JURNAL REKAYASA SISTEM DAN INDUSTRI
e-ISSN: 2579-9142 p-ISSN: 2356-0843

https://journals.telkomuniversity.ac.id/jrsi

Workload Analysis to Determine Labor Requirements Using the Workload Analysis (WLA) Method

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ARTICLE INFO

Article history:
Received 10-05-2026
Fixed 27-05-2026
Approved 06-06-2026

Keywords:
Workload Analysis,
Workforce Planning,
Labor Requirements,
Shoe Manufacturing,
Productivity

ABSTRACT

UD. Hardi Jaya is a shoe manufacturing enterprise implementing a job order production system, causing fluctuating production demand and workload imbalances across production sections. This study aims to analyze workload and determine optimal workforce requirements using the Work Load Analysis (WLA) method. Data were collected through observation, interviews, documentation, and stopwatch time study involving 15 production operators in the cutting, sewing, manual work, sole installation, and packing sections. Data were analyzed using data uniformity and adequacy tests before calculating cycle time, normal time, standard time, and workload values. The results indicate that several operators experienced overload conditions with workload values above 100%, including Sole Installation 1 (114.54%), Sole Installation 2 (109.52%), Cutting 1 (102.85%), and Manual Work operators. The sole installation section was identified as the main production bottleneck with an output capacity of only 68 pairs per day, which was below the production target of 102 pairs per day. Based on WLA calculations, the ideal workforce requirement was 19 workers to achieve the production target of 3,067 pairs per month, compared with the current workforce of 15 workers. However, considering production capacity and labor cost factors, maintaining the existing workforce with an overtime system was considered more economical than recruiting additional workers. The WLA method can support workforce planning, workload balancing, and improved production efficiency.

1. Introduction

Small and medium manufacturing industries (SMEs) play an important role in supporting national economic growth, particularly in creating employment opportunities and fulfilling market demand. In facing increasingly competitive industrial conditions, companies are required to improve the efficiency and productivity of their production processes in order to maintain business sustainability. One of the factors influencing company productivity is proper workforce management in accordance with the workload at each production process [1].

In manufacturing industries, workforce allocation that is not aligned with actual workload conditions may lead to production inefficiencies, bottlenecks, excessive overtime, and decreased worker performance. Therefore, companies are required to implement systematic workload measurement to ensure that the number of workers and work capacity are proportional to production demands. Proper workload management not only affects productivity but also influences employee fatigue, work quality, and operational cost efficiency.

UD. Hardi Jaya is a company engaged in shoe manufacturing using a job order production system. This system causes product demand to fluctuate, requiring the company to adjust its production capacity according to market needs. In its production process, UD. Hardi Jaya consists of several work stages, including material cutting, sewing, manual work, sole installation, and packaging. Each stage has different work characteristics and completion times, which may lead to workload imbalance among workers.

The shoe manufacturing industry generally involves labor-intensive production activities where production performance is highly dependent on worker productivity and the effectiveness of labor allocation. In a job order production environment, fluctuations in customer demand often create uneven workloads among production sections. If this condition is not properly managed, several workstations may experience overload conditions while others experience underutilization, resulting in inefficient production flow and increased operational costs.

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DOI: https://doi.org/10.25124/jrsi.v13i01.11033

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Table 1
Production Data July 2025 – September 2025

Period	Demand (pairs)	Actual Production (pairs)	Remarks
Jul-25	3200	3200	Fulfilled
Aug-25	3260	3120	Unfulfilled
Sep-25	3000	2950	Unfulfilled
Oct-25	3000	3000	Fulfilled
Dec-25	2970	2970	Fulfilled
Dec-25	3150	3100	Unfulfilled

Based on production data from July to December 2025, the company experienced discrepancies between production demand and production realization during several periods. In addition, certain production sections had relatively high overtime levels, particularly in the sewing and sole installation sections. This condition indicates excessive workload in several production areas, where normal working hours are insufficient to achieve the production targets set by the company. Workload imbalance can reduce labor productivity, increase worker fatigue, and decrease overall production efficiency.

In addition, the distribution of workers in each production section at UD. Hardi Jaya is currently still based on company experience and production habits without a standardized workload measurement system. The company employs 15 production workers consisting of 1 cutting worker, 6 sewing workers, 4 manual workers, 2 sole installation workers, and 2 packing workers (see Table 2). The difference in the number of workers in each section indicates that each production stage has different workload characteristics and working time requirements. However, the current workforce allocation has not yet been evaluated based on actual workload conditions, which may result in workload imbalance among workers. Therefore, it is necessary to analyze whether the existing number of workers is proportional to the workload in each production section.

The current workforce determination approach at UD. Hardi Jaya reflects a common problem faced by many SMEs, where labor allocation decisions are often based on managerial intuition rather than quantitative analysis. Although experience-based decision-making may be practical in daily operations, it does not provide objective information regarding worker utilization levels, standard working time, and actual labor requirements. As a result, the company may experience either labor shortages or labor inefficiencies in several production sections.

Table 2
Departmental Data and Workforce Distribution

No	Production Section	Number of Workers
1	Cutting	1
2	Sewing	6
3	Manual Work	4
4	Sole Installation	2
5	Packing	2
	Total	**15**

Currently, workforce determination at UD. Hardi Jaya is still based on company experience and habitual estimation without standardized work measurement. As a result, the company cannot accurately determine whether the existing number of workers matches the actual workload requirements in each production process. Therefore, a method is needed to systematically analyze worker workload to determine the optimal workforce requirement.

Several previous studies have shown that workload analysis can be effectively used to identify workload imbalance and determine optimal labor requirements in manufacturing industries. Workload measurement based on working time analysis provides quantitative information regarding operator capacity, standard time, and workforce utilization levels. By implementing a systematic workload analysis method, companies can improve production efficiency, reduce unnecessary overtime, and optimize workforce planning. Previous studies primarily focused on applying the WLA method only for determining workforce requirements. However, limited studies have evaluated workforce recommendations together with production bottlenecks and labor cost implications in labor-intensive SMEs. Therefore, this study contributes by integrating workload measurement, bottleneck identification, and workforce cost analysis within a shoe manufacturing environment.

One method that can be used to analyze workforce requirements is the Workload Analysis (WLA) method. WLA is used to measure workload levels based on the working time required to complete a particular activity. Through this method, companies can identify workforce utilization levels and determine the appropriate number of workers according to work capacity and production targets. The implementation of WLA is expected to help the company create a more balanced work distribution, improve work efficiency, and reduce excessive workloads in certain sections [2].

The Workload Analysis (WLA) method is widely used in industrial engineering studies because it can evaluate labor workload quantitatively through the calculation of cycle time, normal time, standard time, and allowance factors. In addition, WLA can provide recommendations regarding the optimal number of workers needed to achieve production targets under normal working conditions. This method is considered suitable for labor-intensive industries such as shoe manufacturing, where production activities heavily depend on manual operations and workforce performance. Based on the identified problems, this study aims to analyze worker workload and determine the optimal number of workers in each production section at UD. Hardi Jaya using the Workload Analysis (WLA) method. The results of this study are expected to provide recommendations for improving workforce allocation, balancing workload distribution, reducing excessive overtime, and enhancing production efficiency within the company.

2. Research methods

This research was conducted at UD. Hardi Jaya, a small and medium-sized enterprise (SME) engaged in shoe manufacturing in Mojokerto, Indonesia. The object of this study focuses on production workers involved in the shoe manufacturing process, including the cutting, sewing, manual work, sole installation, and packing sections. This study aims to analyze worker workload and determine the optimal number of workers using the Workload Analysis (WLA) method. Through workload measurement based on working time, the study is expected to identify workload imbalances and provide recommendations regarding workforce requirements in order to improve productivity and production efficiency [3].

The research flowchart illustrates the research stages carried out systematically, starting from problem identification and literature study, followed by data collection through observation, interviews, documentation, and work time measurement using a stopwatch. The observed data were then tested using data uniformity and data adequacy tests to ensure that the data were feasible for analysis. After the data were declared adequate and uniform, cycle time, normal time, and standard time calculations were performed, followed by workload analysis using the Workload Analysis (WLA) method to determine the optimal workforce requirements in each production section, resulting in research conclusions and recommendations.

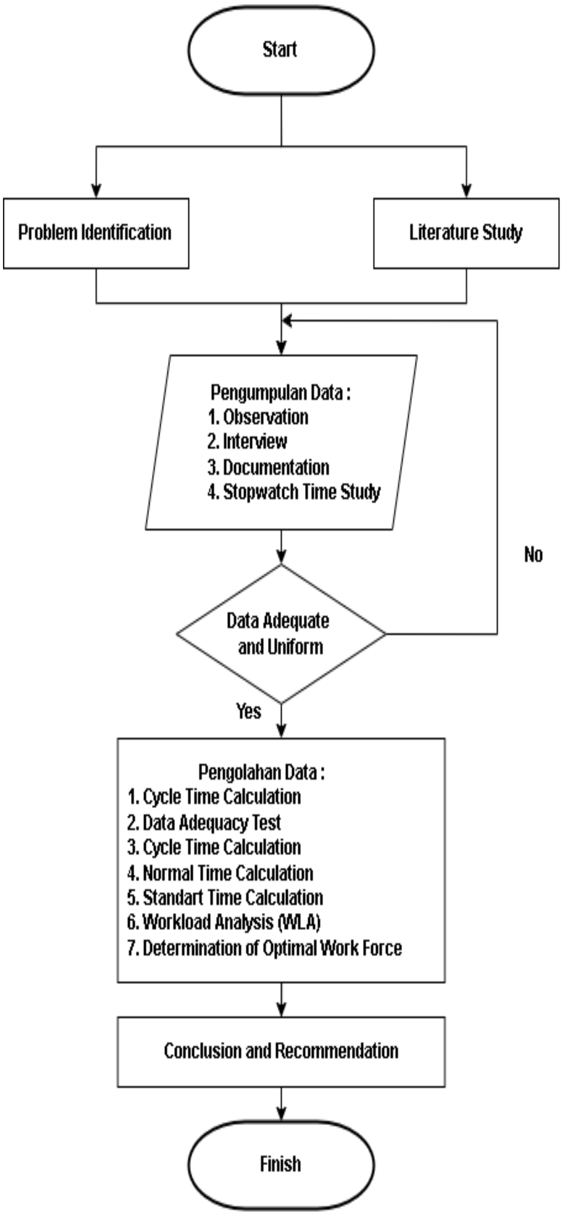

Figure 1 Research Stages

2.1 Research Procedure

Based on observations of the production process at UD. Hardi Jaya, several problems related to workload management were identified, particularly in terms of the absence of a systematic and standardized workload measurement approach. Currently, the determination of the number of workers in each production section is carried out based on experience and managerial judgment rather than on quantitative analysis. This condition indicates that the company has not yet utilized work measurement techniques, such as standard time determination, which are essential for evaluating labor productivity and capacity in a manufacturing system [4]. In addition, the production system at UD. Hardi Jaya operates under a job order system, where production volumes fluctuate depending on customer demand. This dynamic condition requires flexible and well-planned workforce allocation. However, in practice, the company has not adjusted the number of workers based on actual workload requirements. As a result, there is a mismatch between workload and workforce capacity, which affects overall production performance.

Furthermore, an imbalance of workload among production sections was observed. Certain sections, particularly stitching and sole assembly, experience significantly higher workloads compared to other sections. This is evidenced by the high number of overtime hours recorded in these sections. On the other hand, some sections, such as cutting and packing, tend to have lower levels of workload, indicating underutilization of labor. This imbalance reflects an inefficient distribution of tasks and may lead to bottlenecks in the production flow [5].

The absence of standard time calculation also prevents the company from quantitatively evaluating worker performance and workload levels. Without standard time, it is difficult to determine whether a worker is operating under normal, underload, or overload conditions [6]. According to previous studies, workload analysis plays a crucial role in identifying the level of labor utilization and in determining the optimal number of workers required for each workstation. Moreover, the company has not incorporated allowance factors into its work system. Allowances, which include personal needs, fatigue, and unavoidable delays, are essential components in determining realistic working time. Without considering these factors, the calculated working time may not accurately reflect actual working conditions. This can lead to excessive workload in certain sections and inefficiencies such as idle time in others.

In addition to workload imbalance, the lack of proper workload analysis also impacts production performance. The company has experienced difficulties in meeting production targets in several periods, which indicates that the existing workforce capacity is not aligned with production demands. This condition further emphasizes the need for a structured approach to workload measurement.

2.2 Data Collection

The data used in this study consist of primary and secondary data collected to support workload analysis. Primary data were obtained through direct observation and stopwatch time study conducted on the production floor. Direct observation was carried out to understand the workflow and identify work elements at each production stage, including cutting, stitching, manual work, sole assembly, and packing. Meanwhile, the time study was conducted by measuring the time required by workers to complete each task repeatedly in order to obtain accurate and representative working time data.

In addition, interviews were conducted with workers and supervisors to gather qualitative information related to work procedures, job distribution, and factors affecting work performance. This method was also used to validate the results of observation and time measurement, ensuring that the collected data reflect actual working conditions.

Secondary data were obtained through company documentation, including the number of workers, working hours, production output, and overtime data. These data were used to support the calculation of effective working time and workforce requirements. The combination of these data collection techniques ensures that the data are valid and reliable, providing a strong foundation for workload analysis using the Workload Analysis (WLA) method.

2.3 Data Processing (Work Load Analysis)

The data processing in this study was carried out using the Work Load Analysis (WLA) method to determine the workload and the optimal number of workers required in each production stage. The data obtained from work time measurements were processed systematically, starting with data validation through uniformity and adequacy tests to ensure reliability. The validated data were then used to calculate cycle time, normal time using performance rating, and standard time by incorporating allowance factors. Furthermore, the standard time was used to estimate the total production time, which was compared with the effective working time to determine the required number of workers and workload percentage as a basis for evaluating labor efficiency [2]. Fifteen observations were selected because work measurement studies generally recommend a minimum sample size to ensure statistical stability and representation of work conditions. Performance rating was determined using the Westinghouse system based on skill, effort, conditions, and consistency. Allowance values were determined considering personal needs, fatigue, and unavoidable delays. The results of the WLA were then used to identify whether the current workforce distribution was balanced and efficient. Through this analysis, workstations with excessive or insufficient workloads could be identified, enabling the company to make improvements in labor allocation and production planning.

2.3.1 Cycle Time Calculation

The cycle time represents the average time required to complete one work cycle, obtained from repeated observations. This value serves as the basis for determining normal time and standard time.

$$Ws = \frac{\sum xi}{n}$$

Where:
Ws = Average cycle time
Xi = Observation time (i-th)
n = Number of observations

2.3.2 Data Uniformity Test

The data uniformity test is conducted to ensure that the observed time data are within acceptable control limits (homogeneous). This test involves calculating the mean, standard deviation, and control limits, namely the Upper Control Limit (UCL) and Lower Control Limit (LCL).

a. Mean

$$\bar{x} = \frac{\sum xi}{n}$$

b. Standart Deviation

$$SD = \sqrt{\frac{\sum(xi-\bar{x}}{n-1}}$$

c. Control Limits

$$UCL = \bar{x} + k.SD$$
$$LCL = \bar{x} - k.SD$$

where:
$\bar{x}$ = Mean of observations
SD = Standard deviation
k = Confidence level constant

2.3.3 Data Adequacy Test

$$N' = \left(\frac{\frac{k}{s}\sqrt{N\sum(xi^2)-(\sum x)^2}}{\sum x}\right)^2$$

Where:
N' = Required number of observations
N = Number of observations conducted
X = Observation time
K = Confidence level
S = Degree of accuracy

2.3.4 Normal Time Calculation

Normal time is obtained by adjusting the cycle time using a performance rating factor, which reflects the operator's working performance under normal conditions.

$$Wn = Ws \times PR$$

Where:
Wn = Normal time
Ws = Cycle time
PR = Performance rating

2.3.5 Standard Time Calculation

Standard time is calculated by incorporating an allowance factor into the normal time. The allowance accounts for personal needs, fatigue, and unavoidable delays.

$$Wb = Wn \times (1 + Allowance)$$

Where:
Wb = Standard time
Wn = Normal time
Allowance = Allowance factor

2.3.6 Total Production Time Requirement

The total production time is calculated to determine the amount of time required to achieve the production target within a specific production period. This calculation is important for production planning and workforce allocation.

$$TW = W_b \times Output$$

where:
TW = Total production time
Wb = Standard time
Output = Production quantity

2.3.7 Perfomance Rating

Performance rating is used to evaluate the operator's performance level in carrying out a task compared to standard working conditions. This assessment considers several factors, including skill, effort, working conditions, and consistency. The rating is then used to adjust the observed cycle time into normal time.

The performance rating method used in this study adopts the Westinghouse System, which evaluates four main factors: skill, effort, working conditions, and consistency. Each factor has a specific rating scale that contributes to the overall performance rating value. The detailed performance rating criteria used in this study are presented in Table 3.

Table 3
Performance Rating

Skill			Effort		
0,15	A1	Super Skill	0,13	A1	Excessive
0,13	A2		0,12	A2	
0,11	B1	Excellent	0,1	B1	Excellent
0,08	B2		0,08	B2	
0,06	C1	Good	0,05	C1	Good
0,03	C2		0,02	C2	
0.00	D	Average	0.00	D	Average
-0,05	E1	Fair	-0,04	E1	Fair
-0,1	E2		-0,08	E2	
-0,16	F1	Poor	-0,12	F1	Poor
-0,22	F2		-0,17	F2	
Condition			**Concistency**		
+0.06	A	Ideal	+0.04	A	Perfect
+0.04	B	Excellent	+0.03	B	Excellent
+0.02	C	Good	+0.01	C	Good
0.00	D	Average	0.00	D	Average
-0.03	E	Fair	-0.02	E	Fair
-0.07	F	Poor	-0.04	F	Poor

3. Results and Discussion

3.1 Cycle Time Measurement

Cycle time data in this study was obtained through 15 direct observations of each work element in the production process. The 15 repetitions were conducted to ensure that the data collected is more accurate, stable, and representative of actual working conditions in the field. All observation results were then averaged to obtain the standard cycle time, which is used in the WLA calculation. This data serves as the main basis for determining the operator's workload level as well as evaluating labor requirements in the production process.

After 30 observations were conducted for each work element, the total cycle time from all measurements was obtained. Subsequently, the average cycle time was calculated by dividing the total time by the number of observations, resulting in a value that is more representative of actual working conditions. This average value is then used as the basis in the WLA to calculate the operator's workload [7]. In addition, a data consistency test was conducted to ensure that the observation data were statistically stable and within acceptable control limits. This test is important to verify that the recorded cycle times do not contain significant deviations that could affect the accuracy of workload calculations. The consistency test was carried out by determining the UCL and LCL for each work element.

Before presenting the time data, a recap of the observation results was carried out to identify the total processing time and the average cycle time for each worker involved in the production process. The measurement results indicate differences in working time among operators, which are influenced by the type of task, work complexity, and individual working performance. The average cycle time obtained from the observations is then used as the basis for further calculations, including normal time, standard time, and workforce requirements analysis. The detailed results of the time measurements for each worker are presented in Table 4.

Table 4
Time Data

No	Worker	Total Time	Average Time
1	Cutting 1	20787	693
2	Sewing 1	5425	181
3	Sewing 2	7373	246
4	Sewing 3	7334	244
5	Sewing 4	5495	183
6	Sewing 5	5477	183
7	Sewing 6	3670	122
8	Manual Work 1	4480	149
9	Manual Work 2	4542	151
10	Manual Work 3	3606	120
11	Manual Work 4	3595	120
12	Sole Instalation 1	10280	343
13	Sole Instalation 2	10252	342
14	Packing 1	6005	200
15	Packing 2	6076	200

3.2 Data Uniformity Test

The data uniformity test was conducted to ensure that the observed data are consistent and do not contain significant deviations. This test aims to determine whether the collected work time data originates from a stable process condition, making it suitable for further analysis [8]. Through the data uniformity test, any potential outliers or inconsistent data caused by certain factors during the observation process can be identified. The results of this test serve as a basis for ensuring data reliability before being used in the Work Load Analysis (WLA) calculation.

Based on the data processing results presented above, a statistical evaluation of 15 work elements was conducted to ensure data validity through consistency and adequacy testing. The calculation results indicate that all observed cycle times fall within the Upper Control Limit (UCL) and Lower Control Limit (LCL), with high Confidence Levels (CL) ranging from 93.2% to 99.3%. The controlled standard deviation (σ) and precision values (S), which mostly remain below the significant threshold, demonstrate that the collected data is uniform and representative of actual field conditions. Consequently, the data is declared statistically sufficient and valid for use in the subsequent stages of standard time calculation and production capacity planning.

3.3 Data Adequacy Test

The data adequacy test is conducted to determine whether the number of observations collected is sufficient to represent the actual working conditions with an acceptable level of accuracy. This test ensures that the data used in the analysis meets the required confidence level and precision. By performing the data adequacy test, it can be evaluated whether additional observations are needed or if the existing data is adequate for further analysis.

Table 5
Data Consistency Test

No	Process	$\bar{x}$	σ	S	CL	k	UCL	LCL
1	Cutting 1	692.90	18.78	2.7%	97.3%	3	749.24	636.56
2	Sewing 1	180.83	4.38	2.4%	97.6%	3	193.97	167.70
3	Sewing 2	245.77	04.08	1.7%	98.3%	3	258.01	233.52
4	Sewing 3	244.47	4.44	1.8%	98.2%	3	257.78	231.15
5	Sewing 4	183.17	3.59	2.0%	98.0%	3	193.94	172.39
6	Sewing 5	182.57	4.55	2.5%	97.5%	3	196.23	168.91
7	Sewing 6	122.33	2.99	2.4%	97.6%	3	131.29	113.37
8	Manual Work 1	149.33	7.81	5.2%	94.8%	2	164.94	133.72
9	Manual Work 2	151.40	6.34	4.2%	95.8%	3	170.42	132.38
10	Manual Work 3	120.20	8.21	6.8%	93.2%	2	136.61	103.79
11	Manual Work 4	119.83	6.64	5.5%	94.5%	2	133.11	106.56
12	Sole Installation 1	342.67	11.58	3.4%	96.6%	3	377.40	307.94
13	Sole Installation 2	341.73	9.60	2.8%	97.2%	3	370.54	312.93
14	Packing 1	200.17	1.34	0.7%	99.3%	3	204.19	196.14
15	Packing 2	202.53	2.11	1.0%	99.0%	3	208.87	196.19

Table 6
Data Adequacy Test

No	Proces	N'	N
1	Cutting 1	2,56	30
2	Sewing 1	2,04	30
3	Sewing 2	0,96	30
4	Sewing 3	1,15	30
5	Sewing 4	1,34	30
6	Sewing 5	2,17	30
7	Sewing 6	2,07	30
8	Manual Work 1	4,23	30
9	Manual Work 2	6,10	30
10	Manual Work 3	7,21	30
11	Manual Work 4	4,75	30
12	Sole Instalation 1	3,97	30
13	Sole Instalation 2	2,75	30
14	Packing 1	0,16	30
15	Packing 2	0,38	30

The table presents the results of the data adequacy test for 15 production process elements, where the statistical analysis confirms that all collected data are sufficient. This is evidenced by the fact that the minimum required number of observations (N') for every process ranging from cutting to packing is consistently lower than the actual number of observations conducted (N = 15). Since the criteria N' < N is satisfied across all elements, the recorded time data is considered statistically representative and valid, allowing the study to proceed to the standard time calculation phase without the need for additional sampling.

3.4 Performance Rating Determination

Performance rating is an adjustment factor used to assess the operator's level of performance in completing a task compared to normal working conditions. This evaluation is based on several aspects, namely skill, effort, working conditions, and consistency (see Table 7). Each aspect is assigned a value based on field observations, which are then summed to obtain the performance adjustment value [3], [9].

The performance rating for the operators was evaluated using the Westinghouse system, which assesses four key factors: skill, effort, conditions, and consistency. Based on the summary of all process elements, the total adjustment values range from +0.10 to +0.12, resulting in a calculated performance rating factor (P) between 1.10 and 1.12. These figures indicate that the operators performed above the normal average (super-average), with skill and effort factors contributing most significantly to overall work effectiveness. Assigning a rating factor greater than 1.00 serves to normalize the average cycle time into normal time, ensuring a fair and objective measurement for high-performing operators.

Table 7
Performance Rating Determination

No	Process	Skill	Effort	Condition	Consistency	Total
1	Cutting 1	+0.08	+0.05	+0.02	+0.01	0.16
2	Sewing 1	+0.06	+0.05	+0.00	+0.01	0.12
3	Sewing 2	+0.08	+0.05	+0.02	+0.01	0.16
4	Sewing 3	+0.06	+0.08	+0.00	+0.01	0.15
5	Sewing 4	+0.06	+0.05	+0.02	+0.01	0.14
6	Sewing 5	+0.08	+0.05	+0.00	+0.01	0.14
7	Sewing 6	+0.06	+0.05	+0.02	+0.01	0.14
8	Manual Work 1	+0.06	+0.05	+0.00	+0.01	0.12
9	Manual Work 2	+0.08	+0.05	+0.02	+0.01	0.16
10	Manual Work 3	+0.06	+0.08	+0.00	+0.01	0.15
11	Manual Work 4	+0.06	+0.05	+0.02	+0.01	0.14
12	Sole Installation 1	+0.08	+0.08	+0.02	+0.01	0.19
13	Sole Installation 2	+0.06	+0.05	+0.02	+0.01	0.14
14	Packing 1	+0.06	+0.02	+0.02	+0.01	0.11
15	Packing 2	+0.08	+0.05	+0.00	+0.01	0.14

3.5 Allowance

Allowance is an additional factor in work time calculations to account for personal needs, fatigue, and unavoidable delays. It ensures that the standard time is more realistic and reflects actual working conditions [1]. The allowance values presented in the Table 8 indicate the amount of allowance given to each operator based on the observed working conditions. These values are then used in the calculation of standard time to ensure that the resulting work time is more realistic and applicable to actual working conditions.

3.6 Workload Calculation

Workload Analysis is conducted to evaluate operator efficiency by comparing required versus available working time [10]. Based on the results in Table 6, the workload is calculated by multiplying the productive percentage, performance rating, and allowance factor [10]. This identifies whether task distribution is normal, excessive, or insufficient, allowing for the detection of labor imbalances and utilization inefficiencies.

The results of the workload calculation in the Table 9 show that the workload values range from 93.84% to 114.54%. Several operators have values above 100%, such as Cutting 1 (102.85%), Sewing 3 (102.36%), Manual Work 2 (102.85%), Manual Work 3 (101.77%), Sole Installation 1 (114.54%), Sole Installation 2 (109.52%), and Packing 2 (100.69%), indicating overload conditions. Meanwhile, some operators are below 100%, such as Sewing 4 (93.84%), Sewing 6 (93.84%), and Manual Work 4 (94.03%), indicating underload conditions. Overall, most workload values fall within the range of 95%–102%, suggesting that the workload is relatively close to optimal conditions.

3.7 Workforce Planning Results

This section presents the workforce planning results based on workload analysis for each element of the production process. The calculation in the Table 10 conducted using standard time as the main basis, with the bottleneck in the sole attachment process recorded at 422.56 seconds, resulting in a standard output of 9 pairs per hour or 68 pairs per day. This output remains below the production target of 102 pairs per day, indicating a chronic overtime condition within the work system. By applying the WLA-based workforce calculation across 15 work elements, using a monthly demand of 3,067 pairs and 748,800 seconds of available productive time per month, the total optimal workforce requirement is determined to be 19 workers. Table 7 presents the detailed workforce requirement calculation for each work element.

The bottleneck condition in the sole installation section may be caused by longer manual processing time and lower operational capacity compared to other workstations [11]. From a managerial perspective, management may consider workstation redesign, operator redistribution, or process improvement initiatives. The calculation results reveal significant variations in standard hourly output across departments. The highest capacity is observed in the Cutting 1 process (32 units/hr) and several Manual Work stages (26 units/hr). Conversely, the lowest capacity, identifying them as production bottlenecks, is found in Sole Installation 1 and 2, which produce only 9 units per hour. This indicates that the sole installation process is the most labor-intensive and time-consuming stage within the production line.

Table 8
Allowance

No	Process	Personal	Fatigue	Delay	Total (minutes)	Allowance (%)
1	Cutting 1	4	5	6	15	3.10%
2	Sewing 1	3	5	6	14	2.90%
3	Sewing 2	4	6	6	16	3.30%
4	Sewing 3	4	6	7	17	3.50%
5	Sewing 4	3	5	6	14	2.90%
6	Sewing 5	4	6	6	16	3.30%
7	Sewing 6	3	5	6	14	2.90%
8	Manual Work 1	3	5	6	14	2.90%
9	Manual Work 2	4	5	6	15	3.10%
10	Manual Work 3	3	5	6	14	2.90%
11	Manual Work 4	4	5	6	15	3.10%
12	Sole Installation 1	4	6	7	17	3.50%
13	Sole Installation 2	4	6	6	16	3.30%
14	Packing 1	3	4	5	12	2.50%
15	Packing 2	3	4	6	13	2.70%

Table 9
Workload Calculation

No	Process	Productivity (%)	Performance Rating	Allowance (%)	Workload (%)
1	Cutting 1	86,00%	0,16	3,10%	102,85%
2	Sewing 1	83,00%	0,12	2,90%	95,66%
3	Sewing 2	83,00%	0,16	3,30%	99,46%
4	Sewing 3	86,00%	0,15	3,50%	102,36%
5	Sewing 4	80,00%	0,14	2,90%	93,84%
6	Sewing 5	83,00%	0,14	3,30%	97,74%
7	Sewing 6	80,00%	0,14	2,90%	93,84%
8	Manual Work 1	83,00%	0,12	2,90%	95,66%
9	Manual Work 2	86,00%	0,16	3,10%	102,85%
10	Manual Work 3	86,00%	0,15	2,90%	101,77%
11	Manual Work 4	80,00%	0,14	3,10%	94,03%
12	Sole Installation 1	93,00%	0,19	3,50%	114,54%
13	Sole Installation 2	93,00%	0,14	3,30%	109,52%
14	Packing 1	86,00%	0,11	2,50%	97,85%
15	Packing 2	86,00%	0,14	2,70%	100,69%

Table 10
Workforce Requirement Calculation

No	Process	Standard Output/hour	Standard Output/day	Workers Needed
1	Cutting 1	32	252	0.47
2	Sewing 1	18	138	0.86
3	Sewing 2	13	98	1.22
4	Sewing 3	13	99	1.20
5	Sewing 4	17	134	0.89
6	Sewing 5	17	134	0.89
7	Sewing 6	26	201	0.59
8	Manual Work 1	21	167	0.71
9	Manual Work 2	20	159	0.75
10	Manual Work 3	26	202	0.59
11	Manual Work 4	26	204	0.58
12	Sole Installation 1	9	68	1.75
13	Sole Installation 2	9	71	1.67
14	Packing 1	16	126	0.94
15	Packing 2	16	123	0.97
		Total		19

3.8 Capacity and Cost Planning

The production process at UD. Hardi Jaya employs 15 workers across several divisions. This serves as the basis for capacity and cost planning, where the daily wage of Rp.70.000 (Rp.8.750/hour) is used to calculate the monthly labor cost. This planning is essential to ensure that the workforce allocation aligns with production targets efficiently [9].

Tabel 11
Labor Cost Calculation Summary

Description	Formula	Cost
Daily wage/person	Rp70,000/day	Rp70,000
Monthly wage/person	Rp70,000 × 26	Rp1,820,000
Existing workforce (15 workers)	Rp1,820,000 × 15	Rp27,300,000
WLA workforce requirement (19 workers)	Rp1,820,000 × 19	Rp34,580,000
Total overtime cost (6 months)	Accumulated overtime cost	Rp14,512,500

a. Calculations using Workload Analysis (WLA)
   The calculation using Workload Analysis (WLA) indicates a requirement of 19 workers. Consequently, UD. Hardi Jaya must incur a total labor cost of Rp1.820.000×19=Rp34.580.000 per month, or Rp34.580.000×6=Rp207.480.000 for a 6-month period.

b. Overtime Cost Calculation
   The calculation involves 15 workers with additional overtime hours. The overtime rate is set at Rp.8.750 per hour, with a standard working time of 208 hours per month.

Table 12
Overtime Hours Calculation

Period	Overtime Hours	Overtime Cost (Rp.10,750)	Number of Workers	Total Cost
July	12	Rp129,00	15	Rp1,935,000
August	24	Rp258,00	15	Rp3,870,000
September	16	Rp172,00	15	Rp2,580,000
October	10	Rp107,50	15	Rp1,612,500
November	8	Rp86,00	15	Rp1,290,000
December	20	Rp215,00	15	Rp3,225,000
Total				**Rp14,512,500**

Based on the capacity planning for a workforce of 15 employees, the total operational cost incurred by UD. Surya Sejati includes both basic wages and overtime compensation. The calculation for a 6-month period results in a total basic labor cost of Rp163.800.000. When combined with the accumulated overtime cost of Rp.14.512.500, the overall expenditure for the 6-month duration reaches Rp178.312.500. This figure represents the total financial commitment required to maintain production stability using the existing workforce under the specified overtime scenario [9]. This study contributes theoretically by extending the application of Workload Analysis in labor-intensive SMEs through the integration of workload measurement, production bottleneck identification, and workforce cost analysis [12], [13].

4. Conclusion

Based on the results of the workload analysis and workforce determination at UD. Hardi Jaya, it can be concluded that the implementation of the Work Load Analysis (WLA) method successfully identified workload imbalances among several production sections. The analysis showed that several operators experienced overload conditions, particularly in the sole installation section, which became the main production bottleneck with an output capacity of only 9 pairs per hour or 68 pairs per day. This condition indicates that the available working time in several production processes is insufficient to meet production targets under normal working hours, resulting in overtime activities in order to maintain production continuity.

The calculation of standard time and workforce requirements indicates that the company ideally requires 19 workers to achieve the monthly production target of 3,067 pairs optimally. However, the current workforce at UD. Hardi Jaya consists of only 15 workers distributed across the cutting, sewing, manual work, sole installation, and packing sections. Several workload values obtained from the WLA calculation exceeded 100%, such as Sole Installation 1 at 114.54%, Sole Installation 2 at 109.52%, Cutting 1 at 102.85%, and Manual Work 2 at 102.85%, indicating excessive workload conditions that may affect worker productivity and increase fatigue levels if maintained continuously. Based on the labor capacity and cost analysis, if the company follows the WLA recommendation by increasing the workforce from 15 workers to 19 workers, the company would incur a total labor cost of Rp34.580.000 per month or Rp207.480.000 for a 6-month period. On the other hand, maintaining the current 15 workers while implementing an overtime system would result in a total operational cost of Rp178.312.500 over a 6-month period, consisting of Rp163.800.000 in labor costs and Rp14.512.500 in overtime expenses. Although overtime increases worker working hours, this alternative is considered more economical and realistic for the company compared to recruiting additional workers, especially considering the fluctuating production demand under the job order production system applied by the company.

Although maintaining 15 workers with overtime is financially more economical in the short term, continuous overload conditions may create several long-term risks. Excessive workload and prolonged overtime can increase worker fatigue, reduce concentration levels, increase defect rates, and decrease productivity over time. In addition, sustained overload conditions may increase employee turnover and negatively affect product quality consistency. Therefore, overtime implementation should be considered a temporary strategy rather than a permanent workforce policy. Therefore, from both operational and economic perspectives, it is recommended that UD. Hardi Jaya maintain the current workforce of 15 workers while optimizing overtime scheduling in sections experiencing overload conditions, particularly in the sole installation process. In addition, the company is advised to improve work distribution, monitor worker fatigue levels, and periodically evaluate workload conditions to maintain productivity and operational efficiency. The implementation of the WLA method in this study has proven effective in providing a quantitative basis for workforce planning, workload balancing, and production capacity management within the company.Reference. Future studies may integrate the WLA method with line balancing techniques, simulation models, or ergonomic assessment methods to provide more comprehensive workforce planning and production optimization strategies.

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