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Analysis of workload and number of workers in brick SMEs

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Abstract. This research was conducted in two brick SME s whose production processes include mixing, printing, drying and burning. In both SME s, there are idle workers indicating an unbalanced workload. Worker activity observation was done by work sampling method and obtained various productive time, that is 85-96% in first SME and 61-93% in second SME . The calculation of workload indicates an excessive workload on the drying station workers in the first SME also on the printing station workers and drying in the second SME . The calculation of the number of workers shows the number of existing workers can be maintained but it needs to be done to improve the allocation of tasks so that the worker's workload more evenly. The results of research if implemented are expected to increase worker motivation so that SME s can be more productive and competitive.

1. Introduction

Performance of a person in performing his duties is influenced by the workload he receives, so that the workload is seen as one of the important things noticed by the company [1]. Excessive workload can lead to the emergence of work stress faster, on the contrary shortage workload can cause a loss to the organization. Unsuitable workload conditions resulting in workers not being able to provide the best performance [2]. The number of workers assigned to complete a particular job can be determined through the measurement of workload. The productivity of each worker can also be determined by analyzing workload [3].

Each job has different task characteristics. Workload conformance to workers needs to be regulated, needs to be analyzed with the right approach to optimizing working time utilization [4]. Incentives to workers who have excess workload as compensation for high workload can also be a solution of workload analysis [5]. Workload analysis can be done by work sampling method by observing the activities undertaken by workers in their working time [6]. Workload analysis has been done in the welding workshop and the result shows excessive workload and need to add one worker [7]. A workload study was also undertaken in the flour packaging station, and it was recommended that the reduction of the packaging workforce from 9 to 8 people. [8].

This research was conducted in two SMEs producing bricks in North Sumatra. Brick production processes include mixing of materials, printing, drying, and burning. The number of workforce in



1stSME as many as 13 peoples and the number of workers in 2nd SME as many as 10 peoples. Production activities are done manually, except on printing activities. The mixing worker prepares the ingredients, stirs the clay and water, and pours them into the printing press. The printing operator cuts the bricks out of the printing press, cleans them, arranges them into a stroller and carries a stroller to the drying station. The drying worker is in charge of removing the bricks from the stroller and arranging them in the drying area. Arrangement of bricks is done with a posture bend and arise repetitively until all the bricks are neatly arranged so that all parts are exposed to the sun. These activities were done along working hours.

The task of the burning worker is to take the bricks from the drying station, arrange them on the furnace, prepare the fuel, supervise/ maintain the fire condition and remove the burned bricks. Burning stations have the highest number of workers compared to other work stations due to the heavy work activities and hot working conditions.

Based on the initial observation, some workers are too busy while others are idle so workload analysis needs to be analysed. The purpose of this study is to analyze the workload received by each worker and determine the number of workers required at each work station.

2. Method and equipment

This study was conducted by observing directly the activities undertaken by workers in both Bricks SME s. The method used is work sampling method for several working days. A number of variables used in this study are:

- a) Work, which is the productive activity of a worker within the span of his work.
- b) Idle, that is the activity of the worker that is outside the category of productive activity.
- c) Working hours, that is the time limit of the worker to do the job.
- d) Element of activities, that is the activities undertaken by the worker in carrying out its work.
- e) Rating factor, that is the comparison of the performance of a worker with the normal concept.
- f) Allowance, time given for three things that is for personal needs, releasing fatigue and inevitable obstacles.
- g) Total production, that is the number of products produced by workers within a certain time.

In this method the first step is to define worker and worker idle, set observation times, and observe the worker whether to do activities that are classified as work or idle at the time of selected observation. In addition, this paper also observed rating factor, allowance and the amount of work. Instruments used are watch (time indicator) and work sampling sheets.

Data processing is done with the following steps:

- 1) Calculating the productive percentage of each worker from the observation work and idle. Productive percentage was obtained by comparing the number of observations with total observations.
- 2) Testing the uniformity of the research results, the test is done with 95% confidence level and 5% accuracy level.
- 3) Testing the adequacy of the data whether it meets the level of accuracy established.
- 4) Calculation Standard time (Ws) each work with the formula:

$$W_s = \frac{T_t \times W_t \times R_f}{T_p} \times \frac{100}{100 - A_{ll}} \quad (1)$$

Which T_t is the total time during observation, W_t is the working time (average work percentage), R_f is rating factor, T_p is the total product produced, and A_{ll} is the allowance for the job.

- 5) Calculates the workload by dividing the total time required with time available.
- 6) Determination the number of workers and average workload.

3. Results and Discussions

3.1. Analyses of Actual Workload

Observation of work sampling conducted for 10 days in 1stSME and 8 days in 2ndSME. Average results of observations for each worker in each SME can be seen in Table 1. In Table 1 can be seen that the number of workers in 1stSME is 13 people, while in 2ndSME amounted to 10 peoples and duties allocation of each worker.

Table 1. Work Sampling Results in Brick SMEs

No	Station	1 st SME			2 nd SME		
		Workers	% work	% idle	Workers	% work	% idle
1	Mixing	1	76,9%	23,1%	1	78,2%	21,8%
2	Mixing	2	76,7%	23,3%	2	78,6%	21,4%
3	Printing	3	76,9%	23,1%	3	92,7%	7,3%
4	Printing	4	76,4%	23,6%	4	91,8%	8,2%
5	Printing	5	92,6%	7,4%			
6	Printing	6	90,7%	9,3%			
7	Drying	7	96,3%	3,7%	5	89,6%	10,4%
8	Burning	8	72,0%	28,0%	6	61,2%	38,8%
9	Burning	9	72,4%	27,6%	7	61,5%	38,5%
10	Burning	10	72,8%	27,2%	8	61,6%	38,4%
11	Burning	11	72,6%	27,4%	9	60,8%	39,2%
12	Burning	12	73,1%	26,9%	10	62,9%	37,1%
13	Burning	13	72,9%	27,1%			

Table 1 also shows the difference in the number of SMEs workers in each section. 2ndSME only have 2 printing workers and 5 burning workers while the mixing and drying workers are the same number, 2 and 1 each.

Table 1 also shows the productive time distribution of each operator where the lower productive time is found in the burning workers, both in 1stSME and 2ndSME. Testing the uniformity and adequacy of the data conducted on the observations indicates that the data has been uniform and sufficient.

To obtain the Standard Time from each job, it is required the information on the number of production during observation in each section. For one type of activity performed by more than one worker, the standard time of the job is determined based on the normal worker. The result of standard time with the number of worker output is the time required to complete the task. The result of standard time calculation, the time required to complete the task and workload for each worker in 1stSME and 2ndSME is shown in Table 2.

The workload is obtained from the total time required divided by the time available, where time is available for 1stSME is 5400 minutes (9 hours/day x 60 minutes/hour x 10 days of observation), while at 2ndSME is 3840 minutes (8 days of observation with 8 work hours/day)

Table 2. Standard Time, Time Required and Workload in 1stSME and 2ndSME

Station	1 st SME			2 nd SME				
	Worker	Ws	Wp	Bk	Worker	Ws	Wp	Bk
Mixing and Printing	1-6	0.157	4706	87,2%	1-2	0,065	3510	93,5%
					3-4			
Drying	7	0.264	6432	117,4%	5	0,113	4197	109,3%
	8		4638	85,9%	6		2767	72,1%
Burning	9	0.211	4596	85,1%	7	0,614	3381	88,1%
	10		4603	85,2%	8		3535	92,1%
	11		4634	85,8%	9		2459	64,0%
	12		4546	84,2%	10		2613	68,0%
	13		4518	83,7%				

Ws: Standard Time

Wp: Time Required

Bk: Workload

The ideal workload is worth or approaching 100%. Table 2 shows that workers in 1stSME who have overworked workload (above 100%) are drying workers (Worker 7), while other workers work below 90%. In 2ndSME, excessive workload is encountered in workers 3, 4, and 5. Other workers vary from 64-93,5%.

3.2. Analyses of Required Worker

Based on the data processing, it was obtained a comparison of the amount of workload and the number of workers in each brick SME. Comparison of the amount of workload and number of workers in each Brick SMEs can be seen in Table 3.

Table 3. Total Workload and Number of Workers

Station	SME 1			SME 2		
	Total Workload	Total Workers	Average Bk	Total Workload	Total Workers	Average Bk
Mixing	523,0%	6	87,2%	187,0%	2	93,5%
Printing				241,3%	2	120,6%
Drying	117,4%	1	117,4%	109,3%	1	109,3%
Burning	509,9%	6	85,0%	384,0%	5	76,8%

From Table 3 it can be seen that the average load of the burning station workers is the lowest compared to other work stations, both in 1stSME and 2ndSME. In 2ndSME mixing and printing stations are separate (different) work stations, it appears that the load of the printing station is above the ideal load, which is 120,6%. This is very unequal when compared to the workload of the burning station, so that it is necessary to reorganize the allocation of the workers.

3.3. Discussions

If in each SME change are done with the allocation of 1 worker, that is removing 1 person from burning to drying in 1stSME, whereas in 2ndSME, 1 burning workers moved to the printing station, then the comparison of workload result seen in Table 4.

Table 4. Alternative Number of Workers and Workload on Each WorkStation

Section	1 st SME		2 nd SME	
	Number of Workers	Average Bk	Number of Workers	Average Bk
Mixing	6	87,2%	2	93,5%
Printing			3	80,4 %
Drying	7	89.6%	1	109.3%
Burning			4	96.0%
TOTAL	13		10	

The more balance workloads were seen in 2ndSME where the transfer of one worker from burning to printing made the average worker printing load dropped to 80,4% while the burning worker load is close to ideal condition (96,1%) with worker as many as 4 people. There is no change in the size of the SME's workforce with the alternative of the transfer. The second worker at the printing station may also be loaded with the task of assisting in the drying station so that the workload of drying workers is not excessive.

In the 1stSME workload more evenly can be obtained by combining all loads of drying and burning so the handling of both activities is done by 7 workers and obtained the average workload is 89,6% for each worker, but the alternatives must be studied further again to make the implementation more appropriate.

4. Conclusions

From this study, can be concluded that,

- The results of observations in both bricks SME indicate that there is an excessive workload on the drying workers in 1stSME also the printing and drying workers in 2ndSME.
- Alternative solution is to re-adjust the allocation of workers with moving 1 burning workers in 2ndSME to the printing station, and combine the workload of drying and burning tasks in 1stSME.
- There is no change in the number of workers in both SME s, it only needs better job allocation arrangements to make the workload more balanced.

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