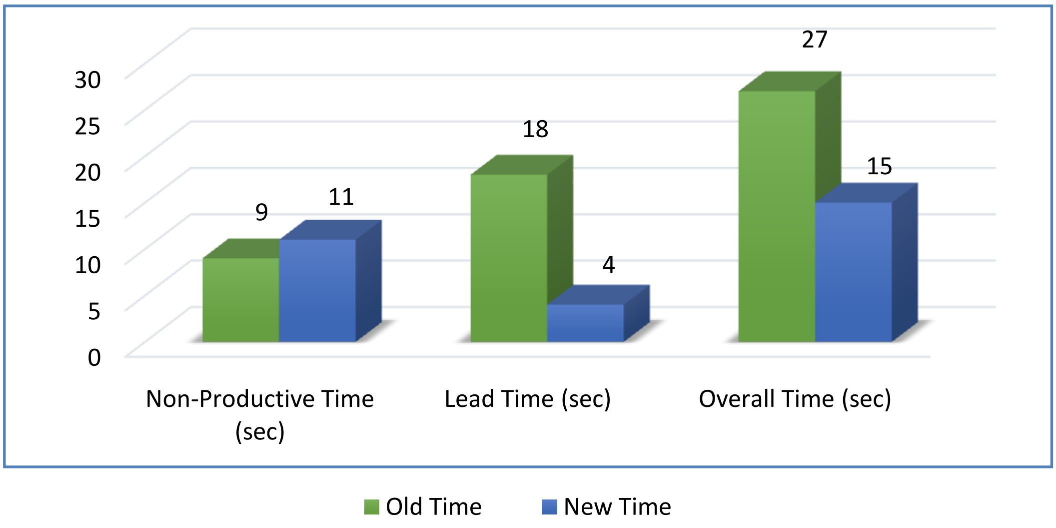

Fig. 2: Comparison of Product Cycle Time

Productivity Improvement Calculations:

Some of the assumptions made are:

No. of working hours for the process - 12 hours/day

Amount given to workers (contract basis) - 300/day

Thus,

No. of work-piece processed previously per day = (60/27) × 60 × 12 = 1600 piece.

Time taken to complete the same no. of pieces by new method = 6 hours and 40 minutes.

Time saved per day for the process = 5 hours and 20 minutes.

Hence, amount saved per worker for the completion of process per day (as per Indian standards):

= (300/12) × 5.33 = Rs. 133.25

For the period of 1 year, amount saved will be,

= 133.25 × 365 = Rs. 48,636.25

Payback Period for the machine can be given as:

= 1 × 22,928 / (48636.25/12)

SPP = 5 months and 20 days [8]

V. CONCLUSION

The index of the productivity matrix is found out by performing analysis consisting of dependant and independent variables. Substantial improvement in productivity is observed as productivity matrix index changes from 1 to 20. Hence, the use of SPM is suggested for the enhancement in productivity.

The test runs were taken to see the practical working of SPM and its feasibility, results obtained from the test were analysed and found suitable for the problem statement given and would prove profitable from users point of view as well.

It is found that the total time required by the conventional method was about 27 sec to complete the whole process whereas by use of SPM it takes only 15 sec which is roughly half of the conventional time. The reduction in process time directly refers to the improvement in productivity along with the increase in rate of production. The machine's design is comfortable for the operator to work with. At the same time, reduction in lead time is achieved successfully. One of the important things to look over in our project is the cost of machine compared to its effectiveness and also the 'Payback Period' for the user is as less as possible. 5 months and 20 days.

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