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Productivity improvement by work and time study technique for earth energy-glass manufacturing company

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Abstract

Production and trade growth opportunities brought about by globalization and increased competition, productivity growth requires in business. Sources declined with each passing day, constantly increasing needs. This in turn increases the need for businesses to use resources more efficiently. Work and time study techniques is raising the efficiency of utilization of the factors of production have been used for all manufacturing and service sectors as a scientific approach. In the content of study a firm that produces tea glass is analysed in terms work/time during the process of model production. In order to measure efficiency of tea glass models, time survey is made and by the help of that method standardized time is calculated. Actual time and standardized time is compared and as a result it is aimed that measuring inevitable times and take necessary precautions against them. As a result of the study, waiting time cause inefficiency in the work of molder and in the content of work/time, efficiency is increased 53 percent and model production capacity is reached at 237.

1. Introduction

Productivity may be defined as follows:

$$Productivity = \frac{Output}{Input}$$

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This definition applies in an enterprise, a sector of economic activity or the economy as a whole. The term "productivity" can be used to assess or measure the extent to which a certain output can be extracted from a given input (Kanawaty, 1992). Productivity has been generally defined as the ratio of an extent of output to the unit of all of the resources used to produce this output.

Operational efficiency is used as an indicator that reveals the level of effectiveness in using production resources such as raw materials and supplies, manpower, land, building, machine, equipments and energy. As is known, the production process uses other production inputs besides manpower. Hence, knowing efficiency levels of other inputs, which determines relationship between these inputs and production, as well as manpower, and observing trends of these inputs under various conditions and replacing one or several of these inputs by changing their qualities and quantities enable businesses to achieve the maximum level of production through the optimum input combination (Dogan, 1989).The economic growth of a country is usually measured by its increase in production or the gross domestic product (GDP), which comes from two sources: a larger quantity of production factors used (inputs) and/or an increase in productivity. Productivity is therefore considered to be a component of growth (Galarneau and Dumas, 1993).

Work study then aims at examining the way an activity is being carried out, simplifying or modifying the method of operation to reduce unnecessary or excess work, or the wasteful use of resources and setting up a time standard for performing that activity. The relation between productivity and work studies thus obvious. If work study results in cutting down the time of performing a certain activity by 20 per cent, merely as a result of rearranging the sequence or simplifying the method of operation and without additional expenditure, then productivity will go up by a corresponding value, that is by 20 per cent. To appreciate how work study acts to cut down costs and reduce the time of a certain activity, it is necessary to examine more closely what that time consists of (Kanawaty, 1992). Work study can be divided into method study and work measurement. It is used to systematically study and improve human working methods by considering all factors that affect the working efficiency and conditions. After the job of interest has been selected, time study can be examined by 1) recording all information about the job, 2) breaking the job down into elements, 3) examining those elements and determining the sample size, 4) recording the time to perform each element using a stop-watch, 5) assessing the speed of working, 6) converting the observed time to basic time, 7) determining the allowances, and 8) determining the standard time (Pisuchpen and Chansangar, 2014).

Work Study is the generic name of methods study and work measurement. It was the most important basis technique in industry engineering, which was developed on the basis of action study of Gilberth and time study of Taylor. The most obvious character is using less investment or no investment to increase the production efficiency and benefit, reduce the cost and to strengthen the competition ability through improving the operating process and method, implementing the advanced and reasonable working quota, fully utilizing the human resources, material resources and financial resources inner the enterprise. Work study includes method study and work measurement. Method study mainly on searching efficiency working method, whereas work measurement is to determine the scientific and reasonable working time quota of each operating (Lan, et al., 2009). Work Study is the systematic methodology of carrying out different yet related activities such as to improve the efficient use of resources and to set up standards of performance & quality for the activities to be carried out. Work Study generally is classified in two areas: Method study (Motion study) and Time study (Work measurement) (Kulkarni, et al., 2014). Method study is essentially concerned with finding better ways of doing things. It adds value and increases the efficiency by eliminating unnecessary operations, avoidable delays and other forms of waste.

When aspects of time study contains a wide diversity of procedures to determine the amount of time required, under an excellent measurement of the state, for work associated with the human, machine, or a combination of both. It is has been introduced by Frederick W. Taylor since the year 1881, but is still widely used as a method of time study. Generally, time study is used to measure work. The decision results than the time study is the period in which a person in accordance with a job or task and fully trained to use specific method, will perform this task if the worker in the normal or expert. This is called the time standard for operation. Align the expert for a work may be made through several methods, where each method is used only in accordance with some specific circumstances. Time study is include using stopwatch, "Predetermined Motion Time System or Synthetic Time System", and "Work or Activity Sampling". However, in this study, only the time study using Stopwatch Time Study will be used in the time measurement. The time study was also allowed to deduct all boarders. Standardization is the objective to be achieved. In organizations that operate without expert time, 60% than the normal organization of achievement. These statistics may be proved by the work sampling operation. If standard set, performance improved to average

85%. This is a 42% increase in performance (Bon and Daim, 2010).

2. Application

2.1. Production Capacity of the Firm and Problem Statement

Toprak Energy – Glass Factory has 2 production lines operated with recuperative type furnace having 22 m^2 glass melting capacity. Both production lines use Blower-Blower T28 machines for shaping the glass and the cutting process takes place automatically only on 1 line. The factory produces glass tea cups. Figure 1.illustrates the general layout plan of production lines.
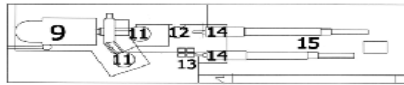
9. Furnace
11. Glass Shaping
12. Cutting Glass
13. Manual cutting
14. Annealing
15.Collecting and packing

Figure 1.Toprak Energy – Glass Factory Layout Plan

This study's purpose is to determine whether or not the molds used for producing glass cups comply with efficiency principles. Accordingly, our goal is to compare standard time which can be achieved through "time study" with actual process times and thus to determine avoidable insufficient periods and to state measures to be taken for preventing these periods.

2.2. Research Method

Observational method is used to collect data for the research. Times observed for designated work cycles and work elements are measured using electronic chronometer and the results are recorded on "preliminary study form" along with the times anticipated for each process element. After completing the timing process, the study results are assessed; the times measured are specified and the times measured are multiplied with ratings to determine the "base periods". "Representative period" is determined on the basis of base periods and "standard time" is calculated by adding these to the shares. The selection of workers to be subject to time study is based on one-on-one interviews with the factory manager and shift manager. The manager and shift engineer are asked to suggest accomplished workers who work at a balanced and average pace and the workers to participate to the timing study are selected accordingly.

2.3. Research Assumptions

The following assumptions are considered while conducting the study and assessing the results:
- The number of observations determined represents the universe.
- The rating is accurate and valid.
- The times measured with chronometer are accurate and valid.

2.4. Research Limitations

Calculating base period is one of the crucial steps in achieving the standard time values and ratings are used for calculating the base period. The ratings of an element are given instantly during observation. The rating process is the step of study that requires extensive experience. The most important limitation on this research is "the difficulty in immediately determining which work pace is standard and which is below or above standard pace". Another limitation is the workers who know they are being observed; they sometimes tend to work slower than their actual performance.

2.5. Application of Time Study

The first step of time study to be performed for mold preparation process at glass tea cup production factory is to select the work process to be studied. The process to be primarily studied is the process of preparing molds used for manufacturing tea glasses of various sizes. Hence, "mold preparation process" is chosen as the process to be studied

in order to improve productivity. Then, the designated mold preparation process is divided into work elements. Basically, the mold preparation process is consisted of 10 repetitive steps. However, the time study based calculations on 7-step process. The changes on the first ten steps shall have impact on improved productivity. All steps are considered as MDS (Machine Check Time); in other words, machines and workers work together at all steps. The progress of these steps is as follows;

1. The process starts by removing worn tea glass molds from machines and bringing them into the molding room. Especially the top sections of molds are worn, the glass contacts with metal surface causing too many neck cracks.
2. Worn molds are cleaned before applying wax polish. The caustic (sodium hydroxide) cleaning water is at 90°C. Wax polishes on the molds are dissolved by boiling the molds in caustic water for 30 minutes.
3. The molds kept in caustic water for 30 minutes are then washed with cold water until all cork residues are cleaned.
4. The washed molds are air-dried.
5. Linseed oil composition is consisted of 3 components; thin linseed oil, thick linseed oil and graphite. The mixture ratios are 400 / 1600 / 300 grams, respectively, and the mixture weighs 2 kilograms in total.
6. This mixture is applied to the mold by using 1inch brush and distributing equally. The stay time of molds is approximately 7 hours. This period might be shorter / longer depending on quality of wax polish applied.
7. The lubricated molds are placed in cork dust and the molds are covered with this dust.
8. The molds are kept in cork dust for approximately 30 minutes.
9. Excessive cork dust on the molds kept in cork dust is removed.
10. The molds are kept in furnace at 335 °C for 25 minutes. The molds are taken out from the furnace and then cooled; the molds are ready to use after cleaning the discharge holes.

Table 1. illustrates the measurements related to the process times listed above.

Table 1. Measurement Results

Process description	Time/ Productivity	1	2	3	Observation Average	Ordinary Time
Taking molds from machines and putting them in caustic boiler	T	4,12	3,41	3,54	3,69	2,71
	P	%70	%75	%75	%73	
Taking molds out of caustic boiler and washing them in water	T	5,34	6,19	4,44	5,32	3,64
	P	%70	%65	%70	%68	
Air-drying the washed molds	T	2,43	2,45	2,51	2,46	1,72
	P	%70	%70	%70	%70	
Lubricating the dried molds and putting them in cork dust	T	30,59	17,01	25,01	24,20	15,73
	P	%60	%70	%65	%65	
Cleaning the dust on molds and putting them in the furnace	T	6,28	4,40	4,52	5,07	3,97
	P	%75	%80	%80	%78	
Taking molds out of the furnace and letting them to cool down	T	4,57	4,52	4,54	4,54	3,18
	P	%70	%70	%70	%70	
Drilling cooled molds with pins	T	7,04	6,58	5,07	6,23	4,26
	P	%70	%70	%65	%68	

The observations are based on 15 for each mold. The waiting period of molds is total 85 minutes, excluding the workmanship time.

Ordinary time: 35,20

Personal needs (5 %): 1,76
Retardants (5 %): 1,76
Rest (5 %): 1,76
Standard Time: 40,48

*t: time; p: productivity

3. Conclusion and Suggestions

The location of mold room subject to the work and time study forces the molder walk for meters during the days and this applies also to the machine operator who comes and collects the ready molds. This causes the molder and machine operator to get tired easily and decreases work productivity. This problem should be eliminated by relocating the mold room at a place closer to the machine. If the mold room is relocated, the walking distance will be minimized and both the molder and machine operator shall be more productive, and this will indirectly improve

productivity throughout the business. The machine operator removes the molds from the machine and leaves them on mold pan next to it. The molds are kept on these pans for several minutes. If the mold room can be closer to the machine, the operator will directly put the molds into the caustic boiler and the work area will have a 30-minute waiting period advantage. A mold has a waiting period of 85 minutes, excluding the workmanship times. If the mold room is relocated, this period will be down to 55 minutes. The molds are taken out of the furnace at the final step of process and they are cooled down for 15 minutes; they are then drilled using a pin: ordinary time: 4, 26 / 15 = 0, 28 minutes (workmanship time required for drilling one mold). When the mold room is relocated, the machine operator will be able to drill while installing the mold. Hence, 15-minute waiting period will be also eliminated. Currently, the waiting period is 85 minutes under the existing working conditions but this period can be reduced down to 40 minutes if the mold room is relocated. Total improvement rate shall be: (85-40)/85 = 53 %. As for the waiting period applied to the mold as per the work method should not be left to the discretion of the molder and the molder should comply with the waiting periods written on the instruction and exceeding these periods should be avoided. The standard time of the molder is 40,48 minutes. (Workmanship time for 15 molds, waiting period not included). According to the current work conditions the total waiting time for 1 mold or 30 molds is 85 minutes. (Since the furnace has a capacity to hold 30 molds, the number of molds is not important in terms of waiting period). Even if there is no improvement, the molder is capable of making (85 / 40, 48) / 15 = 31, 49 molds during 85-minute waiting period. The workplace has a capacity of preparing (420/ 85) * 31, 49) = 155 molds during 420-minute working hours (excluding coffee breaks and lunch breaks). After the improvement, the capacity shall be (155 * 53 %) + 155 = 237 molds.

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