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Workload Analysis in Determining the Optimal Number of Workers with The Work Load Analysis and Work Sampling Approach in Tofu MSMEs

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ABSTRACT

Workload is one of the things that greatly influences the product results in the tofu manufacturing industry of UMKM Tahu NR, which has 6 employees. At the beginning of the survey, it was indicated that there were problems experienced by UMKM in the implementation of tofu production, namely low employee work productivity, which resulted in delays in the completion of tofu production; consumer demand was also delayed due to the high workload experienced by the Operator. This study aimed to analyze the workload experienced by the UMKM Tahu NR Operator. This study applies the Work Load Analysis (WLA) and Work Sampling methods to determine the workload and the optimal number of workers. From the study results, the total excess workload of operators was 116%. One of the factors was due to a poor work environment, with an atmospheric level of 7 points in the ILO table, from the results of dividing the total workload and the total number of operators, the optimal number of workers for UMKM Tahu NR was 8 production operators with a workload of 87%.

Keywords: *Work Load, Work Load Analysis, Work Sampling, Optimal Workforce, Employee Productivity*

Introduction

Human resources are one of the crucial factors in an organization. Human resources are individuals from various groups who work together to achieve certain goals. Human Resources are the main goal of resources that make a company real.[1]. Companies with adequate resources can maximize employee performance, which impacts a company.[2]. Companies must pay attention to maximizing the application of human resources when running their management. Human Resource Design regulates employee relationships and roles actively and effectively related to business goals.[3].

The productivity of the operator's work is the most important factor in determining a business's success. High productivity will benefit business owners and their employees, especially regarding their welfare.[4]Factors affect Productivity, one of which is the workforce. The workforce plays a very important role in a company's sustainability; good workforce productivity is needed to complete each process carried out in a company.[5].

To maximize human resources, it is necessary to calculate the workload of each operator so that the operator can carry out their work activities optimally.[6]Workload refers to the goal of work that needs to be completed in one time under standard conditions. The term "workload" can be interpreted as the difference between the worker and his work demands.[7]Calculating the workload is necessary for work to be more productive and efficient. It collects information about the level of effectiveness and efficiency of a job based on the number of tasks that must be completed.[8]One of the workloads that workers experience when carrying out work activities can affect their performance and productivity; therefore, companies or organizations need to analyze the workload experienced by their workers so that production activities can run optimally and maintain consumer satisfaction.[9].

In addition, work time assessments are carried out to optimize employee work productivity. The purpose of work time assessments is to ensure that workers have the time needed to complete tasks or work.[10]. Measuring working time can be done with two measurement methods, namely, calculating working time by direct calculation and indirect calculation of working time. Direct calculation of working time is the calculation of working time carried out directly at the workstation, measured in a state of ongoing production. One method for direct calculation is the work sampling method. While indirect

measurement of work, namely adjusting working time, refers to adjusting work based on the available work schedule[11].

Quoted from previous research, there is a significant workload of workers through direct observation at the "MTB" Tofu Factory; several factors dominate the workload of workers, including Effort, Performance, Frustration, Mental Demand, Physical Demand, and Temporal Demand. The workload obtained by the operator is of equal value in carrying out the production process according to the job description. The results obtained by previous research from the calculations carried out can be observed in several operators who have a high category of workload level that it causes the employee workforce to be less than optimal during the production process[12]To determine the high workload received by workers during production activities, a method that can be applied to optimize work productivity is needed.[13]. Applying the principle of workload analysis will obtain data on the distribution of human resources to minimize the workload obtained. By using the Work Load Analysis (WLA) and Work Sampling methods[14].

Work Load Analysis(WLA) is a calculation method created to be useful for determining the level of workload of workers at a work station.[15]Implementing Work Load Analysis (WLA) aims to achieve maximum employee productivity and an optimal number of workers.[16]Work sampling is a method for calculating the number of perceptions related to work training, cycles, or workers.[17]This work sampling method is more accurate because the data is obtained directly at where the work process is taking place, allowing the calculated factors to be known in detail.[18].

NR Tofu Factory is one of the MSMEs in Karawang Regency located on Jalan Yudistira, Kepuh, Karangpawitan, Karawang Regency, established in 2010, which is engaged in tofu production. All tofu production activities carried out by workers are still done manually, starting from soaking raw materials, grinding soybeans, boiling soybeans, sedimentation and adding vinegar, filtering soybean essence, moulding and cutting tofu, to the final boiling until it becomes ready-to-sell tofu. In selling tofu products, NR Tofu Factory uses a make-to-order sales strategy where the quantity of tofu production is based on consumer demand.

This NR tofu factory has constraints or problems in tofu production activities, namely frequent work fatigue, several factors of which are uncomfortable working conditions experienced by NR Tofu UMKM workers, factors from the work environment which is quite hot, and work portions that exceed employee capacity. Because of the high level of workload experienced, employees take more frequent breaks during production activities, causing a decrease in the level of work productivity of NR Tofu UMKM employees and impacting the delay in the completion time of orders from consumers. The NR tofu factory has received quite a high demand for tofu in the last few weeks from its consumers in a one-day production time of 6000 to 8000 pieces of tofu, which is done by only 6 employees generally, 6 employees can only complete 6000 pieces of tofu per day. So that when there is excessive demand from consumers, there is a delay, and it causes an increase in the workload experienced by employees. The more or less productive employees depend on the workload they encounter, so the company must pay attention to each workload received by its employees to obtain optimal worker productivity so that the work can be completed on schedule.[19].

Based on previous research and the following introduction, this study discusses how the high workload experienced by factory employees can also affect employee productivity in the tofu production process. Therefore, the purpose of this study is to conduct a workload analysis to find out how high the workload experienced by NR tofu factory employees is to optimize employee performance and find out how many optimal workers are needed by NR Tofu Factory UMKM to minimize the excessive workload obtained by tofu factory workers. The limitation of the research used in this study is that the research was conducted at NR Tofu Factory UMKM. This study only focuses on analyzing the level of workload experienced by employees and determining the optimal number of workers in NR tofu production to minimize the excessive workload on NR Tofu UMKM operators, applying the Work Load Analysis (WLA) and Work Sampling methods without considering financial aspects or product quality.

Research Methods

Research Object

This observation was conducted at the NR Tofu Factory; the NR Tofu Factory is one of the MSMEs in Karawang Regency located on Jalan Yudistira, Kepuh, Karangpawitan, Karawang Regency, which was established in 2010 in the field of tofu production. The object of the study focused on the workload received by NR tofu factory employees, totalling 6 employees, and determining the optimal number of workers for the NR tofu factory. The aim is to identify the workload received by NR tofu

factory workers and choose the optimal number of workers in NR tofu production, minimize the high workload experienced by NR tofu factory employees, and maximize demand from each consumer.

Work Process Flow

The process flow system that was running during the research process was displayed in the form of a flow diagram (Flowchart). The following is a flowchart of the running work process in Figure 1:

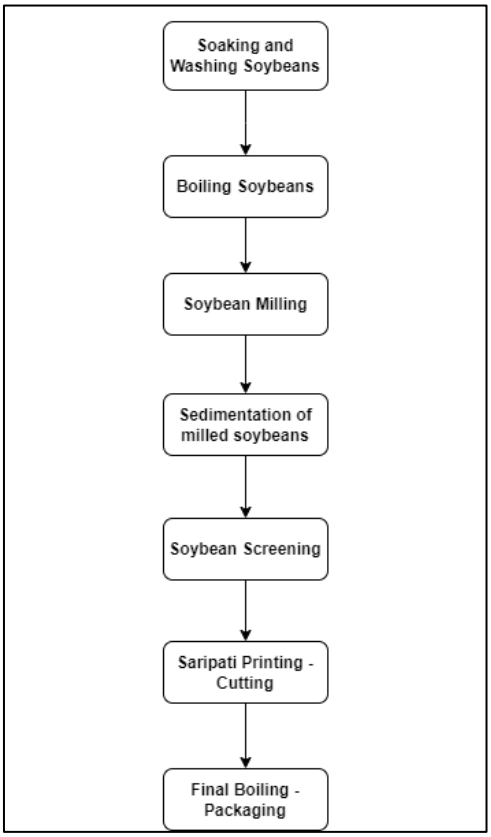

Figure 1. Flowchart of Work Process Flow

In this work process flow, there are several stages in producing tofu from soybean raw materials to finished goods or tofu ready for sale, including the initial stage of soaking and washing soybeans, and sorting the best soybeans to continue to the next stage, then the grinding stage where the ground soybeans have gone through the soaking, washing, and sorting stages of soybeans, then the next stage of boiling the ground soybeans at this stage is carried out by boiling the soybeans for 15-20 minutes, then the soybeans are drained and continued to the sedimentation stage, at the sedimentation stage calcium sulfate is added then stirred periodically and sedimentation is carried out for approximately 10 minutes, then the filtering stage at this stage is carried out the process of pouring water into the essence that is being filtered, then stirring is carried out, repeated twice, then sieving is carried out, then poured into the tofu mold, then continued to the molding stage - cutting at this stage is carried out by pressing the tofu dregs that have been filtered in the previous process several times, then cutting is carried out to form finished tofu, continued with the final boiling stage and packaging at this stage is done by final boiling by adding ground turmeric, so that the tofu becomes yellow, the boiling process is carried out for approximately 5 minutes, after boiling, the tofu is drained first, then packaged until ready to be sold to NR tofu customers.

Research Procedures

The process flow system that was running during the research process was displayed in the form of a flow diagram (Flowchart). The following is a flowchart of the research process that was running in Figure 2.:

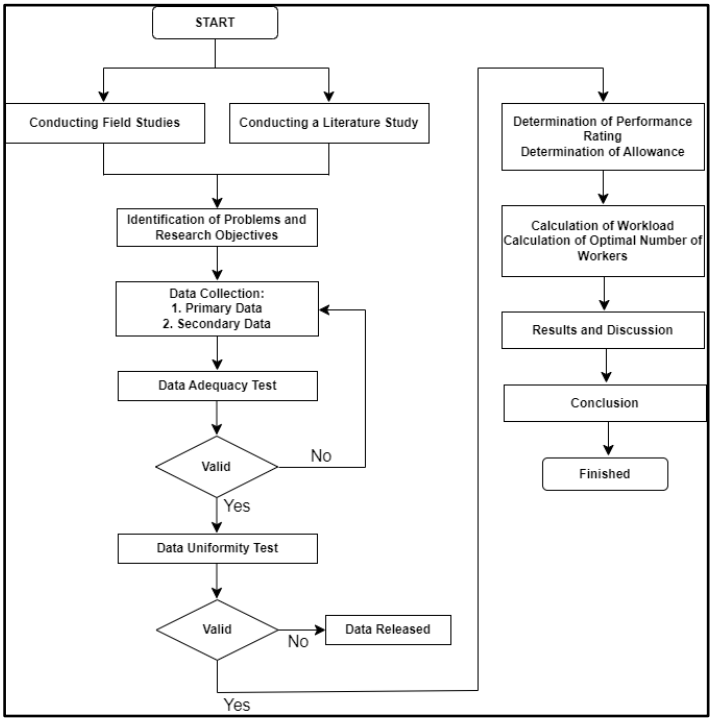

Figure 2. Research Process Flowchart

This research procedure has several stages. The first stage is conducting observations and literature studies, namely the observation process carried out directly in the field to discover an obstacle experienced in the NR tofu factory. After identifying the existing problems, the next step is to determine the objectives of the existing problems so that the research can be carried out. Then the next stage is data collection, in the observations carried out using primary data and secondary data, where the primary data used consists of observations carried out directly on the employees of the NR tofu factory UMKM production, totaling 6 employees during the production process, regarding employee work activities during production. To measure time, Work Sampling (Worker Sampling), the approach taken in taking work samples by observing the operator's work activities, is used when employees do their jobs according to the job description of the production process. Secondary data in this study provides a general description of the NR tofu UMKM and the number of NR tofu workers.

The next stage of data processing In data processing, there are several processing stages, starting from calculating employee work productivity. The formula used is as follows:

$$\%Produktif = \frac{\Sigma Pi}{k} \quad (1)$$

The next stage is to carry out a data adequacy test and a data uniformity test first using descriptive statistical methods, according to[20]Descriptive statistics is a science that focuses on collecting, processing and analyzing quantitative data descriptively, in processing the adequacy test and data uniformity test, the data required is the result of measuring employee working time, productive activities and non-productive activities of employees during production using a stopwatch. Data adequacy testing can be carried out when the existing data meets the provisions that have been applied, if it does not meet the requirements, data collection is carried out again[21]. The formula used is as follows:

$$N' = \left(\frac{K}{S}\right)^2 x \left(\frac{1-P}{P}\right) \quad (2)$$

We continue with data uniformity testing to determine whether the data is within or outside the control limits.[22]. If the data is outside the control limits, the data or attribute will be excluded. The formula used is as follows:

BKA (Upper Control Limit)

$$P + K = \sqrt{\frac{P(1-P)}{n}} \quad (3)$$

BKB (Lower Control Limit)

$$P - K = \sqrt{\frac{P(1-P)}{n}} \quad (4)$$

Next, data processing is carried out to measure the level of workload experienced by employees and to measure the optimal number of workers, namely by analyzing the workload of each tofu production operator based on each operator's work.[23] To determine the workload for each work unit, you must first know the operator's Performance Rating for each work item.[24]. Calculations are performed to determine worker allowances (allowance), which estimate operators who are not in working condition.[25]In seeking worker allowances, an interview approach was carried out with each operator, with an allowance table based on the ILO. Then, the workload is calculated, and the optimal number of workers is calculated. The optimal number of workers can be determined using the results of previous calculations.[26]. The formula used is as follows:

$$Beban\ Kerja = (\%Produktif\ x\ Penyesuaian)\ x\ (1 + Kelonggaran) \quad (5)$$

After conducting data testing and data processing, the next stage is the results and discussion, then continued by making conclusions and suggestions.

Results and Discussion

After conducting observations on the production activities of UMKM Tahu NR, the activities of each work station were obtained, one of which was in the tofu printing and cutting work section, which is attached in the table below:

Table 1. Tofu Printing and Cutting Work Station Activity Description

No	Description of Printing and Cutting Activities
1	Preparing the Tofu mold
2	Squeeze the soybean essence/tofu dregs so there is little water content.
3	Tidy up the tofu essence that has been printed
4	Cutting tofu
5	Arranging the tofu that has been cut
6	Tidy up and clean the tofu molds that have been used.

Table 2. Pre-Work Sampling Data Recapitulation

Worker	Activity	Day 1	Day 2	Day 3	Day 4	Day 5	Amount
Printing and Cutting	Productive	18	20	19	20	21	98
	Non-productive						
	Personal Needs	1	1	1	2	2	7
	Fatigue	3	2	2	1	1	9
	Inevitable	3	2	3	2	1	11
	Amount	25	25	25	25	25	125
	%Productive	72%	80%	76%	80%	84%	82%

The data used is 25 data in a day, from the data above the results are obtained from the percentage value of productive activities and non-productive activities where in non-productive activities there are three, namely personal needs, fatigue (work fatigue), and unavoidable activities, the data is obtained by observing the productive and non-productive activities of operators when carrying out ongoing production activities, the following data used is one sample of the tofu printing-cutting work station, the formula used to calculate the total % productive with the formula:

$$\%Produktif = \frac{Jumlah\ Kegiatan\ Produktif}{Total\ kegiatan\ teramati} \text{ x } 100\%$$

$$\%Produktif = \frac{98}{125} \text{ x } 100\% = 78\%$$

with decimal numbers being 0.784

Data Uniformity Test:

$$\rho = \frac{72+80+76+80+84}{5} = \frac{392}{5} = 78\%$$

$$BKB = \rho - 2\sqrt{\frac{\rho - (1-\rho)}{n}}$$

$$BKB = 0{,}784 - 2\sqrt{\frac{0{,}784 - (1 - 0{,}784)}{125}}$$

$$BKB = 0.65\%$$

$$BKA = \rho + 2\sqrt{\frac{\rho - (1-\rho)}{n}}$$

$$BKA = 0{,}784 + 2\sqrt{\frac{0{,}784 - (1 - 0{,}784)}{125}}$$

$$BKA = 0.92\%$$

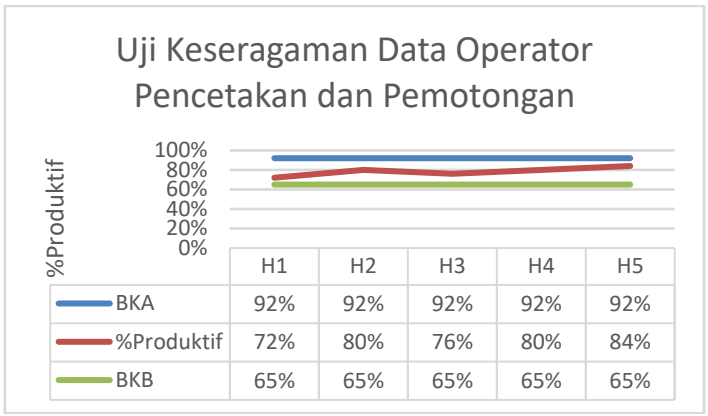

Figure 3. Printing and Cutting Operator Data Uniformity Test

Figure 3 shows that the percentage of productive printing and cutting operators has been between BKA and BKB, so it can be concluded that the data is uniform. In measuring employee workload, a performance rating per work section is needed to assess the speed of employee work, and flexibility supports work sampling so the workload of each worker can be calculated. The following is a summary table of Performance ratings in this study, which was taken by observing and discussing with tofu production employees.

Table 3. Recapitulation Results of Operator Performance Rating Values

No	Operator Name	Wastehouse				Performance Rating	Information
		Skills	Business	Working Conditions	Consistency		
1	Immersion	D = 0.00	D = 0.00	D = 0.00	D = 0.00	1	Average
2	Milling	D = 0.00	D = 0.00	D = 0.00	D = 0.00	1	Average
3	Boiling	D = 0.00	D = 0.00	D = 0.00	D = 0.00	1	Average
4	Sedimentation	D = 0.00	D = 0.00	D = 0.00	D = 0.00	1	Average
5	Filtering	D = 0.00	D = 0.00	D = 0.00	D = 0.00	1	Average
6	Printing- cutting	D = 0.00	D = 0.00	D = 0.00	D = 0.00	1	Average
7	Boiling-coloring	D = 0.00	D = 0.00	D = 0.00	D = 0.00	1	Average

To calculate the Performance Rating for example on the printing and cutting workstation:

Keterampilan Average = D 0.00
Usaha Average = D 0.00
Kondisi Average = D 0.00
Konsistensi Average = D 0.00 +
0,00
0.00

$$P = 1 + Performance\ Rating$$
$$P = 1 + 0{,}00$$
$$P = 1$$

In all the above factors, one is added because the value of 1 is a provision where the operator works normally. Based on Table.4, the results of the Performance Rating value recapitulation show that 7 employees of UMKM Tahu NR as the object of observation have a performance rating value of one, which means that the employees as a whole work normally, with an average speed of employees working.

Allowance calculation is done by adding up all external factors that have a large amount of operator flexibility in doing work. Which includes Allowance, namely the workforce issued, work attitude, work movement, lighting conditions, work environment temperature conditions, atmospheric conditions, noise, mental tension, similarity (monotony), and boredom while working. The following is a table of operator Allowance based on ILO in this study, as follows:

Table 4. Operator Allowance based on ILO

No	Operator Name	Allowance categories based on ILO												Total %
		A	B	C	D	E	F	G	H	I	J	K	L	
Immersion														
1		5	4	2	2	4	0	7	2	0	1	1	0	28%
Milling														
2		5	4	2	0	4	0	7	2	0	1	1	0	26%
Boiling														
3		5	4	2	0	5	0	7	2	0	1	1	0	27%
Sedimentation														
4		5	4	2	0	3	0	7	2	0	1	1	0	25%
Filtering														
5		5	4	2	2	3	0	7	2	0	1	1	0	27%
Printing-Cutting														
6		5	4	2	0	2	0	7	2	0	1	1	0	24%
Boiling-coloring														
7		5	4	2	0	4	0	7	2	0	1	1	0	26%

Based on the results of the Allowance value of each workstation operator in tofu production, the Printing-cutting operator section has the lowest results; this is because the operator from the Job Description Level does fewer work activities. The soaking operator has the highest value at 28% because the operator does quite a lot of work. The allowance value is based on 12 categories determined by the International Labor Organization (ILO) table. Levels A and B are fixed allowances given to workers. While levels C to L are non-fixed allowances based on the work environment.

After obtaining the work assessment value and work allowance, the workload received by the NR tofu UMKM production workers can be calculated in the table below as follows:

Table 5. Workload of Each Workstation

No	Operator Name	%Productive	Performance Rating	Allowance	Workload
1	Immersion	80%	1	28	102.40%
2	Milling	79%	1	26	99.06%
3	Boiling	78%	1	27	95.94%
4	Sedimentation	78%	1	25	97,50%
5	Filtering	81%	1	26	102.87%
6	Printing-Cutting	78%	1	24	101.66%
7	Boiling-colouring	79%	1	26	99,54%

Workload of printing and cutting workstation:

$$Beban\ Kerja = (\%Produktif \text{ x } Performance\ rating) \text{ x } (1 + Allowance)$$

$$Beban\ Kerja = (78\% \text{ x } 1) \text{ x } (1 + 24\%)$$

$$Beban\ Kerja = 101{,}66\%$$

Determining the optimal number of workers for UMKM Tahu NR from the work stations that have been studied, the following determines the optimal number of workers in this study:

a. Total Overall Workload = 698,97%

b. Average Workload (Current) = $\frac{698{,}97\%}{6} = 116\%$

c. Average Workload (Proposed) $= \frac{698{,}97\%}{8} = 87\%$

The results obtained in determining the optimal number of workers for UMKM Tahu NR, which initially had 6 employees for seven existing workstations, produced a total workload of 698,97% divided by 6 operators and an average workload of 116% before the proposal to add operators. After the proposal to add the ideal number of employees to 8 operators, an average workload of 87% was produced. One of the factors that cause high operator workload is the excess work capacity of the operator and poor environmental factors, which makes NR tofu production operators often experience work fatigue, which has an impact on decreasing the work productivity of the operator.

Conclusion

Based on the results of the observations that have been carried out, the first conclusion is that one of the factors that causes a decrease in the level of work productivity is the indicator of excessive workload experienced by employees/production operators at the NR tofu UMKM, which before the proposal to add operators was made, the overall workload was obtained with an average of 101.66%, which exceeds the maximum workload limit of 100%. After the overall operator workload is known, the optimal number of workers needed by UMKM Tahu NR is obtained by adding production operators to 8 people, initially only 6 production operators. Adding the number of workers can reduce the excessive workload experienced by previous operators from 116% with 6 employees to 87% with 8 employees/tofu production operators, which aims to optimize the performance of UMKM Tahu NR employees.

For subsequent observations, it is recommended to conduct observations regarding the quality of products produced by the related MSMEs and conduct cost analysis to consider financial aspects in subsequent observations. It is recommended that the Lean Manufacturing approach be applied to tofu production.

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