Volume 13 Number 01 (2026)

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

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

Optimization of Workforce Placement in Box HEPA Production Using Workload Analysis Method to Fulfill Production Demand

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ARTICLE INFO

Article history:
Received 18-05-2026
Fixed 27-05-2026
Approved 29-06-2026

Keywords:
Workload Analysis, Time Study, Capacity Planning, Workforce Optimization

ABSTRACT

CV. XYZ experienced production inefficiencies due to workload imbalance among production departments, particularly in the Welding Division, resulting in bottlenecks, overtime, and the inability to consistently meet production demand. This study aims to determine the standard production time, evaluate worker workload, identify the optimal workforce allocation, and compare workforce planning alternatives to improve production efficiency. A quantitative approach was employed using direct observation, interviews, and stopwatch time studies involving 20 observations for each work element. Data were validated through uniformity and adequacy tests before calculating cycle time, normal time, standard time, and workload using the Workload Analysis (WLA) method. The findings indicate that the total standard production time for one Box HEPA unit is 217 minutes. Based on WLA, the production process requires six workers distributed across four production departments. Furthermore, capacity and cost planning identified an alternative workforce configuration consisting of four workers supported by planned overtime, reducing monthly labor costs from Rp 21,658,000 to Rp 15,379,030, resulting in a cost saving of Rp 6,278,970 (approximately 29%) while maintaining the required production capacity. The proposed approach enables a more balanced workload distribution, reduces labor inefficiencies, and supports better workforce planning in a make-to-order manufacturing environment. This study contributes by integrating time study, workload analysis, and capacity-cost planning into a practical decision-support framework that can assist small and medium-sized manufacturing enterprises in optimizing workforce allocation and improving operational performance.

1. Introduction

Small and medium-scale manufacturing industries play a crucial role in supporting national economic growth. In an increasingly competitive industrial landscape, companies are required to improve the efficiency and productivity of their production processes. One of the key factors influencing productivity is appropriate workforce management in accordance with the workload at each stage of production [1]. Effective workforce allocation not only affects production output but also influences operational efficiency, labor utilization, production lead time, and the company's ability to fulfill customer demand consistently. In labor-intensive manufacturing industries, improper workforce allocation may result in bottlenecks, idle time, excessive overtime, and decreased production performance.

CV. XYZ, located in Waru, Sidoarjo, is a manufacturing company engaged in the production of stainless steel and iron-based goods under a make-to-order production system. The primary product manufactured on a regular monthly basis is the Box Hepa Ducting, which is routinely ordered by other companies. The production process encompasses the following stages: Cutting and Bending, Welding, Coating/Painting, Finishing, and Packing. As a make-to-order manufacturer, the company is highly dependent on workforce flexibility and production capacity balance to meet fluctuating customer demand within the required lead time. Therefore, production planning and workforce allocation become critical aspects in maintaining operational continuity and customer satisfaction.

The primary issue confronting the company is a workload imbalance among work stations. The Welding Division operates with only one worker, whereas other divisions employ two operators, resulting in material accumulation (bottleneck)

DOI: https://doi.org/10.25124/jrsi.v13i01.11114

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at that station. This condition subsequently causes production delays and unmet customer demand. The bottleneck occurring in the Welding Division disrupts the continuity of the production flow because the production capacity of this station is lower than the capacity of other stations. Consequently, semi-finished products accumulate before the welding process, increasing waiting time and reducing overall production efficiency.

Workload imbalance across production divisions causes inefficient workforce utilization, bottlenecks, excessive overtime, and production delays, thereby affecting production efficiency and customer satisfaction. Therefore, workforce allocation based on actual workload conditions becomes essential for improving operational performance. while operators in other divisions tend to have idle time due to lower work intensity. This imbalance indicates that the existing workforce allocation has not been adjusted proportionally to the actual production workload. In manufacturing systems, unequal workload distribution can reduce line efficiency, increase production lead time, and create instability in production scheduling. If this condition continues without improvement, the company may face increasing operational inefficiencies and higher labor costs caused by overtime and production delays.

Table 1
Production Data July 2025 – September 2025

Month	Box Hepa Ducting (units)	Demand (units)	Remarks
July	96	101	Not fulfilled
August	104	104	Fulfilled
Sept	95	95	Fulfilled
Oct	106	106	Fulfilled
Nov	96	102	Not fulfilled
Dec	98	102	Not fulfilled
Total	595	610	

Based on Table 1, the production data for Box Hepa Ducting during the period of July to December 2025 indicates that, out of a total demand of 610 units, the company was only able to produce 595 units, resulting in a shortfall of 15 units, or approximately 2.46% of total demand. Unfulfilled demand occurred in July (5 units), November (6 units), and December (4 units). This condition indicates the presence of a production capacity constraint caused by workload imbalances across work stations, particularly in the Welding Division, which operates with only one worker. Material accumulation (bottleneck) in that division directly affects the overall flow of production, preventing the company from fulfilling all customer demand in certain periods. Therefore, a further analysis of workload and optimal workforce requirements is necessary to increase production capacity in accordance with the established demand targets.

Workload imbalance across production divisions causes inefficient workforce utilization, production delays, bottlenecks, and increased overtime costs, thereby reducing production efficiency and affecting customer satisfaction. The inability to fulfill demand consistently also indicates that the current workforce allocation does not yet reflect the actual workload conditions in each production department. Therefore, an objective and measurable approach is required to evaluate workforce utilization and determine the optimal workforce composition. Furthermore, the distribution of workers across production departments at CV. XYZ is currently determined based on company experience and production habits, without a standardized workload measurement system. The company employs eight production workers, consisting of one foreman (who does not have fixed working hours), two workers in the Cutting and Bending Division, one worker in the Welding Division, two workers in the Coating/Painting Division, and two workers in the Finishing Division. This variation in workforce size across departments indicates that each production stage possesses distinct workload characteristics and working time requirements. However, the current workforce allocation has not been evaluated based on actual workload conditions, which may result in workload imbalances among workers. Therefore, it is necessary to analyze whether the existing number of workers is optimal in relation to the workload at each production department.

Table 2
Departmental Data

No	*Work Center*	Number of workers (Box Hepa)
1	Foreman	1
2	Cutting and Bending Division	2
3	Welding Division	1
4	Coating/Painting Division	2
5	Finishing Division	2
Total Employees		**8**

At present, workforce determination at CV. XYZ 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 aligns with the actual workload requirements of each production process. Therefore, a systematic method is needed to analyze worker workload and determine the optimal workforce requirement.

One method that can be used to analyze workforce needs is Workload Analysis (WLA). WLA is employed to measure the level of workload based on the working time required to complete specific activities. Through this method, companies can identify the degree of workforce utilization and determine the appropriate number of workers relative to work capacity and production targets. The implementation of WLA is expected to assist companies in creating a more balanced work distribution, improving work efficiency, and reducing excessive workload in certain departments [2].

Several previous studies have demonstrated that Workload Analysis (WLA) is effective in determining optimal workforce requirements and improving production efficiency in manufacturing industries. However, most previous studies primarily focused on identifying workforce shortages without integrating workload analysis with production capacity planning and labor cost evaluation. In contrast, this study not only evaluates workload distribution but also incorporates capacity and cost planning to determine the most efficient workforce configuration for the company. Moreover, this study contributes practically by providing recommendations regarding workforce allocation strategies that can minimize labor costs while maintaining production capacity. From an academic perspective, this research enriches the application of Workload Analysis in make-to-order manufacturing systems, particularly in small and medium manufacturing enterprises that often experience workforce imbalance and production bottlenecks.

Unlike previous studies that mainly focused on workforce requirement estimation, this study integrates workload measurement, workforce allocation, and labor cost planning within a make-to-order manufacturing system. Although this study does not propose a new optimization algorithm, it contributes by providing an integrated decision-support approach for SMEs facing workforce imbalance and production bottlenecks.

Based on these conditions, this study aims to determine the standard production time for Box Hepa Ducting products, analyze worker workload using the Workload Analysis (WLA) method, and identify the optimal workforce requirement in each production division. In addition, this study also aims to develop workforce capacity and cost planning alternatives to obtain the most efficient workforce configuration capable of fulfilling production demand with minimum labor cost.

2. Research methods

This study was conducted at CV. XYZ, a small-to-medium manufacturing company specializing in iron and stainless steel-based products in Sidoarjo, Indonesia. The research subject focuses on production workers directly involved in the Box Hepa manufacturing process, including one foreman (without fixed working hours), two workers in the Cutting and Bending Division, one worker in the Welding Division, two workers in the Coating/Painting Division, and two workers in the Finishing Division. This study aims to analyze working time and determine the optimal number of workers using the Workload Analysis (WLA) method. The research objective focuses on production workers directly involved in the Box Hepa manufacturing process. The study aims to analyze the workload of workers in each production department and determine the optimal number of workers using the Workload Analysis (WLA) method. By measuring workload based on working time, this study is expected to identify workload imbalances and provide recommendations regarding workforce requirements to improve production productivity and efficiency[3].

The research flowchart illustrates the systematic stages of the study, beginning with problem identification and literature review, followed by data collection through direct observation, interviews, documentation, and time measurement using a stopwatch. The collected data are subsequently subjected to data uniformity and data sufficiency tests to ensure their suitability for analysis. Once the data are declared adequate and uniform, the calculation of cycle time, normal time, and standard time is performed, followed by workload analysis using the Workload Analysis (WLA) method to determine the optimal workforce requirement in each production department, ultimately yielding research conclusions and recommendations[4]

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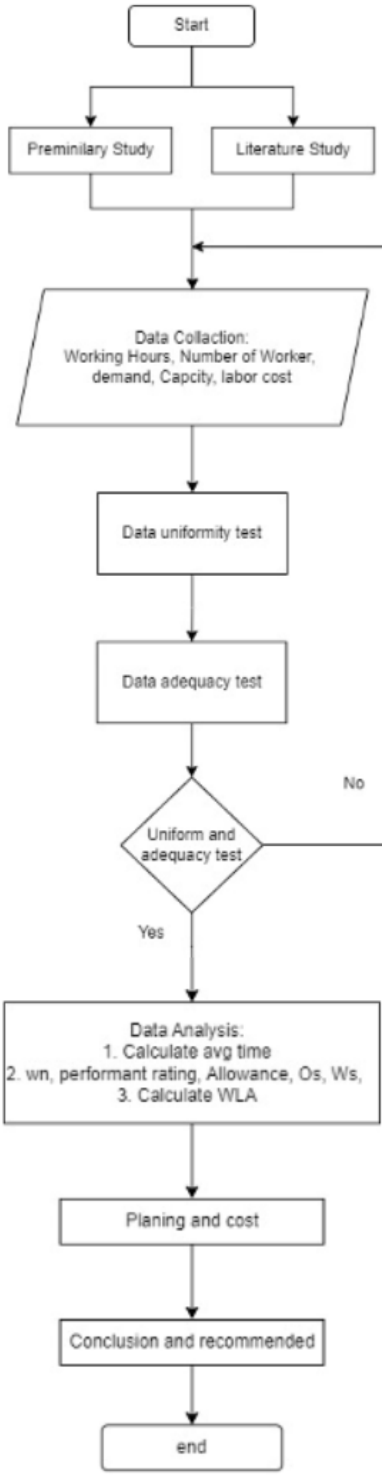

Figure 1. Flowchart

2.1 Problem Identification

Through direct observation of the company's production activities, a number of problems related to workforce management were found, especially regarding the lack of a structured and standardized method for measuring work performance. The current practice of determining the number of employees in each production division relies on manual processes, driven by experience and managerial intuition rather than data-based evaluation. This situation reflects the fact that the company has yet to implement work measurement approaches, such as the establishment of standard time, which play a critical role in assessing workforce productivity and production capacity within manufacturing environments.[5].

In addition, the company's production system operates under a job order system, in which production volume fluctuates depending on customer demand. This dynamic condition necessitates 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, a mismatch between work portions and workforce capacity occurs, which adversely affects overall production performance[6].

Furthermore, workload imbalances among production departments were identified. Certain departments, particularly the Welding Division, experience a significantly higher workload compared to others. This is evidenced by the longest recorded working hours, which are handled by a single worker in that department. On the other hand, several departments, such as Cutting and Finishing, tend to have a lower and more stable workload level, indicating underutilization of workforce capacity. This imbalance reflects an inefficient task distribution and may cause bottlenecks in the production flow[6].

The absence of standard time calculations 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, underloaded, or overloaded conditions. According to previous studies, workload analysis plays a critical role in identifying workforce utilization levels and in determining the optimal number of workers required at each work station. In addition, the company has not incorporated allowance factors into its work system. Allowances, which account for personal needs, fatigue, and unavoidable delays, constitute an essential component in determining realistic working time. Without considering these factors, the calculated working time may not accurately reflect actual working conditions, potentially resulting in workload overload in certain departments and inefficiencies such as idle time in others.

Beyond workload imbalances, the lack of proper workload analysis also impacts production performance. The company has experienced difficulty in meeting production targets in several periods, indicating that the existing workforce capacity is insufficient to meet production demands. This condition further underscores 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 the workload analysis. Primary data were obtained through direct observation and time study using a stopwatch, conducted in the Box Hepa production department. Direct observation was performed to understand the workflow and identify work elements at each production stage, including the Cutting and Bending, Welding, Coating/Painting, and Finishing divisions. The time study was conducted by measuring the time required for workers to complete each task repeatedly over 20 observations to obtain accurate working time data.

In addition, interviews were conducted with workers and supervisors to gather qualitative information regarding work procedures, job distribution, and factors influencing work performance. This method was also used to validate the results of the observations and time measurements, ensuring that the collected data reflect actual working conditions as observed in the field.

Secondary data were obtained from 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 solid foundation for workload analysis using the Workload Analysis (WLA) method.

2.3 Data Processing (Work Load Analysis)

Data processing in this study was performed using the Workload Analysis (WLA) method to determine the workload and optimal number of workers required at each production stage. The data obtained from work time measurements were systematically processed, beginning with data validation through uniformity and sufficiency tests to ensure reliability[7]. The validated data were then used to calculate cycle time, normal time (using performance rating), and standard time (incorporating allowance factors). The standard time was subsequently utilized to estimate the total production time, which was then compared with the effective working time to determine the required number of workers and the workload percentage as a basis for evaluating workforce efficiency.[2].

A. 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[8].

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

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

B. 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).

Mean

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

Standart Deviation

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

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

C. 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

D. 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.

$$Wn = Ws \times P$$

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

E. 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

F. Perfomance Rating

Performance rating is used to assess the operator's level of performance in completing a job compared to normal conditions. Performance ratings were evaluated jointly by the production supervisor and researchers through direct observation during production activities. The evaluation followed the Westinghouse System considering skill, effort, working conditions, and consistency. To reduce subjectivity, repeated observations and interview validation with supervisors were conducted.

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			**Consistency**		
+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 were obtained through 30 direct observations of each work element in the production process. Twenty repetitions were conducted to ensure that the collected data were 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 was subsequently used in the WLA calculations. These data serve as the primary basis for determining operator workload levels and evaluating workforce requirements in the production process.

Table 4
Time Data

Division	Operator	Total Time (Min)	Average (Min)
Cutting and Bending	Opr 1	1581,7	79,085
	Opr 2	1599,7	79,985
Welding	Opr 1	1405,4	70,27
Coating	Opr 1	992,6	49,63
	Opr 2	1009,4	50,47
Finishing	Opr 1	499,3	24,965
	Opr 2	504,4	25,22

Conducted for each work element, the total cycle time for all measurements was obtained. The average cycle time was then calculated by dividing the total time by the number of observations, yielding a value more representative of actual working conditions. This average value was subsequently used as the basis in the WLA to calculate operator workload.

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 working time data originate from a stable process condition, thereby making them suitable for further analysis [3]. Through the data uniformity test, any potential outliers or inconsistent data caused by specific factors during the observation process can be identified.

Table 5
Data Consistency Test

Divisition	Oprator	X	Average	σ	S	CL	K	BKA	BKB
Cuting dan bending	Opr 1	1581,7	79,085	3,05	4%	95,65%	2	85,19	72,99
	Opr 2	1599,7	79,985	2,94	4%	95,65%	2	85,87	74,11
las	Opr 1	1405,4	70,27	3,15	4%	95,65%	2	76,57	63,97
Couting	Opr 1	992,6	49,63	2,27	5%	95,65%	2	54,17	45,09
	Opr 2	1009,4	50,47	2,12	4%	95,65%	2	54,17	45,09
Finishing	Opr 1	499,3	24,965	1,08	4%	96,14%	2	54,17	45,09
	Opr 2	504,4	25,22	1,01	4%	95,65%	2	27,15	22,81

Based on the data processing results presented above, a statistical evaluation of four work stations was conducted to ensure data validity through uniformity and sufficiency testing. The calculation results indicate that all observed cycle times fall within the Upper Control Limit (UCL) and Lower Control Limit (LCL), with a high Confidence Level (CL) ranging from 95.65% to 96.14%. The standard deviation values and precision (s), which remain mostly below the significance threshold, indicate that the collected data are uniform and representative of actual field conditions. Therefore, the data are 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 sufficiency test was conducted to determine whether the number of collected observations is sufficient to represent actual working conditions with an acceptable level of accuracy. This test ensures that the data used in the analysis meet the required confidence and precision levels. By conducting the data sufficiency test, it can be evaluated whether additional observations are necessary or whether the existing data are adequate for further analysis.

Table 6
Data Adequacy Test

Division	Oprator	N'	N
Cutting and Bending	Opr 1	2,25	20
	Opr 2	5,44	20
Welding	Opr 1	2,67	20
Coating	Opr 1	8,24	20
	Opr 2	2,78	20
Finishing	Opr 1	3,1	20
	Opr 2	2,4	20

The table 6 presents the results of the data sufficiency test for seven operators across the production process, in which 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 each process from cutting to packing is consistently lower than the actual number of observations conducted (N = 20). Since the criterion N' < N is satisfied across all elements, the recorded time data are deemed 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 performance level in completing a task relative to normal working conditions. This evaluation is based on four aspects: skill, effort, working conditions, and consistency. Each aspect is assigned a value based on field observation, which are then summed to obtain the overall performance adjustment value

Table 7
Performance Rating Determination

Divisition	Oprat or	Ski ll	Effo rt	Conditi on	Consiste ncy	Tot al
Cutting and Bending	Opr 1	0,1 1	0,06	0,02	0,01	0,20
	Opr 2	0,0 8	0,03	0,02	0,01	0,14
Welding	Opr 1	0,0 8	0,05	0,02	0,01	0,16
Coating	Opr 1	0,0 8	0,05	0,02	0,01	0,16
	Opr 2	0,1 1	0,1	0,02	0,01	0,24
Finishing	Opr 1	0,0 8	0,05	0,02	0,01	0,16
	Opr 2	0,1 1	0,1	0,02	0,01	0,24

Operator performance 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 +0.14 to +0.24, resulting in calculated performance rating factors between 1.14 and 1.24. These figures indicate that operators perform above average (super-average), with the skill and effort factors contributing most significantly to overall work effectiveness. The application of a performance rating factor greater than 1.00 serves to normalize the average cycle time into normal time, thereby ensuring a fair and objective measurement for high-performing operators.

3.5 *Allowance*

Allowance is an additional factor in working time calculation that accounts for personal needs, fatigue, and unavoidable delays. It ensures that the standard time is more realistic and reflects actual working conditions [9].

Table 8
Allowance

Division	Personal	Fatigue	Delay	Total (Minutes)	Allowance %
Cuting dan bending	7	4	8	19	4,52%
las	7	6	10	23	5,48%
Couting	5	4	7	16	3,81%
Finishing	7	4	8	19	4,52%

The allowance values listed in the table indicate the amount of allowance granted to each operator based on observed working conditions. These values are subsequently used in the standard time calculation to ensure that the resulting working time is more realistic and consistent with actual working conditions.

3.6 Workload Calculation

The identified bottleneck in the Welding Division suggests uneven workload distribution that may increase waiting time and reduce line efficiency. Such imbalance can negatively affect production flow continuity and operational responsiveness. Workload Analysis was conducted to evaluate operator efficiency by comparing the required working time against the available working time. Based on the results in Table 9, the workload was calculated by multiplying the productive percentage, performance rating, and allowance factor. This identifies whether the task distribution is normal, excessive, or insufficient, thereby enabling the detection of workforce imbalances and utilization inefficiencies[5].

Table 9
Workload Calculation

Division	WLA	Required Workers
Cutting and Bending	1,89	2
Welding	0,83	1
Coating	1,21	2
Finishing	0,6	1
Total		6

The WLA calculation results presented in the table indicate that the total WLA values range from 0.60 to 1.89. Certain divisions record values below 1, such as the Welding Division (0.83), indicating workforce underutilization, while others exceed 1, such as the Coating Division (1.21), indicating that additional workforce is required.

3.7 Workforce Planning Results

Based on the Workload Analysis (WLA) calculations, the workforce requirements for each production division can be determined. The Cutting and Bending Division has a WLA value of 1.89, requiring 2 workers. The Welding Division records a WLA value of 0.83, which is rounded up to 1 worker. In the Coating Division, a WLA value of 1.21 indicates a requirement of 2 workers, while the Finishing Division, with a WLA value of 0.60, can be handled by 1 worker. Overall, the total workforce required across the four divisions amounts to 6 workers. A WLA value below 1 indicates that a worker's capacity is not fully utilized, whereas a value approaching or exceeding the next whole number serves as the basis for additional workforce allocation to ensure the smooth continuity of the production process [10].

3.8 Capacity and Cost Planning

The production process at the company currently employs seven workers across several divisions. This serves as the basis for capacity and cost planning, in which a daily wage of IDR 119,000 (Rp 17,000/hour) is used to calculate monthly labor costs. This planning is essential to ensure that workforce allocation is aligned with production targets in an efficient manner. Daily labor cost: Rp 119,000 (Rp 17,000/hour); Monthly cost per person: Rp 119,000 × 26 working days = Rp 3,094,000/month; and Total monthly cost (7 workers): Rp 3,094,000 × 7 = Rp 21,658,000

a. Calculations using Workload Analysis (WLA)

The WLA calculation indicates a requirement of 6 workers. Consequently, the company must bear a total monthly labor cost of Rp 3,094,000 × 6 = Rp 18,564,000, or Rp 18,564,000 × 6 = Rp 111,384,000 for a six-month period.

b. Overtime Cost Calculation

This calculation involves 4 workers with additional overtime hours. The calculation is derived from the WLA results; the remaining hours from each division are multiplied by the overtime rate to obtain the overtime compensation for each worker. The overtime rate is set at Rp 15,000 /hour.

Table 10
Overtime Hours Calculation

No	Division	Selected Alternative	Alternative Cost
1	Cutting and Bending	1 Worker + OT	Rp 5.523.500
2	Welding	1 Worker	Rp 3.094.000
3	Coating	1 Worker + OT	Rp 3.667.530
4	Finishing	1 Worker	Rp 3.094,000
	Total Cost		**Rp15.379.030**

Based on the capacity planning for 4 workers with overtime, the total operational cost incurred by the company comprising basic wages and overtime compensation amounts to Rp 15,379,030. The calculation for a six-month period yields a total basic labor cost of Rp 92,274,181. This figure represents the total financial commitment required to maintain production stability under the specified overtime scenario, utilizing the existing workforce. Although overtime improves production capacity, excessive overtime may negatively affect worker fatigue, health, and long-term operational sustainability.

4 Conclusion

Based on the results of the analysis and data processing conducted in this study on the optimization of workforce placement in Box HEPA production at CV. XYZ, using the Workload Analysis, Time Study, and Capacity and Cost Planning methods, the following conclusions can be drawn. The total standard time for the Box HEPA manufacturing process from raw materials to finished product is 217 minutes per unit. This standard time was obtained through direct measurement using the Time Study method, encompassing all production stages from the Cutting and Bending Division to the Finishing Division. Based on Workload Analysis calculations, a total of 6 workers without overtime are required, consisting of 2 workers in the Cutting and Bending Division, 1 worker in the Welding Division, 2 workers in the Coating/Painting Division, and 1 worker in the Finishing Division, with a total expenditure of Rp 18,564,000. Following capacity and cost planning, an alternative of 4 workers with overtime in the

Cutting and Bending and Coating Divisions was identified, comprising 1 worker in Cutting and Bending with overtime, 1 worker in Welding, 1 worker in Coating with overtime, and 1 worker in Finishing.

The optimal number of workers based on capacity planning calculations is 4 workers, yielding the highest monthly production capacity at a total cost of Rp 15,379,030. Compared to the pre-planning condition, which required a cost of Rp 21,658,000, a cost saving of Rp 6,278,970 is achieved. This study only focused on workload measurement and workforce allocation based on working time. Ergonomic aspects such as physical workload, posture risk assessment, CVL, and worker fatigue were not included and should be considered in future studies. This study demonstrates that integrating Time Study and Workload Analysis can improve workforce allocation decisions in make-to-order manufacturing systems. From a managerial perspective, the proposed approach may help SMEs optimize workforce utilization, reduce bottlenecks, and improve production performance. Future studies may integrate ergonomic analysis, line balancing, simulation approaches, and multi-objective optimization methods to improve workforce planning decisions.

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