Productivity Improvement at Actuator Assembly Section Using Manual and Video Work Study Techniques

Rohini P. Tippannavar, Vinayak N. Kulkarni and V. N. Gaitonde

Abstract Work study is one of the important productivity improvement tools in industrial engineering methods and practices, through which productivity of man and machine can be improved. Work study has two main approaches, one is method study and other being time and motion study. This paper focuses on improving the productivity by minimizing the time and cost in an assembly section of an organization with the help of both manual and video work study techniques. Results of both the methods are initially analyzed and compared at the end. The existing method followed to assemble the actuators was recorded, and improved method was proposed using industrial engineering methods and practices which consumed less time and also unnecessary movements are eliminated. By adapting the proposed method, productivity improvement of 41.66% is being observed, and the time saved for assembling actuator was found to be 4 min per actuator. Video work study is found to be more accurate than conventional manual work study.

Keywords Productivity · Work study techniques · Video work study · Manual work study · Industrial engineering

1 Introduction

Work study refers to investigation of work accomplished in an organization by efficiently using the procurable resources like materials, men, machines and capital in order to minimize the time and obtain the highest possible quality of work by causing less fatigue to the labors [1]. It is the basic technique for method study and work measurement. It is systematic both in problem investigation and in obtaining

R. P. Tippannavar (✉)
Department of Industrial and Production Engineering, B V B College of Engineering and Technology, Hubballi, Karnataka, India
e-mail: rohiniprakash062@gmail.com

V. N. Kulkarni · V. N. Gaitonde
School of Mechanical Engineering, KLE Technological University, Hubballi, Karnataka, India
e-mail: vinayak33me@gmail.com

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the solution. It can be accomplished by uninterrupted analysation of work in the selected area where the activities are taking place [2]. Work study involves investigation of the work done in the organization to make the best possible use of the available resources [3]. Work study mainly focuses on simplifying the work which increases the productivity. It makes use of work measurement to evaluate the work content. Work study aims at eliminating the unnecessary time involved in the process [4]. Bon and Daim conducted a study which focuses on increasing the productivity by minimizing the costs. The results showed that the cost and time saved can be utilized further to develop the organization through different work study techniques [4]. Kulkarni et al. studied the cycle time of different work stations in an assembly unit and proposed a new better method for performing assembly operation by reducing unwanted motion involved in the operation by memo motion study [5]. Similarly, Kamble and Kulkarni suggested that the ineffective time and unwanted motions have to be observed and removed from any assembly section to improve the productivity through work study concepts [6]. Although some work has been done in the area of work study, time study and motion study in different industrial scenarios, there are very few works based on concentrated work on work study and ergonomics. Especially, the comparison between manual work study and video work study has not been concentrated in many areas of research works mentioned above. In the present study conducted, it was observed that more time was consumed to assemble an actuator due to unnecessary movement of the worker, affecting the productivity of the assembly unit. Systematic arrangements were not followed in the assembly section of an electrical actuator unit, and hence the time consumed to assemble was more. Therefore, the objective of the present study is to "study and improve the existing method of assembling electrical actuators by suggesting improved method so as to simplify the work and eliminate the inappropriate time involved in the assembling process." The following sections of the paper explain the application of manual work study technique and video work study technique for studying the existing method and proposing new method for improving the productivity of assembly unit. Video work study used in this project is one of the easiest and simplest methods for work study purpose. The results obtained through video work study are more accurate than manual work study. This method consumes less time, and hence it is an effective and quick way for improving the operations in any organization.

2 Methodology

The methodology starts from conducting structured interviews and ends with comparing the manual and video work study. The following section discusses the details of methodology adapted for this project work (Fig. 1).

The study represents the application of work study techniques to improve the productivity. During the initial field survey, the plant layout was studied. The selected industry was small and medium scale (SME) that involved the manufacturing of actuators. The problems were identified in the assembly section. It was observed that

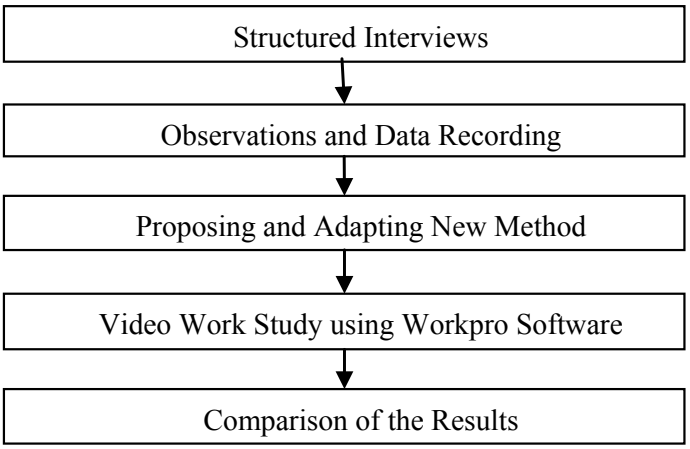

Fig. 1 Methodology

many operations were repeated which consumed lot of time. There was unnecessary movement of workers to pick the materials which also resulted in consumption of extra time. This affected the productivity of worker. Hence the further section of this paper highlights the methodology used to address the above use.

- **Structured interviews regarding the existing method**: Details of the existing method in the assembly section of the organizations were discussed with the production manager, supervisors and the workers. Several basic questions were asked during the interviews. The discussion was followed by both formal and informal sessions. The higher managers along with workers were involved in the discussions before proceeding to observation and recording section.
- **Observations and data recording of the existing method**: The existing process of assembly was observed and recorded. All the relevant data were collected to examine. A manual flow process chart of workers assembly work was drafted. The identified problems in existing method for assembling were analyzed with the help of work study techniques, i.e., method study and work study. Method study is where the production methods are improved, and work measurement where the human activities are assessed [7]. The assembly section had the fastener tray which consisted of variety of fasteners which were not sorted. It had no compartments, and hence time consumed while searching for a particular type of fastener was more. Different cylinders were all kept together near the assembly area which made the area messier. Connecting wires were all kept on the table without separating. During the final step of assembling, the tightening of nuts was made with spanner which consumed extra time. This caused fatigue to the worker since he had to bend every time as observed.
- **Proposing and adapting new method**: Considering all the circumstances of the existing method and through a detailed analysis of flow process chart of existing method, a new method for assembling the actuators has been proposed which not

only reduces the ineffective time and reduces the fatigue of the workers but also is economical. A new flow process chart was drafted where the unnecessary operations were eliminated. The fastener tray was designed with several compartments. The assembly components with stand were made accessible near the assembly section which helped eliminate the unnecessary movement of the worker. For the cylinders, a separate rack was made in a single stand and different cylinder sections were named, and the cylinders were kept in the respective racks. This made the assembly section spacious and clean. The connecting wires were stored in different bins. Instead of spanner, an air gun bush was given which made the tightening of nuts quicker, and fatigue of the worker was also reduced. The assembling time was reduced. Suggestions to vary the method of assembling steps were also given which helped to reduce the cycle time. The proposed method was presented to all the members of the organization using demonstrations.

- **Video work study using WorkPro software**: Video work study involves the use of video to study the selected work. During manual work study, there are many situations which are difficult to observe because of the high-speed activities or complexity of the operation, and to avoid those situations, video work study is adapted [8]. In this study, the video work study was done at the assembly section which involved a lot of hand motions and movement of the worker. Video work study was carried out for both existing and proposed methods. The equipments used for this study were Nikon L-120 camera and a tripod stand. The tripod was placed at the right place with the camera, and the video was taken. The video was later extracted for the analysis. The analysis of the video was done by the WorkPro software. Video work study which is profitable is one of the easiest and simplest methods for work study purpose. This method consumes less time to give the results, and hence it is an effective and quick way for improving the operations in any organization. It uses multi-media and database technologies to do the Video Time Study (VTS) and Video Method Study (VMS) which are helpful in manufacturing and allied sectors to set the new records.
- **Comparison of the results between manual and video work study**: After the results are obtained from the software, a comparison is made with the manual work study results. It also compares activity between machines and workers hence providing accurate results. There are many in detail and in depth analysis that can be obtained through video work study.

3 Data Analysis and Results

Analyzing data is important to obtain the desired results. Based on the data collected, the analysis is carried out. Manual work study data was obtained using stopwatch and paper. A flow process chart was plotted based on the data collected. Video work study gives the flow process chart, standard time and delay analysis charts through WorkPro software. The comparison of manual work study of existing and proposed

Table 1 Comparison of existing and proposed methods of manual method

Activity	Existing (s)	Proposed (s)	Savings (s)
Operation	321.7	209.7	112
Inspection	26.04	29.57	−3.53
Transportation	228.6	62.12	166.48
Delay	5.97	9.89	−3.92
Total	582.31	311.28	271.03

Table 2 Comparison of existing and proposed methods of video work study method

Activity	Existing (s)	Proposed (s)	Savings (s)
Operation	330.32	209.94	120.38
Inspection	29.12	29.271	−0.15
Transportation	178.64	61.051	117.58
Delay	6.02	9.82	−3.8
Total	544.100	310.082	234.018

Table 3 Comparison of manual and video work study

Work study type	Existing (s)	Proposed (s)	Savings (s)
Manual work study	582.31	311.28	271.03
Video work study	544.100	310.082	234.018

methods is as shown in Table 1. The comparison of manual and video work study is shown in Table 2.

From Table 1, it is seen that the work study is analyzed in the form of operation, inspection, transportation and delay activities. It can be observed that the transportation consumes 228.6 s because of improper work layout. Operations consume 321.7 s since there are many unnecessary movements involved. Table 2 shows the analysis of video work study where the time consumed is more accurately obtained. In Table 3, it is seen that by implementing the suggested method, the overall time to assemble the actuator is reduced to 311.28 s from 528.31 s. Hence 271.03 s of time is saved. From Table 2, it is seen that the assembly time in video work study for existing method is 544.100 s, whereas for proposed, it consumed 310.082 s by saving 234.018 s of time.

3.1 Video Work Study for Existing Method

See Figs. 2, 3 and 4.

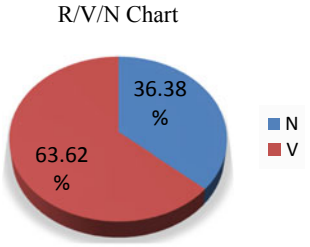

Fig. 2 R/V/N chart for existing method

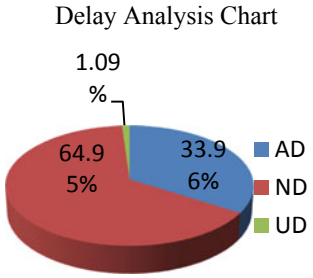

Fig. 3 Delay analysis chart for existing method

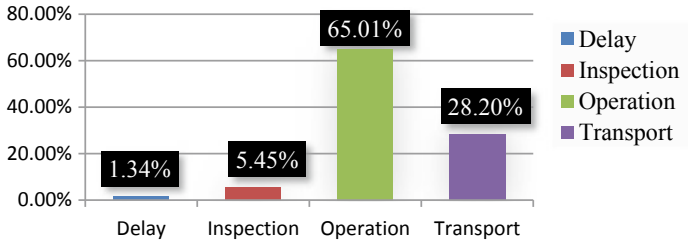

Fig. 4 Flow analysis chart for existing method

3.2 Video Work Study for Proposed Method

Figure 2 is the R/V/N chart of existing method where R stands for required non-value added time. V stands for value added time which is 63.62% and N stands for non-value added time which is 36.38%. Figure 3 represents the delays involved during the assembly process. The avoidable delay (A) occurred is 33.96%, no delay (ND) occurred is 64.95% and unavoidable delay (UD) occurred is 1.09%. Figure 4 represents the flow analysis chart where the time consumed by various activities is recorded. In the existing method, the transportation involved is 28.20%. Figure 5 represents the R/V/N chart of proposed method where the value added time is improved

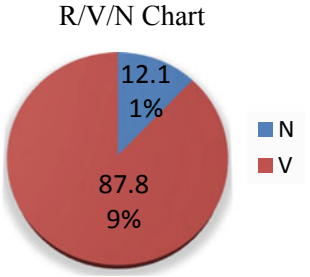

Fig. 5 R/V/N chart for proposed method

to 87.89%, and non-value added time is reduced to 12.11%. Figure 6 represents the delay analysis chart of proposed chart where the avoidable delay (AD) is 39.64%, no delay (ND) is 58.02% and unavoidable delay (UD) is 2.34%. In Fig. 7, the flow analysis chart of proposed method shows the transportation is reduced to 19.92%.

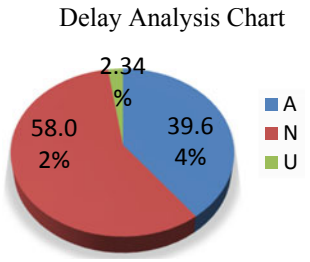

Fig. 6 Delay analysis chart for proposed method

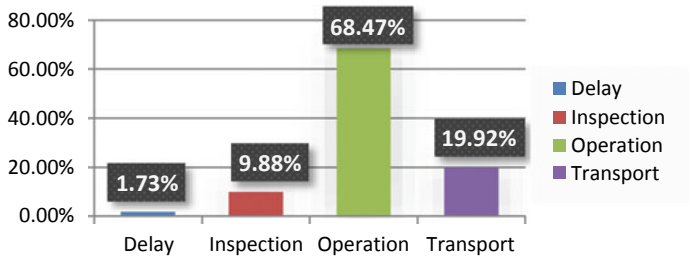

Fig. 7 Flow analysis chart for proposed method

4 Conclusions

Elimination of unnecessary time was possible by proposing new method. Reduction of unnecessary movements was observed by rearranging the assembly layout and also by designing of fastener tray with different compartments, storage bins for different wires, and the working area was rearranged by systematically placing the cylinders in the shelf. By adapting the proposed new method, the inappropriate or any repeated operations were eliminated which resulted in saving time. Productivity improvement of 41.66% was seen. Therefore, it can be observed that a good profit can be obtained to the organization by using the work study techniques as the productivity of the labor increases. Also, work layout changes make worker more comfortable while working on assembly section. After the comparison of existing method and proposed method was made, it was observed that the time taken to assemble one eight-inch actuator per day was 9.7 min in existing method and was reduced to 5.7 min. The actuators assembled per day by per worker were increased from 24 actuators to 34 actuators. Hence the productivity of actuators per day with two workers was observed from 48 actuators to 68 actuators. From the obtained data, it was found that the profit from one model of eight-inch actuator is Rs. 240. Productivity improvement per day has increased to 68 actuators from 48 actuators. Hence the total profit per day for the improved productivity is 20 * 240 = Rs. 4800 per day. If the proposed method is adopted, then the profit for the company can go up to Rs. 14,40,000 per year (considering 25 days working per month). After adapting the proposed method, increased efficiency in productivity was observed which helped in enhancing the industry's profitability.

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