Volume 5, No. 9 September 2026 (974-989)
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

Determining the Number of Workers Based on a Time-and-Motion Study to Meet Production Demand at the XYZ Tofu and Tempe Factory in Nabire

Jean Belynda Lalihatu*, Julianus Hutabarat, Ellysa Nursanti
Institut Teknologi Nasional, Indonesia
Email: Jeanlaihatu@gmail.com*, julianushutabarat1@gmail.com, EllysaNursanti1@gmail.com

Keywords:
Time and Motion Study; Ergonomics; Workforce Scheduling; Scenario Analysis; Productivity

Abstract

One of the food industries that plays an important role in meeting community needs is the tofu and tempeh production industry. Therefore, this role must be supported by adequate infrastructure and workforce capacity to ensure that the production process runs effectively. This research determines the appropriate number of workers using a time-and-motion study to identify and eliminate unnecessary activities and establish standard working times for tofu production. The XYZ tofu and tempeh factory in Nabire has operated for approximately 10 years with six employees divided into two production sections: two workers for tofu production and four workers for tempeh production. A quantitative approach using direct stopwatch observation and the Westinghouse performance rating method was applied. The results show that the standard time for the entire tofu production process is 212.22 minutes, consisting of 177.73 minutes per box and an additional 34.49 minutes required only once at the beginning of production. Workload analysis indicates that the workload per worker decreases from 550.435 minutes with two workers to 485.443 minutes with three workers, while daily output increases from six to eight boxes of tofu. The improvement scenario involving three workers producing eight boxes results in a monthly wage cost of IDR 4,500,000 and an income of IDR 118,380,000, making it more profitable than the scenario with two workers (32.7% lower productivity) and the overtime scenario with two workers (0.36% lower productivity). These findings imply that adding one worker represents the most optimal policy for the factory to meet consumer demand without overburdening existing employees.

INTRODUCTION

Micro, small, and medium enterprises form an important foundation for regional economies, and one of the food industries that plays a significant role in meeting community needs is the tofu and tempeh production industry. To ensure that the production process runs effectively, the tofu and tempeh industry needs to be supported by adequate infrastructure and workforce capacity; therefore, the appropriate number of workers must be determined. Previous research has stated that the ideal number of workers for two production furnaces is eight employees in the tofu production section and four employees in the tempeh production section (Hiller et al., 2015; Nurwidiana & Ela, 2025; Saputro et al., 2024; Tajidan et al., 2024; Widjayanti, 2023).

The XYZ tofu and tempeh factory, located in the Nabire region, has been operating for approximately 10 years with six workers divided into two production sections, namely two workers for tofu production and four workers for tempeh production. The factory's production

capacity ranges from 5–8 boxes per day, with the output distributed to the morning market, the SP market, and vegetable stalls. Production activities take place daily from 5:00 WIT to 17:30 WIT; however, in practice, the soybean soaking process for tofu production begins at 3:00 WIT. The factory's production data are presented in Tables 1, 2, and 3.

Table 1. Tofu Production Process Data at the XYZ Tofu and Tempeh Factory Nabire

No	Tofu Production Process	Time
1	Raw Material Preparation	5 Minutes
2	Soybean Washing	10 Minutes
3	Soaking	540 Minutes
4	Grinding	10 Minutes
5	Cooking	20 Minutes
6	Filtering	15 Minutes
7	Coagulation	10 Minutes
8	Molding and Cutting	80 Minutes
9	Transferring Tofu to Box	5 Minutes
10	Processing 2	140 Minutes
11	Processing 3	140 Minutes
12	Processing 4	140 Minutes
13	Processing 5	140 Minutes
14	Processing 6	140 Minutes

Source: XYZ Tofu and Tempeh Factory Nabire

Based on Table 1, the tofu production process, from raw material preparation to transferring the tofu into boxes for subsequent processing, is carried out by two workers, with each box containing 64 pieces of tofu. The tofu-making process at this factory is still performed using simple methods and primarily traditional equipment, with limited technological support, such as the use of a grinding machine (Ariyani, 2019; Nadiyah et al., 2026; Widjayanti, 2023; Zhang et al., 2018).

Table 2. Tempeh Production Process Data at the XYZ Tofu and Tempeh Factory Nabire

No	Tempeh Production Process	Time
1	Soybean Material Preparation	5 Minutes
2	Soybean Washing	10 Minutes
3	Soybean Soaking	480 Minutes
4	Boiling	120 Minutes
5	Cooling	20 Minutes
6	Yeast Mixing and Spreading	10 Minutes
7	Soybean Wrapping	120 Minutes
8	Transferring to Rack	13 Minutes
9	Processing 2	283 Minutes

Source: XYZ Tofu and Tempeh Factory Nabire

The tempeh production process presented in Table 2 begins with raw material preparation and ends with transferring the tempeh onto stacked racks. The fermentation process of soybeans into tempeh takes 48 hours, or approximately two days, until the tempeh is ready for marketing.

Meanwhile, tempeh workers continue the production process daily without waiting for the fermentation process to be completed.

Table 3. Monthly Production Volume of Tofu and Tempeh at XYZ Nabire (May 2025)

Product ype	Daily Output	Monthly Output	Unit	Unit Price
Tofu	384	11,776	Pieces	IDR 8,000
Tofu Dregs	6	186	Sacks	IDR 50,000
Large Tempeh	1,500	45,000	Pieces	IDR 10,000
Small Tempeh	350	10,500	Pieces	IDR 5,000
Gembus Tempeh	50	1,500	Pieces	IDR 1,000

Source: XYZ Tofu and Tempeh Factory Nabire

Based on Table 3, a daily tofu output of six boxes, or 384 pieces, is produced by two workers who must work beyond regular working hours, while actual consumer demand exceeds this production capacity. If production were increased without adjusting the number of workers, tofu production workers would be at risk of overtime and fatigue because they do not have sufficient rest periods from the beginning to the end of the production process, unlike tempeh workers who have breaks during the soybean boiling process. High consumer demand requires the company to continuously optimize its production capacity; therefore, a time-and-motion study is needed to identify and eliminate unnecessary activities and establish standard working times for tofu production. The factory had planned to recruit additional employees but had not yet determined the appropriate number of workers required. Workforce scheduling can be defined as determining the right number of workers (right number), with the right qualifications (right people), in the right location (right place), and at the right time (right time). Based on this description, this study aims to determine the appropriate number of workers required to increase tofu production at the XYZ tofu and tempeh factory in Nabire using the time-and-motion study method. The scope of the study is limited to the tofu production workforce and engineering analysis for determining workforce requirements (Ramadhania, 2025; Widodo et al., 2022).

Several previous studies relevant to the topic of determining the number of workers are presented in Table 4.

Table 4. Summary of Previous Research

No	Researcher (Year)	Title	Main Findings
1	Haikal (2024)	Analysis of the Number of Workers in the Tofu Industry Using the WLA and WFA Methods	Standard times and WLA/WFA values vary across work elements; the WLA-WFA method can serve as a reference for determining the number of workers.
2	Sumerli (2023)	Productivity Optimization Using the Time and Motion Study Method at PT XYZ	Implementing TMS increased production output by 6–18% with a reduction in cycle time from 3.32 to 2.98 seconds per unit.
3	Ihsan et al. (2022)	Analysis of Workforce Needs in the Tissue Packing Area	Standard time for packer 1 was 199.6 seconds and packer 2 was 194.1

			seconds; one additional worker was required at each station.
4	Afiani et al. (2017)	Determination of Standard Tim Using the Stopwatch Time Study Method, Case Study of CV. MANS Group	Standard process time for the ITC product was 4,244.5 seconds, or 70.74 minutes per product.
5	Ardhandy et al. (2025)	Improvement Productivity Using the Time Motion Study Method in the Soy Dissolving Area of PT XNX	Optimizing the number of operators from 6 to 5 people increased workforce productivity to a higher level than the initial 53.11%.

Source: Compiled from various previous studies (2017–2025)

Based on these previous studies, the time-and-motion study approach has proven to be relevant for determining standard times and workforce requirements across various manufacturing industries. Therefore, its methods and measurement procedures can serve as references for this study.

Theoretically, a time-and-motion study utilizes elements from various work procedures, whether involving machines, workers, or a combination of both, to establish standard working times through direct time measurement using a stopwatch (stopwatch time study) or through work sampling for tasks with uncertain durations (Muti et al., 2022; Al Faridzi et al., 2022; Nurdiansyah & Satoto, 2023). Workload, which arises from task demands, the work environment, and worker capabilities, needs to be measured objectively so that companies can determine the ideal number of workers, as both an excess and shortage of workers can affect productivity and worker welfare (Yusuf, 2019; Aminah & Porusia, 2024). Productivity itself is the ratio between the output achieved and the total resources (input) used per unit of time (Juwardi et al., 2023). Therefore, productivity improvement can be achieved, among other ways, by producing greater output using the same resources or by adding relatively small additional resources. In addition to time and productivity, ergonomics is also an important consideration because work that is not ergonomically designed can cause discomfort, fatigue, decreased performance, and an increased risk of accidents or occupational health disorders (Hoe et al., 2018; Rahma, 2025). These three aspects—standard time, productivity, and ergonomics—form the basis for determining the appropriate number of workers in this study.

Based on the problem formulation above, this study aims to measure the standard working time for tofu production using the time-and-motion study method, determine the appropriate number of workers required to meet the daily target of eight boxes, compare three workforce scenarios (two workers, two workers with overtime, and three workers) in terms of productivity and profitability, analyze workload distribution and ergonomic aspects before and after workforce addition, and provide recommendations for optimal workforce scheduling that maintains worker welfare. The benefits of this research are expected to be experienced by various parties. For factory management, the results provide objective data for decision-making regarding workforce addition, cost-efficiency analysis, and production optimization while maintaining worker welfare. For similar small and medium enterprises, this study serves as a practical reference for applying time-

and-motion study methods to determine workforce requirements under limited resources. For the development of industrial engineering knowledge, this research enriches the literature on the application of time-and-motion studies in the traditional food industry and validates the effectiveness of combining stopwatch studies, the Westinghouse rating system, and scenario analysis. For academics and future researchers, this study provides baseline data and a case study for further research development.

METHOD

This research used a quantitative approach based on positivist philosophy. Data were collected using research instruments and analyzed statistically to determine the appropriate number of workers required to increase production at the XYZ tofu and tempeh factory in Nabire through a Time-and-Motion Study (TMS) and engineering analysis approach. The research was conducted at the XYZ tofu and tempeh factory located on Jalan Jayanti, Central Papua Province, in August 2025. The research stages included preparation, data collection, data processing, and data analysis.

Data were collected through direct observation of working conditions, interviews with the factory owner and workers, and documentation of factory records. Working time was measured directly using a stopwatch to determine the cycle time for each work element, with 18 observations conducted for each work element across the 10 stages of tofu production. Worker performance ratings were assessed using the Westinghouse method. The standard time data were then processed using Microsoft Excel, followed by scenario analysis and engineering analysis.

The research flow consisted of three main stages: initial identification, data collection and processing, and analysis. The identification stage included reviewing the research background, literature, field conditions, problem formulation, objectives, benefits, and research scope. The data collection and processing stage involved identifying tofu production work elements and analyzing time-and-motion study data through stopwatch time study and work sampling. The analysis stage compared the initial and improved tofu production conditions to develop conclusions and recommendations. The research flow is presented in Figure 1.

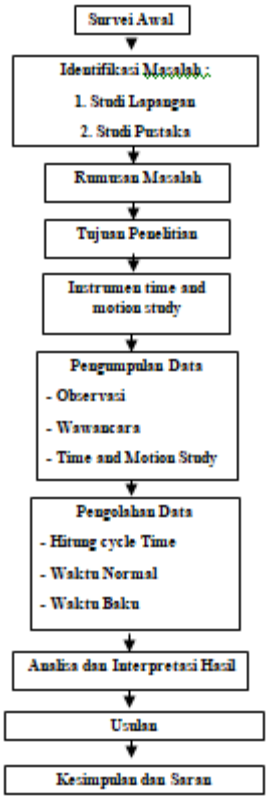

Figure 1. Research Flow

Source: Author's Compilation (2025)

The work measurement calculations in this study used standard equations from industrial engineering. Cycle time was calculated as the average observation time (∑x/N). Normal time was obtained by multiplying the average cycle time by the performance rating based on the Westinghouse system, which considered skill, effort, working conditions, and consistency factors. Data uniformity was tested by calculating the upper control limit (UCL) and lower control limit (LCL) using the standard deviation at a 95% confidence level (k = 2). Data were considered uniform when all observation points fell within the specified control limits. Data adequacy was tested at a 95% confidence level with a 10% degree of accuracy using the adequacy test formula, and the data were considered sufficient when the calculated sample size (N′) was less than or equal to the number of observations (N). Standard time was calculated by adjusting normal time with the allowance factor, using an allowance value of 12% (10% for workers and 2% for machines).

The number of workers (JTK) was calculated by dividing the total workload, which consisted of standard time multiplied by the daily production quantity, by the total effective working time per day. Scenario analysis was then conducted to compare three alternative company policies: the initial condition, the addition of overtime hours, and the addition of workers. The scenarios were evaluated based on wage costs, sales income, and productivity changes. The final analysis stage applied the Need-Know-How-Solve (NKHS) engineering method to systematically formulate solutions for determining the required number of workers.

RESULTS AND DISCUSSION

Identification of Tofu Production Work Elements

Implementation of the Time and Motion Study begins by defining the work to be measured and dividing the work cycle into work elements according to established rules. Time observations and measurements were carried out 18 times for each work element across the 10 stages of tofu production work, carried out during working hours from 05.00 to 17.30 WIT. These ten work-element stages are presented in Table 5.

Table 5. Work Elements in the 10 Stages of Tofu Production

Sequence	Work Element
1	Raw Material Preparation: lifting soybeans from the warehouse and opening soybean sacks
2	Soybean Washing: pouring soybeans into the strainer/tub and washing them with water
3	Soybean Soaking: pouring soybeans into the box/tub and filling it with soaking water
4	Soybean Grinding: transferring soaked soybeans, sprinkling water, and grinding with a machine
5	Cooking: cutting firewood, lighting the boiler, cooking, and adding water
6	Filtering: washing/mounting the filter cloth and filtering the soybean extract
7	Coagulation: adding vinegar solution and draining the settled water
8	Molding: washing the cloth, transferring the tofu curd, and closing the mold
9	Cutting Tofu: opening the mold/cloth, measuring, and cutting the tofu
10	Transferring Tofu to Box: filling the box with water and transferring the tofu

Source: Observation Data

Cycle Time Measurement

Each work element was measured using a stopwatch for 18 observations (N=18). A recapitulation of the total time and average observation time for the 15 work sub-elements is presented in Table 6.

Table 6. Recapitulation of Cycle Time Measurement Results

No	Work Element	N (times)	Total Time (Minutes)	Average (Minutes)
1	Lifting soybeans from the warehouse and opening soybean sacks	18	51	2.8
2	Pouring soybeans into the strainer/tub and washing with water	18	159	8.8
3	Pouring soybeans into the box/tub and filling with soaking water	18	72	4

4	Transferring soaked soybeans to sacks/trays and sprinkling water	18	263	14.6
5	Turning on the grinding machine and pouring soybeans into the machine	18	204	11.3
6	Cutting firewood and lighting the boiler	18	80	4.4
7	Cooking and adding water after foaming	18	581	32.2
8	Washing/mounting the filter cloth and filtering the soybean extract	18	340	18.8
9	Adding vinegar solution and coagulation	18	192	10.6
10	Draining the settled water with a hose	18	79	4.3
11	Washing the cloth and placing it in the mold	18	29	1.6
12	Transferring the tofu curd to the mold and pulling the cloth	18	81	4.5
13	Closing the mold and lifting the weight stone	18	1090	60.5
14	Opening the mold/cloth, measuring, and cutting the tofu	18	47	2.6
15	Filling water into the tofu box and transferring the tofu into the box	18	64	3.5

Source: Observation Data (processed)

The data in Table 6 serve as the basis for the data uniformity test, the data adequacy test, and the calculation of normal time and standard time in the subsequent stages.

Data Uniformity Test

The data uniformity test was performed to ensure that the observed data fall within the control limits at a 95% confidence level (k=2), using the formula UCL = $\bar{x} + k\sigma$ and LCL = $\bar{x} - k\sigma$. The results of the uniformity test for all work elements are presented in Table 7.

Table 7. Results of Data Uniformity Test

No	Work Element	UCL	LCL	Standard Deviation	Average (Minutes)
1	Lifting soybeans from the warehouse and opening soybean sacks	3.56	2.05	0.38	2.8
2	Pouring soybeans into the strainer/tub and washing with water	10.36	7.24	0.78	8.8
3	Pouring soybeans into the box/tub and filling with soaking water	5.08	2.92	0.54	4
4	Transferring soaked soybeans to sacks/trays and sprinkling water	15.52	13.68	0.46	14.6
5	Turning on the grinding machine and pouring soybeans into the machine	12.66	9.94	0.68	11.3

No	Work Element	UCL	LCL	Standard Deviation	Average (Minutes)
6	Cutting firewood and lighting the boiler	5.8	3	0.7	4.4
7	Cooking and adding water after foaming	33.8	30.74	0.75	32.2
8	Washing/mounting the filter cloth and filtering the soybean extract	21.08	16.52	1.14	18.8
9	Adding vinegar solution and coagulation	11.96	9.24	0.68	10.6
10	Draining the settled water with a hose	5.52	3.08	0.61	4.3
11	Washing the cloth and placing it in the mold	2.6	0.6	0.5	1.6
12	Transferring the tofu curd to the mold and pulling the cloth	5.52	3.48	0.51	4.5
13	Closing the mold and lifting the weight stone	62.06	58.94	0.78	60.5
14	Opening the mold/cloth, measuring, and cutting the tofu	3.6	1.6	0.5	2.6
15	Filling water into the tofu box and transferring the tofu into the box	4.25	2.48	0.51	3.5

Source: Observation Data (processed)

Based on the control-limit calculation results in Table 7, all observation data fall within the UCL and LCL range, so the data are declared uniform and suitable for use in the subsequent calculation stages.

Data Adequacy Test

The data adequacy test was carried out with a 95% confidence level (k≈2) and a 10% degree of accuracy (s≈0.1) using the formula $N' = [(k/s)\sqrt{(N\sum x^2 - (\sum x)^2) / \sum x}]^2$. The data are declared adequate if the required number of observations (N′) is less than or equal to the number of observations already performed (N=18). The results of the data adequacy calculation for each work stage are presented in Table 8.

Table 8. Results of Data Adequacy Test

Sequence	Work Element	N (times)	N′ (Calculated Result)	Remarks
1	Raw Material Preparation	18	6.76	Adequate
2	Soybean Washing	18	2.89	Adequate
3	Soybean Soaking	18	3.3	Adequate
4	Soybean Grinding	18	0.36	Adequate
5	Cooking	18	1.36	Adequate

Sequence	Work Element	N (times)	N′ (Calculated Result)	Remarks
6	Filtering	18	9.48	Adequate
7	Coagulation	18	0.205	Adequate
8	Molding	18	0.23	Adequate
9	Cutting Tofu	18	1.56	Adequate
10	Transferring Tofu to Box	18	9.67	Adequate

Source: Observation Data (processed)

Table 8 shows that the N′ value for all work stages is smaller than N=18, so the number of observations already performed is declared adequate and no additional observations are required.

Performance Rating, Normal Time, and Standard Time

The performance rating assessment uses the Westinghouse system, which considers worker skill, effort, working condition, and consistency. Normal time is calculated by multiplying the average cycle time by the performance rating, while standard time is obtained by adding an allowance of 12% (10% worker allowance and 2% machine allowance) to the normal time using the formula Standard Time = Normal Time × [100%/(100%−%allowance)]. The calculation results are presented in Table 9.

Table 9. Performance Rating, Normal Time, and Standard Time

No	Work Element	Performance Rating	Average Cycle Time	Normal Time (Minutes)	Standard Time (Minutes)
1	Lifting soybeans from the warehouse and opening soybean sacks	1.11	2.8	3.108	3.11
2	Pouring soybeans into the strainer/tub and washing with water	1.07	8.8	9.416	9.42
3	Pouring soybeans into the box/tub and filling with soaking water	1.18	4	4.72	4.72
4	Transferring soaked soybeans to sacks/trays and sprinkling water	1.18	14.6	17.228	17.24
5	Turning on the grinding machine and pouring soybeans into the machine	1.12	11.3	12.656	12.67
6	Cutting firewood and lighting the boiler	1.08	4.4	4.752	4.75
7	Cooking and adding water after foaming	1.1	32.2	35.42	35.46
8	Washing/mounting the filter cloth and filtering the soybean extract	1.14	18.8	21.432	21.45
9	Adding vinegar solution and coagulation	1.18	10.6	12.508	12.52
10	Draining the settled water with a hose	1.18	4.3	5.074	5.08

No	Work Element	Performance Rating	Average Cycle Time	Normal Time (Minutes)	Standard Time (Minutes)
11	Washing the cloth and placing it in the mold	1.18	1.6	1.888	1.89
12	Transferring the tofu curd to the mold and pulling the cloth	1.18	4.5	5.31	5.31
13	Closing the mold and lifting the weight stone	1.18	60.5	71.39	71.47
14	Opening the mold/cloth, measuring, and cutting the tofu	1.13	2.6	2.938	2.94
15	Filling water into the tofu box and transferring the tofu into the box	1.18	3.5	4.13	4.13

Source: Data Processing Results

The total normal time for all tofu production work elements is 211.97 minutes, so the total standard time for the entire production process is 212.22 minutes. This standard time consists of 34.49 minutes for work elements 1–4, which are initial production activities (performed only once at the start, namely preparation through grinding of raw materials), and 177.73 minutes for work elements 5–15, which represent the standard time for processing one box of tofu. These findings show that the cooking process (work element 7) and mold closing (work element 13) are the activities with the largest standard time durations, at 35.46 minutes and 71.47 minutes respectively, making them the critical points (bottlenecks) in the tofu production process.

Figure 2. Tofu Product of the XYZ Tofu and Tempeh Factory Nabire

Source: XYZ Tofu and Tempeh Factory Nabire Documentation (August 2025)

Determination of the Number of Workers

The tofu production demand that must be met each day is 8 boxes, so the number of workers (JTK) required is calculated by dividing the workload by the total effective working time. The initial workload (2 workers, 6 boxes) is calculated as (6 × 177.73) + 34.49 = 1,100.87 minutes, while the improved workload (8 boxes) is calculated as (8 × 177.73) + 34.49 = 1,456.33 minutes. With a total effective working time of 9.35 hours (561 minutes) per day, JTK = 1,456.33 / 561 = 2.6 ≈ 3 workers.

Based on these calculation results, the workforce requirement for tofu production is 3 people, an increase from the initial condition of 2 people, so tofu production can be increased from 6 to 8

boxes per day. A comparison of the workload before and after the improvement in the number of workers is presented in Table 10.

Table 10. Improvement in the Number of Workers and Workload

Work Element	Initial Workers	Initial Workload (Minutes/Worker)	Improved Workers	Improved Workload (Minutes/Worker)
Tofu Production	2	550.435	3	485.443

Source: Data Processing Results. Initial workload = 1,100.87 : 2 = 550.435 minutes; improved workload = 1,456.33 : 3 = 485.443 minutes.

Adding one worker reduces the workload per worker from 550.435 minutes to 485.443 minutes, while simultaneously increasing production capacity from 6 to 8 boxes of tofu per day. As a result, the daily production target can be met and the workload of the tofu production workforce is significantly reduced.

Figure 3. Tofu and Tempeh Production Process at the XYZ Factory Nabire

Source: XYZ Tofu and Tempeh Factory Nabire Documentation (August 2025)

Scenario Analysis and Productivity

Scenario analysis was carried out to compare the impact of workforce policies on wage costs and factory income. Scenario one is the initial condition with 2 workers without a production increase; scenario two is 2 workers with an additional 4 hours of overtime per day, following the provisions of Law No. 35 of 2021 on Job Creation (overtime wage of 1.5 times the hourly wage), to reach a production of 8 boxes; and scenario three is an increase to 3 workers without overtime to reach a production of 8 boxes. The calculation results for wage costs and income for the three scenarios are presented in Table 11.

Table 11. Results of Cost and Income Scenario Analysis

Scenario	Workers	Daily Production	Monthly Wage Cost	Monthly Income
1 (Initial Condition)	2 people, no overtime	6 boxes (384 pieces)	IDR 3,000,000	IDR 89,160,000
2 (Overtime)	2 people + 4 hours overtime/day	8 boxes (512 pieces)	IDR 4,925,280	IDR 117,954,720
3 (Additional Worker)	3 people, no overtime	8 boxes (512 pieces)	IDR 4,500,000	IDR 118,380,000

Source: Data Processing Results

Productivity across scenarios is calculated using the formula Productivity = [(New Income − Old Income)/Old Income] × 100%. The comparison between scenarios 1 and 2 yields a productivity of 32%; the comparison between scenarios 1 and 3 yields a productivity of 32.7%; while the comparison between scenarios 2 and 3 yields only a 0.36% difference in productivity. A recapitulation of the productivity calculation results is presented in Table 12.

Table 12. Productivity Across Scenarios

Comparison	Income Difference	Productivity
Scenario 1 vs Scenario 2	IDR 28,794,720	32%
Scenario 1 vs Scenario 3	IDR 29,220,000	32.7%
Scenario 2 vs Scenario 3	IDR 425,280	0.36%

Source: Data Processing Results

The analysis results show that scenario three, namely adding one worker to make a total of 3 people to achieve a production of 8 boxes of tofu, provides the highest income of IDR 118,380,000 with a wage cost of IDR 4,500,000, and is more profitable than either scenario one or scenario two. Although scenario two (overtime) can also achieve the target production of 8 boxes, the overtime cost that the factory must pay is higher, while its productivity is only 0.36% behind scenario three, so adding workers remains a more efficient and sustainable policy compared to continuously relying on overtime hours.

Ergonomics and Workforce Scheduling Review

The workload assigned to employees directly affects company operations, because workload arises from task demands, the work environment, worker capability, and interactions among employees. Before the improvement, the two tofu production workers bore an average workload of 550.435 minutes per worker without any rest period from the beginning to the end of the process, unlike tempeh workers who have a break during the boiling process. This condition is consistent with physical ergonomics theory, which states that excessive physical workload sustained continuously without recovery time can cause fatigue, decrease work performance, and increase the risk of musculoskeletal disorders. After adding one worker, the workload per worker decreased to 485.443 minutes, so from an ergonomic standpoint the distribution of workload across three workers becomes more balanced, and the risk of work fatigue can be reduced, while still being able to meet the increased production target from 6 to 8 boxes of tofu per day.

From the workforce scheduling perspective, the results of this study confirm that scheduling relates to the allocation of the right resources, namely determining the right number of workers (right number), with the right specifications (right people), in the right place (right place), and at the right time (right time). Adding one worker to the tofu production section is a form of rescheduling the allocation of human resources that not only increases resource utilization and reduces process waiting time, but also reduces the risk of delays in meeting consumer demand. Compared with the option of adding overtime hours in scenario two, the option of adding workers in scenario three proved to be more profitable as well as more ergonomic, because it does not repeatedly burden the same workers with additional working hours, but instead distributes the workload to new workers, thereby better preserving long-term productivity sustainability.

Engineering Analysis Using the Need-Know-How-Solve Method

Engineering analysis using the Need-Know-How-Solve (NKHS) method was used to systematically formulate a solution for determining the number of workers. In the Know aspect, it is known that two workers were only able to produce 6 boxes of tofu (64 pieces per box) within a working time of 9.35 hours. In the How aspect, the time and motion study methodology was used to determine the standard time and workforce requirements in a measurable way. In the Solve aspect, the result of determining the number of workers shows that by adding one worker, the factory can produce more than 6 boxes, namely 8 boxes of tofu, within the same working hours. This finding confirms that determining the number of workers based on time and motion study can be an effective and efficient solution for small-to-medium-scale tofu and tempeh factories in meeting production demand without sacrificing worker welfare.

CONCLUSION

Based on the analysis and data processing conducted in this time-and-motion study at the XYZ tofu and tempeh factory in Nabire, it can be concluded that the standard time for the entire tofu production process was 212.22 minutes, consisting of 177.73 minutes for the production process per box of tofu and 34.49 minutes for initial production activities performed only once. The workload calculation results showed a decrease from 550.435 minutes per worker with two workers to 485.443 minutes per worker after increasing the workforce to three workers, which simultaneously increased production capacity from six to eight boxes of tofu per day. The improvement scenario involving three workers producing eight boxes of tofu resulted in wage costs of IDR 4,500,000 and income of IDR 118,380,000, making it more profitable than Scenario 1, with a productivity increase of 32.7%, and Scenario 2, involving overtime work, which only resulted in a productivity increase of 0.36%. Therefore, adding one worker was identified as the most optimal policy for the factory to meet production demand without overburdening existing workers. Based on these findings, it is recommended that the XYZ tofu and tempeh factory in Nabire periodically evaluate workload distribution and workforce requirements in each production unit to ensure that labor needs remain aligned with dynamic market demand. In addition, the factory may consider balancing workloads through worker rotation between the tempeh and tofu production units as a short-term alternative before recruiting additional workers, thereby reducing operational costs without compromising production capacity or worker welfare.

REFERENCES

Ariyani, L. (2019). Designing Clean Production of Tofu Processing Industry in UD. Sumber Urip Pelaihari. *Jurnal Agroindustri*.

Afiani, R., & Pujotomo, D. (2017). Penentuan waktu baku dengan metode stopwatch time study kasus CV. Mans Group. *Industrial Engineering Online Journal, 6*(1), 1–30.

Al Faridzi, S., Kusnadi, K., & Hamdani, H. (2022). Pengukuran waktu baku untuk menentukan produktivitas karyawan dengan menggunakan metode jam henti (Studi kasus CV. Mulia Tata Sejahtera). *Jurnal Serambi Engineering, 7*(1), 2693–2700. https://doi.org/10.32672/jse.v7i1.3832

Aminah, R. A. S., & Porusia, M. (2024). Hubungan masa kerja, jenis kelamin dan iklim kerja dengan kelelahan kerja di PT Batik X. *Holistik Jurnal Kesehatan, 18*(5), 652–659.

Ariyani, L. (2019). Designing clean production of tofu processing industry in UD. Sumber Urip Pelaihari. *Jurnal Agroindustri*.

Haikal, A. F. (2024). Analisis jumlah tenaga kerja pada industri tahu dengan metode work load analysis dan work force analysis (Studi kasus: Industri Tahu Bintang Samarinda). *Jurnal Teknik Industri dan Manufaktur, 8*(1), 1–14.

Hiller, M., Zahner, A., & Harvey, K. (2015). Green Climate Fund, Sustainable Development Goals, and energy access: A new opportunity for climate change and development. In *International energy and poverty* (pp. 216–227). Routledge.

Hoe, V. C. W., Urquhart, D. M., & van der Hulst, R. R. (2018). Ergonomic interventions for preventing work-related musculoskeletal disorders of the upper limb and neck among office workers. *Cochrane Database of Systematic Reviews*, (12).

Juwardi, U., Rahmat Adnan, S., Rachman, T., Derajat Amperajaya, M., Erni, N., Rasjidin, R., & Cahya Fajrah, M. (2023). Perhitungan waktu baku dan penentuan produktivitas pada pengerjaan pembersihan kaca Gedung X. *Jurnal Konversi Energi dan Manufaktur, 8*, 67–77.

Muti, A. A., Sari, T. N., & Ahmad, N. H. (2022). Determinasi patokan waktu pabrikasi dengan stopwatch time study (Studi kasus cemilan SBR). *Jurnal Rekayasa Sistem Industri, 8*(1), 36–40. https://doi.org/10.33884/jrsi.v8i1.6370

Nadiyah, K., Senjawati, M. I., Hidayat, M. S., & Jaeba, K. A. (2026). Integrated work mapping to optimize small-scale tofu production: Evidence from Padang, West Sumatra. *Jurnal IPTEK Bagi Masyarakat, 5*(3), 399–409.

Nurdiansyah, Y. A., & Satoto, H. F. (2023). Optimasi waktu standar kerja menggunakan metode stopwatch time study. *JURMATIS: Jurnal Manajemen Teknologi dan Teknik Industri, 5*(1), 59–68. https://doi.org/10.30737/jurmatis.v5i1.2913

Nurwidiana, N., & Ela, N. (2025). Designing sustainable value stream mapping to enhance sustainability performance in the tofu industry. *IOP Conference Series: Earth and Environmental Science, 1543*(1), 12026.

Rahma. (2025). Pengaruh ergonomi pada kantor teknik terhadap produktivitas kerja karyawan. *Lintas Ruang: Jurnal Pengetahuan dan Perancangan Desain Interior*.

Ramadhania, F. (2025). Strengthening vocational competencies and quality culture in small-scale food enterprises: A case study of tofu production improvement using the Six Sigma approach. *Journal of Supply Chain and Entrepreneurship, 1*(3), 111–120.

Saputro, D. D., Astuti, P., Santoso, D. B., & Rachmadi, M. F. (2024). Increasing productivity, quality, hygiene and marketing of tofu processed products in Gunungpati District, Semarang City. *Unram Journal of Community Service, 5*(4), 539–543.

Tajidan, T., Fernandez, E., Efendy, S. N., Mulyawati, S., & Rohman, M. A. (2024). The added value analysis of the tofu agro-industry business and its impact on the welfare of workers in Masbagik District. *International Journal of Innovative Research in Multidisciplinary Education*, 2833–4515.

Widjayanti, F. N. (2023). Analysis of agroindustry tofu in household scale Rambipuji District Jember Regency. *Proceeding International Conference on Economics, Business and Information Technology, 4*, 16–25.

Widodo, L., Sukania, I. W., & Hendri, M. (2022). Ergonomic intervention to improve work efficiency (Case study: Small and medium enterprise of tofu industry). *Journal of Modern*

Manufacturing Systems and Technology, 6(1), 32–40.
Yusuf, B. S. (2019). Analisis waktu baku dan jumlah pekerja berdasarkan beban kerja pada PT XYZ bagian packing. *1st Conference on Industrial Engineering and Halal Industries*, 18–24.
Zhang, Q., Wang, C., Li, B., Li, L., Lin, D., Chen, H., Liu, Y., Li, S., Qin, W., & Liu, J. (2018). Research progress in tofu processing: From raw materials to processing conditions. *Critical Reviews in Food Science and Nutrition, 58*(9), 1448–1467.