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Enhancing Productivity through the Utilization of a Work-Measuring Methodology

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Abstract

A work-study is a systematic examination of the methods used to complete tasks, intending to improve resource utilization and set performance standards for the activities being carried out. The application of this technology has considerable potential for improving productivity in management. By implementing method study and time study within an organization, it is feasible to achieve enhanced productivity at a lower expense, while concurrently enhancing the quality of the output. As a result, this results in increased levels of productivity. The main objective of this study is to reduce machine idle time, improve production efficiency, and mitigate worker fatigue. The objective of this study is to determine the standardized performance methods and cycle time required to maximize the efficiency of equipment and labour while minimizing excessive efforts and wasteful handling of materials. This study focuses on the production lines specifically involved in the manufacturing of dairy milk. There are four machining centres in the production line. The time study approach has been chosen as the methodology for quantifying labour. The present investigation was carried out at a dairy milk-producing plant to examine the application of time and work study approaches. This decision was prompted by the substantial quantity of unproductive time seen during the operation. After implementing the suggested measures for improvement, the company experienced a significant increase in productivity, namely by 27.77%. A refined flow process chart is suggested, derived from meticulous observations and in-depth talks with the company's manager.

Keywords

Work study, idle time, productivity, worker's fatigue, method study.

1. Introduction

For a considerable period, work-study was commonly referred to as "time and motion study". However, as the technique evolved and found application in a diverse array of activities, a significant number of individuals began to perceive the previous terminology as too limited and lacking in descriptive adequacy. Productivity can be defined as the quantitative relationship between the output and input of a given process or system. The concept refers to a quantitative correlation between the output of our production and the corresponding expenditure incurred in the production process. The numerical value provided is 70. Productivity can be defined as the process of minimizing the inefficient utilization of various resources, such as labor, materials, machinery, time, space, and capital. The concept can be defined as the collective endeavors of individuals to enhance productivity by minimizing resource inputs, hence facilitating optimal distribution. According to the City Council, productivity might be seen as a mindset or attitude. The concept pertains to a mindset focused on advancing and enhancing existing elements. The ability to consistently improve upon one's previous performance is a definitive aspect of personal growth. The concept refers to the ongoing process of adapting economic and social activities in response to evolving circumstances. The application of novel approaches and methodologies necessitates a persistent and ongoing endeavor. The concept being referred to is the belief in the advancement of humanity. According to Peter Drucker, productivity refers to achieving a state of

equilibrium among all variables of production, resulting in the highest possible output while minimizing effort. However, as per the International Labour Organization, productivity can be defined as the ratio between the volume of output, measured by production indicators, and the corresponding volume of labor input, measured by production indices and employment indices. This term is applicable to a variety of contexts, including enterprises, industries, and entire economies.

1.1 Objectives

The scope of this study encompasses the production lines involved in the making of dairy milk. The production line comprises four machining centres. The time study approach has been selected as the method for measuring work. The cycle times of all machines were measured using an element and their breakpoints. This study demonstrates an instance of reducing non-value-added time in a business activity. This analysis demonstrates the strategic approach of counteracting the problem at hand and proposes an effective methodology for doing work measurement.
The objectives are as follows: -

- Minimized machine idle time.
- One potential objective is to enhance productivity.
- Minimize worker weariness.
- The objective is to determine the established performance techniques and cycle time standards.
- Efficiently utilize equipment and human resources to maximize productivity.
- Efforts that are deemed wasteful and the processing of material that serves no use should be eliminated**.**

2. Literature Review

Chouhan (2019) Productivity holds paramount significance and enjoys widespread prominence within the realm of manufacturing. This paper presents a system that has been developed to improve worker productivity and efficiency, as well as reduce tiredness in production lines. The methodology utilizes Time Study methodologies to identify unnecessary movements made by operators and workers. The exploration of productivity enhancement through work-study can be achieved by employing time-study methodologies. According to Gujar and Sahare (2018), The focus of this project lies in examining the potential for enhancing productivity through the implementation of a work-study program within a manufacturing business. The project was executed in real time, employing a variety of technologies and approaches to enhance the industry's efficiency and productivity. According to Nagaich (2017) , Enhancing productivity is a crucial element for organizational survival and attaining a competitive advantage. The focus of this study pertains to enhancing productivity within the automotive sector. Singh and Yadav (2016) conducted a study. The Indian small industries have seen significant challenges in terms of productivity, quality, cost, delivery, and other aspects due to the globalization of the Indian economy. In order to achieve success in the global market, it is important to implement substantial enhancements in the production methods employed by small-scale process firms. According to Patil (2016), market trends and customer demand undergo rapid modernization. Globalization has facilitated the expansion of trade opportunities in order to meet the demands of consumers. However, it has also brought forth intensified competition, enhanced product quality, and heightened productivity. According to Mishra (2015) , enhancing productivity is a critical determinant for a firm's survival and attainment of significant advancements. The research conducted focuses on optimizing productivity within the automotive sector. Centindere (2015) is a scholarly work that is referenced in this context. The work and time study technique was employed in the implementation of the manufacturing process at Earth Energy Glass Manufacture Company. Specifically, attention was focused on the arrangement of the Mold room, taking into consideration the forces associated with work and time study. As a result, the moulder and machine operator was required to traverse a distance of several meters throughout the course of their workday. This applied to both the moulder, who had to access the Mold room, and the machine operator, who retrieved the completed Molds.

3. Methods

The study conducted in this research measures both the work content and cycle times, while also facilitating the analysis of many variables that contribute to non-value-added time in the overall operation. In the initial phase, a

comprehensive analysis is conducted on the entire production line to determine the cycle times for each individual machine (Figure 1*)*.

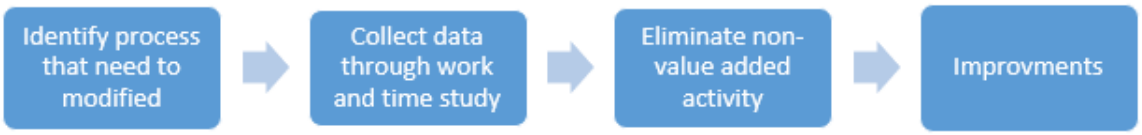

Figure 2. Flow Chart of study

Subsequently, the bottleneck stations underwent an elemental examination utilizing the time study technique. The labour cycles were further fragmented into discrete operations, with each operation further subdivided into quantifiable pieces. The cycle time for each element has been recorded on observation sheets.

4. Data Collection

Existing Process: The process flow of an existing process for dairy milk manufacturing is mentioned as follows:
The company that produces products from milk and fruits. Their products include fresh milk, laban, fruit juices, cheese, butter, and snack food. These products are put into different containers like jars, pots, foils, plastic packs, paper cartons, and plastic bottles; Plastic bottles are used as containers for Almarai's milk, laban, and juices. They range in size from 200 milliliters to 2 liters. Bottles used for milk and juices are transparent, while those for laban are opaque.
Products in plastic bottles, pots, jars, and other containers are loaded into crates before stacking into pallets. Pallets of products are loaded into trucks and delivered to depots and customers. Almarai produces some plastic bottles, but some come from outside suppliers who deliver to Almarai by trucks. Plastic bottles sent by suppliers to the planet are received in the crates bay for unloading. These are taken from the trucks by hand lifts, stored in storage areas, or fed into the production lines.
In this study, the method study has been conducted at the crates bay, the unloading of plastic bottles that came from Almarai suppliers has been observed. The time that the workers have been recorded while doing their work and looking for ways to become more productive. The problems that hinder the productivity of workers as follows:

4.1 Case I: Ineffective unloading of bottles

Plastic bottles delivered by trucks to the Plant are directed into the crates bay for unloading. The bay for the plastic bottles is protected by a 100 mm diameter bollard since forklifts were used some time ago to remove the bottles from the trucks. A bollard was installed to ensure that the forklifts would not hit the top portion of the bay opening. But now only hand lifts are being used to remove the bottles. Unfortunately, since the bollard is lower than the bay's opening while the bottles inside the truck are higher, some boxes of bottles hit the bollard and fall down (Figure 2).

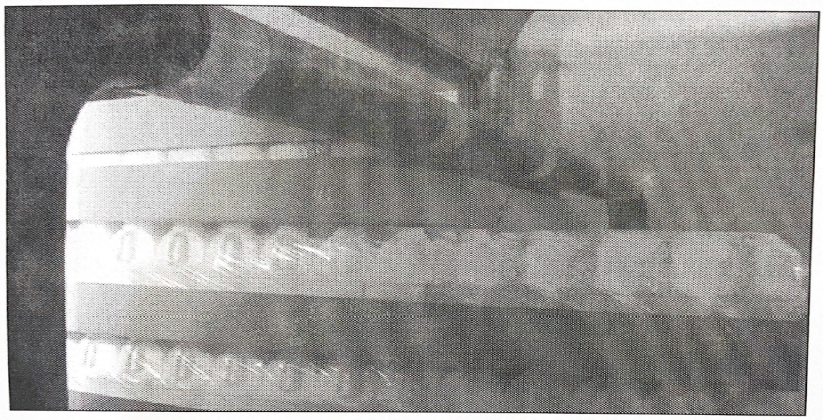

Figure 2. Bottles received hitting the bollards causing them to fall.

4.2 Case II: receiving bottles without pallet

Bottles from suppliers are delivered without pallets. They are just stacked inside the trucks, sometimes too high to reach the trucks' roofs. Unloading them would mean getting plastic pallets from storage areas, arranging cartons of bottles into the pallets, and taking them by hand lifts to the corridor. The bottles are loaded into an elevator to the second floor, fed into the production lines or arranged in the storage areas (Figure 3).

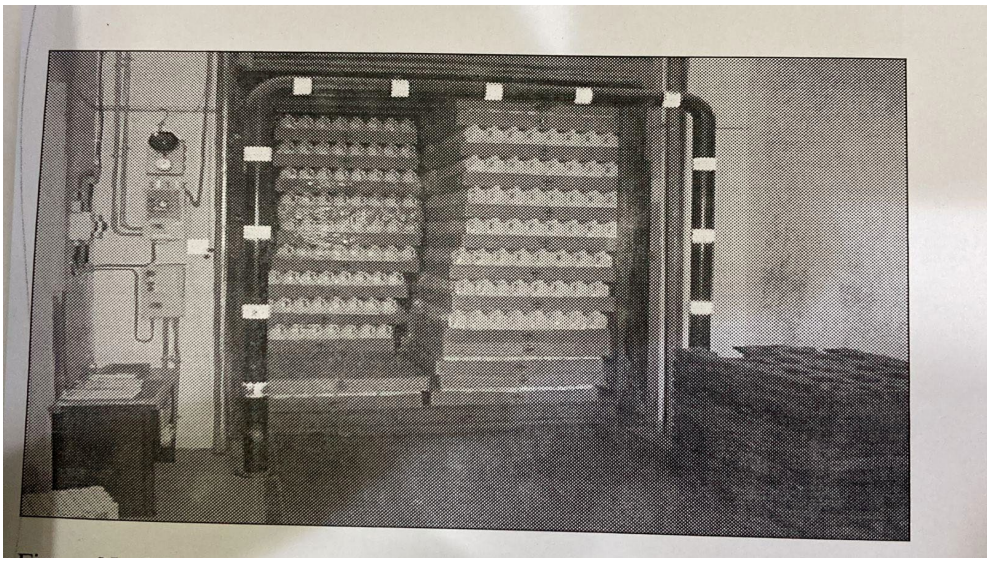

Figure 3. Bottles received without pallets.

4.3 Case III: Non-Standard Trucks

Sometimes bottles are delivered by trucks that are not fit for the bay. Parking is difficult for this kind of truck on the bay since the trucks are not standard. In addition, that taut liner will have to be placed lower or higher than the unloading floor, making unloading the bottles difficult (Figure 4).

Figure 4. Non-standard truck.

The operation has been observed five times for each operation for taking time for particular operations. After taking observation time, it converted to basic time with a particular rating for each worker by using equation (2). After that, we transferred this basic time by adding allowance to standard time using equation (3). We consider two types of allowance for calculating standard time: relaxation allowances and contingency allowances. First, we consider the eight hr working time for each worker. The graphical representation of the capacity of each station is shown in Figure 5.

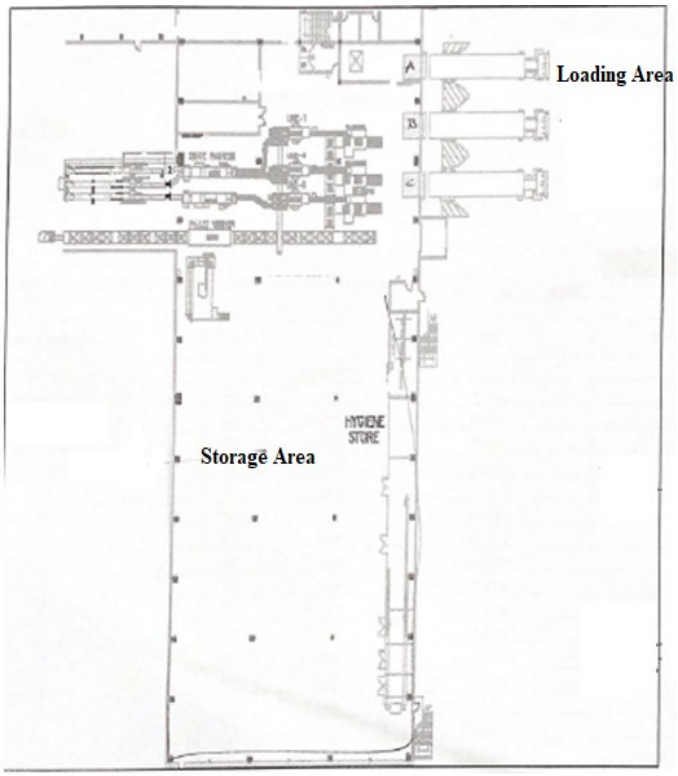

Figure 5. facility layout for the production line.

As per the existing process flow, the dairy milk need standard processes and 41.629 min to produce the complete component, which is in actual a time-consuming process (Figure 6). To find out the actual standard time of the existing process, need to calculate it in details, following table shows the standard time calculations

Table 1. time study for bottles using hand lift.

Time Study Top Sheet

Department: **Crates Bay**			Study No: 5 Sheet No: 1		
Operation: Unloading Plant/Machine: Tools and gauges: Hand lift			Time off: 23:07:35 Time on: 22:17:45 Elapsed time:50.50 Operator name: Alen Position:		
Product/Part: Material: Bottles(2Ltr)			Studied by: Alawadh Date: 10/11/2021 Shift: day		
Element description	R	WR	BT	Remark	

Before				
A-arrange bottles on pallet	95	1.407	1.337	
B-putting high more	95	0.610	0.580	
C-putting bottles at lift	90	0.753	0.677	
D-return from lift to truck	95	0.305	0.290	
A	90	1.290	1.161	
B	95	0.360	0.342	
C	95	1.042	0.900	
D	95	0.283	0.269	
A	95	1.574	1.495	
B	95	0.267	0.254	
C	95	0.900	0.855	
D	95	0.290	0.276	
A	95	1.616	1.536	
B	95	0.198	0.188	
C	90	1.057	0.951	
Waiting		2.823	0.000	Received plt
D	95	0.201	0.191	
A	95	1.860	1.767	
B	95	0.257	0.244	
C	90	0.810	0.729	
D	90	0.207	0.186	
A	95	1.406	1.336	
B	95	0.960	0.912	
C	95	1.920	1.824	
D	95	0.305	0.289	
A	95	1.804	1.713	
B	100	0.384	0.384	
C	95	0.931	0.884	
D	100	0.333	0.333	
A	100	1.666	1.666	
B	95	0.577	0.548	
C	95	0.588	0.558	
D	95	0.460	0.437	
A	100	0.683	0.683	
B	95	0.403	0.383	
C	95	0.699	0.664	
D	100	0.350	0.350	
A	95	1.343	1.276	
B	95	0.236	0.224	
C	95	1.039	0.987	
D	95	1.001	0.951	
A	85	1.530	1.301	
B	95	0.242	0.230	
C	95	0.167	0.158	
D	95	0.129	0.122	
A	95	2.473	2.350	
B	95	0.242	0.230	
C	95	1.003	0.953	
D	100	0.261	0.261	
A	95	1.695	1.610	
B	95	0.286	0.272	
C	95	1.147	1.089	

D	100	0.270	0.270	
A	95	0.354	0.336	
B	95	1.122	1.066	
C	95	0.697	0.662	
Return to office		0.750	0.000	

TOTAL TIME (SW)= 51.36 MIN TOTAL= 41.629 MIN

TOTAL PELLETS WERE PICKED= 14 PC

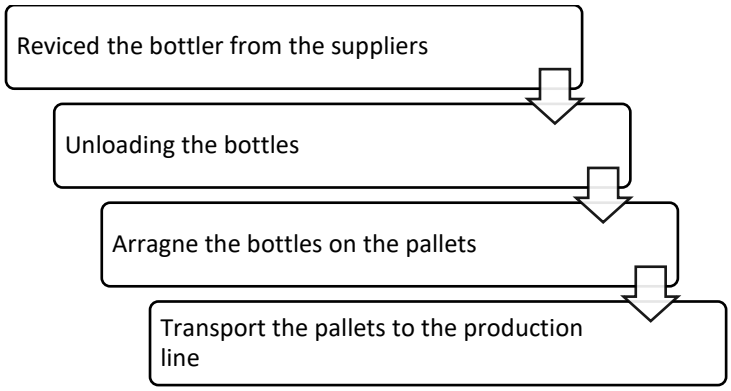

Figure 6. Process flow of dairy milk manufacturing (existing process).

5. Results and Discussion

In the analysis of the time study results, we believe that the almost 10-minute difference between the basic time and the local time of unloading the bottles is significant enough to implement some corrective actions that could increase productivity in the area.

To solve these problems, several solutions were proposed:

- Raising the height of the bollard above the opening of crates bay. This will ensure that no bottles will hit the bollard and fall down.
- Removing the bollard. The bollard may be removed since the workers are using only hand lifts to remove the pallets of bottles from the trucks.
- The problem of bottles not being put into the pallets can be solved by discussing the problem with the supplier and getting him to ensure that all future deliveries of bottles will come in pallets. Furthermore, bottles not contained in pallets should not be unloaded or the excess manpower needed in unloading of bottles should be charged to the supplier.
- The problem with non-standard trucks can be solved by requiring the supplier of bottles to use only standard trucks. In addition, bottles not loaded onto standard trucks should not be unloaded or the unloading of bottles should be charged to the bottle supplier.

After implementing the proposed solution like removing the bollard, ensuring that bottles would come in pallets, and standardizing the trucks, we made a new time study when 2-liter bottles are being unloaded. Below is the time study top sheet We made for that particular time study. Another time study was also conducted during the unloading of 200 ml bottles. The time study top sheet is also attached.

The result of time studies after implementing corrective actions showed a big improvement in the area's productivity. For example, comparing the results with the previous data, we found that the basic time had decreased from 41.629 to 16.85 minutes, while the total time had decreased from 51.36 to 22.526 minutes. Similarly, the total unloading time from the tautliner to the elevator which was previously 3.03 minutes, had now decreased to 1.23 minutes, while the target time decreased from 2.8 minutes to 0.336 minutes. These clearly show that the corrective actions implemented are successful and would directly improve the area's productivity.

Table 2. time study improvement for bottles using hand lift.

Time Study Top Sheet

Department: Crates Bay			Study No: 2 Sheet No: 1	
Operation: Unloading Plant/Machine: Tools and gauges: Hand lift			Time off: 23:07:35 Time on: 22:17:45 Elapsed time:50.50	
			Operator name: Alen Position:	
			Studied by: Alawadh Date: 10/11/2021	
Product/Part: Material: Bottles (2Ltr)			Shift: day	
Element description	R	WR	BT	Remark
Before			0.000	
A-picking packing bottles with pallet from reefer	100	0.294	0.294	
B-putting bottles at lift	100	0.147	0.147	
C-return from lift to truck	100	0.159	0.159	
A	95	0.396	0.376	
B	100	0.188	0.188	
C	100	0.129	0.129	
A	100	0.287	0.287	
B	100	0.244	0.244	
C	100	0.106	0.106	
A	95	0.349	0.331	
B	100	0.245	0.245	
C	100	0.134	0.134	
A	100	0.256	0.256	
B	100	0.283	0.283	
C	100	0.126	0.126	
A	100	0.186	0.186	
B	95	0.315	0.299	
C	100	0.102	0.102	
A	100	0.178	0.178	
B	95	0.326	0.309	
C	100	0.161	0.161	
A	95	0.313	0.297	
B	95	0.451	0.429	
C	95	0.245	0.232	
A	100	0.180	0.180	
B	95	0.468	0.444	
C	100	0.188	0.188	
A	95	0.263	0.249	
B	95	0.469	0.445	
C	100	0.264	0.264	
A	95	0.257	0.245	
B	95	0.476	0.452	
C	90	0.251	0.226	
A	100	0.190	0.190	

B	95	0.469	0.446	
C	85	0.383	0.352	
A	90	0.350	0.315	
B	95	0.473	0.449	
C	85	0.393	0.334	
A	100	0.190	0.190	
B	90	0.981	0.883	
C	85	0.417	0.354	
A	100	0.177	0.177	
B	90	0.819	0.737	
C	85	0.465	0.395	
A	90	0.618	0.556	
B	100	0.141	0.141	
C	85	0.480	0.408	
A	100	0.176	0.176	
B	95	0.424	0.403	
C	85	0.454	0.386	
A	95	0.287	0.272	
B	100	0.122	0.122	
C	85	0.421	0.358	
A	95	0.331	0.314	
B	95	0.344	0.327	
C	90	0.442	0.398	
Return to office		0.750	0.000	

TOTAL TIME (SW)= 22.526 MIN
TOTAL PALLETS WERE PICKED= 14 PC

6. Conclusion

Work measurement encompasses two primary techniques: time study and motion study. In order to attain reliable outcomes, it is imperative to employ a combination of time and motion studies when doing work measurement. Prior to doing a time study, it is imperative to also take into account the motion study. Therefore, it may be argued that motion study serves as a fundamental framework for doing time study. As previously mentioned, time study is a method used to quantify the amount of time needed to complete a specific task by a predetermined process flow. The researchers conducted a study on bottleneck stations in order to reduce unnecessary time and enhance manufacturing output on the machine. The time required for each element was initially computed and afterward examined in order to identify any necessary modifications to be made to the machine. The examination of existing processes in a dairy milk-producing facility is conducted through the application of method study and layout techniques. Based on the preceding discourse, it can be inferred that the enhancement of the process may be achieved by the use of method study, optimization of work procedures, and effective usage of machinery. The proposed improvement has the potential to enhance the existing process by mitigating process complexity, lowering time requirements, and alleviating worker fatigue. Following the implementation of the recommended improvement strategies, the firm had a notable enhancement in production, with a significant rise of 27.77%.

References

Baines A., Productivity improvement. Work Study, MCB University Press 46: 49-51, 1997.

Shantideo Gujar, Dr. Achal S. Shahare, Increasing in Productivity by Using Work Study in a Manufacturing Industry, International Research Journal of Engineering and Technology, 5(5), 1982-1990, 2018.

M. P. Singh and Hemant Yadav, Improvement in Process Industries by Using Work Study Methods: A Case Study, International Journal of Mechanical Engineering and Technology, 7(3), 426-436, 2016.

Rishabh Mishra, Productivity improvement in Automobile industry by using method study, International Journal of Scientific Engineering and Applied Science, 1(4), 361-363, 2015.

Mutombozana Tapiwa, Mugwindiri Kumbirayi, Chikuku Tauyanashe, The use of Work Study Techniques in Optimizing Manufacturing Plant Maintenance Processes: an Investigation into a Fertilizer Manufacturing Company in Zimbabwe, International Journal of Science and Research, 2(2), 99-103, 2013.

Mayank Dev Singh, Shah Saurabh K, Patel Sachin B, Patel Rahul, To improve productivity by using work study and design a fixture in small scale industry", International Journal on Theoretical and Applied Research in Mechanical Engineering, 1(2), 2319 – 3182, 2012.

Bahale, A.P., Deshmukh S.S., Improving Material Handling Efficiency in a Ginning Machine Manufacturing Company, International Journal of Innovate Research in Science, Engineering and Technology, Vol.-3 No.3, pp.- 2319-8753, 2014.

Parthiban P., Raju. R., Productivity improvement in shoe making industry by using method study",IOSR Journal of Mechanical Engineering and Civil Engineering, Vol.-2278-1684, No.-2320-334, PP.-01-08, 2014.

Amol Nayakappa Patil, M Prabhakaran, Labour Productivity Improvement by Work Study Tools of Fiber Composite Company, International Journal of Research in Engineering and Technology, 5(9), 351-355, 2016.

Cengiz Duran, Aysel CetindereYunus, Emre Aksu, Productivity improvement by work and time study technique forearth energy-glass manufacturing company, 4th World Conference on Business, Economics and Management, WCBEM, 2015.

Mayank Dev Singh, Shah Saurabh K, Patel Sachin B, Patel Rahul B & Pansuria Ankit P., To Improve Productivity By Using Work Study & Design A Fixture In Small Scale Industry, International Journal on Theoretical and Applied Research in Mechanical Engineering, 1(2), 75-81, 2012.

Gyanendra Prasad Bagri, Prem Raushan, Productivity Improvement Of Forging Section Using Work Study and Automation in Existing Axle Manufacturing Plant, International Journal of Mechanical And Production Engineering, 2(6), 1-4, 2014.

Prem Singh Chouhan, Sanjeev Singh Chauhan, Enhancement of Workers Efficiency and Value Added Activities by Time Study Techniques in an Edible Oil Industry, Journal of Applied Engineering, 6(1), 2-10, 2019.

Patange Vidyut Chandra, An Effort to Apply Work and Time Study Techniques in A Manufacturing Unit for Enhancing Productivity, International Journal of Innovative Research in Science, Engineering and Technology, 2(8), 4050-4058, 2013.

Satish Keru Raut, A Case Study Of Productivity Improvement By Using IE Tools, International Journal Of Innovations in Engineering Research and Technology, 1(1), 1-2, 2014.

Biography

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