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Workload Analysis in Determining the Number of Workers Handling Delivery of Brake Master Cylinder Products at Company X

Sesmaro Max Yuda[1], Rocky[2], Dikky Antonius[3]

[1,2,3]Mechanical Engineering, Faculty of Engineering, Universitas Kristen Indonesia, Indonesia
Mayjen Sutoyo Street No.2, Cawang, Kec. Kramat jati, Kota Jakarta Timur, Daerah Khusus Ibukota Jakarta 13630, Indonesia

Corresponding author: sesmaro@uki.ac.id

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ABSTRACT

Company X is one of the largest automotive companies engaged in manufacturing in Indonesia. In company X, there is a section for shipping finished goods/products called the handling delivery section. In this research, a time study was carried out using the stopwatch time study method to obtain standard time, workload, and number of workers to complete the delivery handling process. From the analysis results, it was found that the average working time for PMH hand pallet activities was 327.92 seconds, and PMH forklift was 167.623 seconds. Then, based on working time/worker/day of 420 minutes or 25,200 seconds, with 438 product deliveries per day, the workload of five workers experienced an excess of PMH hand pallet 113.991% and PMH forklift 145.67%. With the addition of one worker for PMH hand pallet, and one worker for PMH forklift, the workload is not excessive, namely 94.99% for PMH hand pallet and 97.10% for PMH forklift.

Keywords: Stopwatch Time Study, Standard Time, Workload

INTRODUCTION

Company X is an automotive company that operates in the manufacturing sector and is one of the suppliers of automotive components such as brake master cylinders to various large automotive companies in Indonesia. In the context of company competitiveness and development, company X pays special attention to increasing productivity and efficiency.

At company X, there is a delivery section for finished goods or products called the delivery handling section. One Company Currently, the delivery handling process at company X has high overtime, namely above 50% with working hours of 7 hours, from data received from HR that over time per shift reaches 3.5 hours for each manpower. With scheduled working hours Monday-Friday.

To reduce high overtime, we must first observe and calculate the working time for each activity element in the delivery handling process. This working time calculation is carried out using the stopwatch time study method to obtain standard time after taking into account the allowance factor for workers [1][2].

With the standard time obtained and the target number of products to be sent to customers, the workload can be calculated using workload analysis. The results of calculating the workload of workers in completing the capacity of products to be sent to customers are used to analyze the occurrence of high overtime to provide an alternative number of workers needed that does not exceed the workload [3][4].

Time Measurement

Measuring working time is related to efforts to determine the standard time needed to complete a job effectively and efficiently. Measuring working time is an activity carried out to observe workers and record working time including cycle time using appropriate measuring instruments. There are also uses for standard time, including planning labor needs, estimating costs for work wages, making production schedules and budgeting, planning a system for giving bonuses to workers who excel, and indicating the output produced by a worker [5][6].

There are various methods for conducting time studies, such as stopwatch time studies, predetermined time systems, standard data, time formulas, and work sampling. In this research, the stopwatch time study method was used. This method was chosen because the activities in the delivery handling process that are carried out take place in a short time and are repeated. Measuring working time using a stopwatch is carried out directly at the place where the work is being carried out. The results of measuring work using the stopwatch time study method are the standard time for completing work for each element of the work activity. Standard time is the time required for workers to complete their work, taking into account allowances or rest time for tired workers, personal matters, and unnecessary

delays. can be avoided, and pay attention to adjustments by determining the adjustment value given to workers regarding their competence in carrying out a job [7][8].

Work research will focus its attention on how a certain type of work will be completed. By applying optimal principles and techniques in the work system, the most effective and efficient results will be obtained. A job will be said to be effective and efficient if the completion time is the shortest [9][10].

Data Sufficiency Testing

Data adequacy requirements need to be met because data collected through observing work time in the field does not always provide consistent and objective measurements. A data adequacy test is needed to ensure that what has been collected and presented in the weighing report is objectively sufficient. The data adequacy test is carried out to ensure that the population characteristics are described by the characteristics used, because the greater the number of observations, the better the expected results and the greater the effort/cost required. The formulation for fulfilling the requirements can be seen in Equation 1 below [11].

$$n' = \left[\frac{\frac{k}{s}\sqrt{n\sum_{i=1}^{n} x_i{}^2 - (\sum_{i=1}^{n} x_i)^2}}{\sum_{i=1}^{n} x_i}\right]^2$$

n' states the minimum number of observations that must be taken, X_i represents the time data read by the stopwatch, n is the number of observations for the measured work element that has been taken, k is the level of confidence in the observation and s is the level of accuracy in the observation. Data is said to be sufficient if an n value is greater than or equal to the n' value ($n \geq n'$) [12].

RESEARCH METHOD

This research aims to analyze the working time of material handling activities. The activity analyzed is only the material handling preparation delivery activity. The research stages start with data collection and field observations to obtain the data needed to analyze the working time of material handling activities. The implementation of this research was carried out at the company Product finishing warehouse area, scanning and preparation area, and shipping. Analysis of man power's work activities was completed on April 20, 2024. Then the next step was to analyze the results that had been researched, namely the analysis of standardization of work methods through waste elimination, cycle time data processing, normal time data processing, and standard time data processing. The overall implementation of the research is shown in Figure 1.

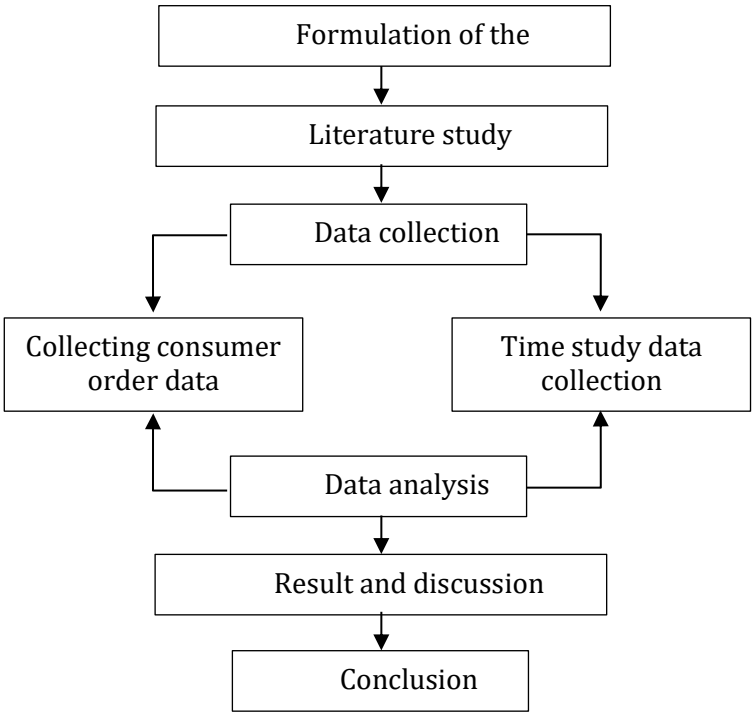

Figure 1. Research flow

Data Uniformity Test

Data uniformity testing is needed so that no extreme data appears in the observed data. Control charts are an appropriate tool for testing the uniformity of data obtained from observations. Data uniformity testing can be done by applying a control chart to find out whether there is data that is outside the control limits by calculating and determining the upper control limit (BKA) and lower control limit (BKB). Determination of BKA and BKB can be calculated using the following formula: [13]

$$\mathrm{BKA} = \overline{\mathrm{X}} + \mathrm{k}.\sigma$$

$$\mathrm{BKB} = \overline{\mathrm{X}} - \mathrm{k}.\sigma$$

$\overline{\mathrm{X}}$ is the average value $\frac{\sum x_i}{N}$, k is the level of confidence, and σ is the standard deviation, which is calculated using the following formula: [14]

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{N-1}}$$

Adjustment Factor

During the measurement, the measurer must observe the reasonableness of the work indicated by the operator. Irregularities can occur, for example, working not really, too quickly, because of difficulties, or because of poor room conditions. Irregularities like this affect work speed resulting in too short or too long completion times. The adjustment factor is to maintain work fairness. To overcome operator work irregularities, the measurer must normalize the observed working time by making adjustments. There are several adjustment methods, such as the Percentage method, Shumard method, and Westinghouse method [14][15].

Allowance Factor

Allowance is the allowance used to calculate standard time. Allowance is the time given to the operator to do the things he must do, such as; allowance for personal needs, allowance to relieve fatigue (fatigue), allowance that cannot be avoided [16][17].

Workload

Based on the decree of the minister for state apparatus utilization number KEP/75/M.PAN/7/2004, workload is several work targets or target results that must be achieved in a certain unit of time. Workload calculations can be done after previously knowing the job description and completion time for each task, as well as the amount of working time per day. The workload classification is called normal if the workload is 100%, where the number of workers matches the workload received. If the workload is >100%, it is called overload, where the amount of work is less than the load received. And, if the load is <100% it is called underload. The following is the formula for determining worker workload [18][19].

$$\text{Workload} = \frac{\text{Standard time} \times \text{Number of units}}{\text{Total time available} \times \text{Number of workers}}$$

Calculation of Number of Workers

Calculation of the number of workers is carried out using the following formula:

$$\text{Number of worker} = \frac{\text{Standard time} \times \text{Request}}{\text{Total time available}}$$

The number of workers affects how much workload the workers receive [20][21].

RESULT AND DISCUSSION

Delivery Handling Process

At the company In handling delivery, two types of Material Handling Equipment (PMH) are used, namely PMH hand pallet and PMH forklift. There are six floors/work locations, and fourteen activity elements. For handling delivery using PMH hand pallet there are four working floors and ten elements. Meanwhile, for handling delivery using PMH forklift there are two working floors with four working elements. The delivery handling process is carried out continuously and sequentially. Below is a table of the arrangement and sequence of work locations and activity elements, as well as the number of workers based on PMH which is shown in Table 1.

Table 1. Arrangement of delivery handling process for PMH hand pallets

Location	Code	Activity	Number of employees
Hand pallet parking (PHP)	O-1	Take Hand Pallet (HP-1).	5
	T-1	Drive HP-1 to GP.	
Pallet Warehouse (GP)	O-2	Lifting Pallets from the stack to the floor	
	O-3	Place the Pallet from the floor to the top of HP1	
	T-2	Pushing HP-1 which has a pallet installed on top of it to the Product Warehouse (GP)	
Final Product Warehouse (GPA)	O-4	Take the BP (Product Box) from the pile and put it on the Pallet above HP-1	
	T-3	Pushing HP-1 and PBP (Pallet which is on top of HP-1 and has been loaded with product boxes/boxes) to AP-1 (Preparation Area-1)	
Preparation Area-1 (AP-1)	O-5	Lower the PBP from HP-1 to the floor	
	T-4	Pushing and Parking HP-1 to PHP	
	O-6	PBP Strapping	

Table 2. Arrangement of delivery handling process for PMH forklift

Location	Code	Activity	Number of employees
Preparation Area-2 (AP-2)	O-7	PBP scanning	2
	O-8	Carrying the Forklift from the PF (Forklift Parking) and Lifting PBP-2 (Pallets and Boxes/Product Boxes that have been strapped and sanitized) onto the Forklift	
	T-5	Moving PBPA-2 using a Forklift to SA	
Shipping Area (SA)	T-6	Moving Forklift to PF	

Calculation of Number of Products

Information about the number of products (in product units) sent by Company X to customers in 2023 is shown in Table 3.

Table 3. Data on the number of product deliveries to each customer (product/customer), each month, in 2023

Month	Customers (products/customers/month)								Work Days
	TMMIN	ADM	MMKI	SGMW	HPM	IAMI	SIM	IGP	
1	18,282	75,687	12,153	384	18,176	1,968	16,832	17,880	22
2	18,323	75,674	12,743	576	19,260	552	16,285	17,034	20
3	20,293	81,037	13,907	1,536	23,623	1,590	18,987	19,596	23
4	9,907	42,640	7,340	1,024	10,830	1,032	9,016	6,972	12
5	22,068	66,603	13,348	1,600	22,170	1,380	16,256	18,666	21
6	17,265	69,387	12,185	408	21,690	1,620	15,022	16,710	19
7	17,358	75,802	12,470	608	22,410	1,572	13,967	17,988	22
8	21,498	71,591	13,267	672	21,900	1,680	11,918	17,796	22
9	23,412	74,107	12,782	864	18,770	1,464	10,738	15,699	20
10	24,871	73,901	12,738	1,078	20,312	1,726	12,208	18,300	22
11	26,334	77,814	12,726	992	18,170	1,800	11,352	22,860	22
12	26,617	71,107	9,227	960	14,151	1,278	9,584	18,888	20

Products sent to customers are packaged in product boxes. Each box contains a maximum of two master brake cylinder products. In one transport/transfer cycle by PMH from one work location to the next there are nine boxes of product. From the provisions on the number of products in box packaging and the number of boxes per transportation cycle, it is obtained that the number of delivery handling cycles carried out is 438 cycles/day, and the average number of boxes transported is 3908 boxes/day.

Working Time Measurement

Working time measurements were carried out on seven workers; five workers who carry out work on delivery handling activities with PMH hand pallets, and two workers who carry out activities with PMH forklifts [22]. Table 4. Below is data from measuring the working time of Worker 1, who carried out activities in the delivery handling process with PMH hand pallet.

Table 4. Measurement of work time for worker 1, PMH hand pallet

O-1	T-1	O-2	O-3	T-2	O-4	T-3	O-5	T-4	O-6
14.19	10.56	3.21	14.67	55.53	92.61	59.56	2.11	11.21	22.89
12.39	9.97	3.19	14.9	47.31	97.97	61.34	2.13	11.56	22.35
14.83	10.31	4.42	15.59	63.24	90.21	55.67	2.54	11.89	20.47
14.55	10.76	4.65	14.23	59.32	96.01	74.65	2.45	10.67	22.47
12.34	10.31	3.56	15.82	52.54	82.00	50.32	2.05	11.46	22.49
13.32	10.21	3.23	14.85	47.34	101.09	52.25	3.02	10.34	22.15
13.75	10.55	3.59	14.92	53.24	83.69	69.75	2.69	11.26	20.34
13.43	9.29	2.94	14.27	53.67	87.80	58.93	2.74	11.55	20.19
13.57	10.75	3.54	15.93	46.22	91.28	60.34	2.19	11.24	20.84
14.57	12.61	3.22	14.76	48.76	87.35	63.36	2.96	10.23	22.32
14.75	10.56	3.37	14.92	50.43	92.70	56.43	2.56	10.34	22.33
12.34	10.87	2.94	14.07	43.27	119.47	56.65	2.16	11.23	22.11
14.31	10.87	2.94	14.39	45.44	97.97	48.67	2.43	10.34	20.98
13.46	10.12	3.29	14.69	46.65	83.25	78.53	2.56	12.43	24.89
14.12	10.92	3.48	14.57	46.53	97.61	61.24	2.15	11.35	22.38
13.45	10.54	3.19	14.92	43.67	95.38	54.88	2.83	11.34	22.91
13.22	10.98	3.01	14.56	49.95	95.29	54.55	3.06	11.21	22.11
13.24	9.87	3.33	14.69	61.32	83.78	58.34	3.011	10.89	21.09
14.44	10.93	3.54	14.38	62.32	93.60	62.19	2.91	11.44	22.13
13.67	10.54	3.06	14.94	56.44	74.86	54.67	2.28	11.95	22.19
14.86	10.98	3.49	14.73	50.22	101.98	56.63	2.49	11.34	22.84
13.56	12.43	3.24	14.73	54.32	88.15	64.53	2.07	11.35	22.99
13.42	11.93	3.91	16.31	59.53	102.16	73.23	2.48	11.78	22.34
14.38	10.21	3.41	14.83	60.22	92.70	65.33	2.77	11.35	22.44
14.27	10.83	3.47	14.19	57.45	103.86	59.56	2.46	11.26	22.31
12.98	9.39	3.28	14.63	41.15	89.05	62.33	2.76	11.34	22.73
13.45	10.53	3.21	14.55	55.53	101.00	52.72	2.48	11.34	22.98
14.39	10.76	3.45	14.67	53.37	95.11	54.56	2.58	11.06	22.07
12.98	10.32	3.48	14.38	47.44	97.43	57.55	2.78	10.68	22.78
14.21	10.22	3.58	14.78	49.23	88.06	53.56	2.33	10.68	22.49

Data Sufficiency Test

In this research, the data adequacy test to determine whether the amount of data resulting from measuring working time with the level of confidence and level of accuracy is sufficient or not was carried out with a degree

of accuracy of 5% (s = 0.05), which shows the maximum deviation of the research results, and 95% confidence level with k = 2 which indicates the measurer's confidence in the accuracy of the data [23]. The following is the formula and example of calculating the data adequacy test for Worker 1, who carries out the activity element of picking up a hand pallet from the Hand Pallet Parking Lot during the delivery handling process with PMH hand pallet, (code: O-1).

$$N' = \left[\frac{\frac{k}{s}\sqrt{N\sum x_i^2 - (x_i)^2}}{n}\right]^2$$

$$= \left[\frac{\frac{2}{0.05}\sqrt{30(5685.632) - (412.44)^2}}{412.44}\right]^2$$

$$N' = \left[\frac{859.9594}{412.44}\right]^2 = 4.348 \text{ data}$$

The results of the data adequacy test for the activities of workers 1 to worker 5, taking hand pallets (code O-1) which is an activity element in the delivery handling process with PMH hand pallets are shown in table 5.

Table 5. Data adequacy test results for worker 1, hand pallet picking activity

Worker	Average	X	X²	N	N'	Data sufficiency
1	13.75	412.44	5685.632	30	4.348	suffice
2	13.88	416.28	5784.254	30	2.203	suffice
3	14.03	421.01	5916.866	30	2.314	suffice
4	13.97	419.06	5863.09	30	2.565	suffice
5	13.97	419.14	5864.51	30	2.340	suffice

Based on the calculation results obtained, N'<N, the data taken can be declared sufficient.

With the same calculations, a data adequacy test is carried out for all work element observation data. From the results of the calculations carried out for all activity elements carried out by all workers, it is found that all data adequacy test results are sufficient, therefore all activity data collected can be subjected to subsequent tests [24].

Data Uniformity Test

The data uniformity test was carried out using the working time observation data for each element of the delivery handling activity [25]. The following calculates the average results of working time measurements, standard deviation, and determination of BKA and BKB values for work elements taking hand pallets (code O-1) by Worker 1.

a. Average value of observation data

$$\overline{X} = \frac{14.2 + 12.4 + \cdots + 13.0 + 14.2}{30}$$

$$= 13.75$$

b. Standard deviation

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{N-1}}$$

$$\sigma = \sqrt{\frac{(1.42 - 13.75) + (12.4 - 13.75) + \cdots}{30-1}}$$

$$\sqrt{\frac{\ldots + (13.0 - 13.75) + (14.2 - 13.75)^2}{30-1}}$$

$$= 0.729$$

c. Determining Control Limits

$$BKA = \overline{X} + k.\sigma = 13{,}75 + 3 \times 0{,}729 = 15.93$$

$$BKB = \overline{X} - k.\sigma = 13{,}75 - 3 \times 0{,}729 = 11.56$$

Of the 30 data in Table 4, the highest observation value is 14.9 and the lowest is 12.3, thus all observation data is between the

specified values of BKA = 15.93 and BKB = 11.56 or there are no outliers, so the data can be said to be uniform. The results of the data uniformity test for the activities of Workers 1 to 5, taking Hand Pallets (code O-1) which is an activity element in the delivery handling process with PMH hand pallets are shown in Table 6.

Table 6. Uniformity test results for hand pallet picking activity data

Worker	Average	Std	UCL	LCL	Data sufficiency
1	13.75	0.729	15.93	11.56	suffice
2	13.88	0.524	15.45	12.31	suffice
3	14.03	0.543	15.66	12.41	suffice
4	13.97	0.569	15.68	12.26	suffice
5	13.97	0.543	15.60	12.34	suffice
1	13.75	0.729	15.93	11.56	suffice

Based on the results of data uniformity test calculations for all activity elements, it was found that there were no data that were outliers or were above the BKA or below the BKB; everything was between the BKA and BKB values, so it could be said that all the data collected was uniform

Standard Time Calculation

Determination of standard times is carried out based on calculations of sufficient and uniform data. In calculating standard time, apart from sufficient and uniform data, Performance Rating data from the workers being observed and allowance values for each work element are also required.

Determination of Performance Rating

The performance rating value is determined based on direct observation and also based on interviews with operators who work in the delivery handling section [26]. Table 7. below is the result of determining the performance rating value for the delivery handling process with PMH hand pallets and forklifts.

Table 7. Determining performance rating using PMH hand pallet and PMH forklift

Factor	PMH hand pallet			PMH forklift		
	Rating	Code	Customization	Rating	Code	Customization
Skill	Fair	E1	-0.05	Good	C2	0.03
Effort	Good	C1	0.05	Good	C1	0.05
Condition	Average	D	0	Average	D	0
Consistency	Good	C	0.01	Good	C	0.01
Total			101%			109%

Determination of Allowances

The allowance value is needed as a consideration for the personal needs of the workforce. Determining the allowance value is based on the work carried out by the workforce and the environmental conditions in which they work at the company. Based on the Sutalaksana book, the calculation of allowances is carried out by considering six factors, namely: energy expended, work attitude, work movements, eye fatigue, workplace temperature conditions, and atmospheric conditions [27]. Table 8, is the allowance value determined for the two PMH categories used, namely: allowance value with PMH hand pallet and with PMH forklift.

Table 8. Allowance value with PMH hand pallet and PMH forklift

Type of allowance	Allowance	
	PMH hand pallet	PMH forklift
Energy expended	7.5	5
Work attitude	2.5	2.5
Work movement	0	0
Eye fatigue	1	1
Workplace temperature conditions	2	2
Atmospheric conditions	0	0

Determination of Normal Time

The previously obtained cycle time is used to calculate normal time. The following is a formula and example of calculating normal time for worker activity 1, taking Hand Pallet (code O-1) which is an activity element in the delivery handling process with PMH hand pallet [28].

$$W_n = \text{Observation Time} \times \frac{\text{Performance ratings \%}}{100\%}$$

$$W_n = 13.748 \times \frac{101\ \%}{100\%} = 13.89$$

Determination of Standard Time

The standard time calculation is obtained from the normal time that has been previously calculated and then multiplied by the resulting allowance value. The following is a formula and example of calculating Standard Time for worker activity 1, taking Hand Pallet (code O-1) which is an activity element in the delivery handling process with PMH hand pallet [29].

$$W_s = \text{Normal Time} \times \frac{100\ \%}{(100\% - \%\ \text{Allowance})}$$

$$W_s = 13.89\ \text{x}\ \frac{100\ \%}{(100\% - 13\%)} = 15.96\ \text{second}$$

The results of calculating normal time and standard time (Ws) for the activities of Workers 1 to 5, picking up Hand Pallets (code: O-1), which is an activity element in the delivery handling process with PMH hand pallets, at Company X are shown in Table 9.

Table 9. Calculation results of normal time and standard time for hand pallet picking activities

Worker	Average	Total performance ratings	Normal time	Allowance	Standar time
1	13.75	101%	13.89	13.00%	15.96
2	13.88	101%	14.01	13.00%	16.11
3	14.03	101%	14.17	13.00%	16.29
4	13.97	101%	14.11	13.00%	16.22
5	13.97	101%	14.11	13.00%	16.22

In the same way, the normal time and standard time of all activity elements with PMH hand pallet and forklift can be determined. After that, the average standard time for all activity elements is calculated by adding up the standard time for each worker divided by the number of workers carrying out that activity [30]. The results of calculating the average standard time for the delivery handling process at Company X are shown in Table 10.

Table 10. Calculation results of average standard time for delivery handling activities

PMH	Code activity	Standar time	
		Every element	PMH
Hand pallets	O-1	16.159	327.920
	T-1	12.408	
	O-2	3.982	
	O-3	16.929	
	T-2	62.777	
	O-4	107.539	
	T-3	66.157	
	O-5	3.001	
	T-4	13.112	
	O-6	25.855	
Forklift	O-7	64.075	167.623
	O-8	58.922	
	T-5	27.371	
	T-6	17.254	

From the calculation of the standard time for the delivery handling process with the PMH Hand Pallet, a standard time value of 327.92 seconds was obtained. For delivery handling activities that use a forklift (PMH forklift), from picking up the Forklift to bringing the product to the shipping area requires a standard time of 167.623 seconds.

Workload Analysis

In calculating workload, the standard time value is taken from the results of calculating the average standard time for delivery handling activities in Table 11. The number of units is the number of cycles of activity elements carried out in one day, namely 438 cycles. The total time available using KEP/75/M.PAN/7/2004, namely seven working hours, equals 420 working minutes, or 25,200 seconds/worker/day. The number of workers is seven people, consisting of five workers in the delivery handling process with PMH Hand Pallet and two workers with PMH Forklift. The following is the calculation carried out to obtain the workload value for the Hand Pallet picking activity (code: O-1) which is an activity element in the delivery handling process with PMH Hand Pallet:

$$\text{Workload} = \frac{\text{Standard Time} \times \text{Number of Units}}{\text{Total Time Available} \times \text{Number of Workers}}$$

$$\text{Workload} = \frac{16.159 \text{ second} \times 438 \text{ times picked up Hand Pallet}}{7 \text{ hours} \times 60 \text{ menit} \times 60 \text{ minutes} \times 5 \text{ workers}} = 113.991\%$$

In the same way, you can calculate the workload of all activity elements in the delivery handling process. The workload value for each PMH is calculated by adding up all the workload values for the activity elements contained in the delivery handling process for each PMH [31]. Table 11 below is the result of calculating the workload for all activity elements in the delivery handling process.

Table 11. Workload calculation

PMH	Code activity	Standard Time (seconds)	Target (units)	Workload	
				Activity	PMH
Hand pallets	O-1	16.159	438	5.617 %	113.991 %
	T-1	12.408	438	4.313 %	
	O-2	3.982	438	1.384 %	
	O-3	16.929	438	5.885 %	
	T-2	62.777	438	21.822 %	
	O-4	107.539	438	37.383 %	
	T-3	66.157	438	22.998 %	
	O-5	3.001	438	1.043 %	
	T-4	13.112	438	4.558 %	
	O-6	25.855	438	8.988 %	
	O-7	64.075	438	55.685 %	
Forklift	O-8	58.922	438	51.206 %	145.672 %
	T-5	27.371	438	23.787 %	
	T-6	17.254	438	14.995 %	

For PMH hand pallet with a workforce of five people, the workload was 113, meaning that the number of workers available was smaller than the workload received, so PMH hand pallet delivery handling experienced an overload. Likewise, the PMH forklift activity has an overload workload value, with a workload of 145.672%. This excessive

workload value is what causes high overtime in the delivery handling process at company X.

Calculation of Number of Workers

After previously calculating the workload, the number of workers for each activity element is then calculated. The following is the calculation of the number of workers in the activity element of picking up hand pallets (HP-1), which is an activity element in the delivery handling process with PMH hand pallets:

$$\text{Number of Workers} = \frac{\text{Standard Time} \times \text{Request}}{\text{Total Time Available}}$$

$$\text{Number of Workers} = \frac{16.159 \text{ seconds} \times 438 \text{ times taking Hand}}{7 \text{ hours} \times 60 \text{ minutes} \times 60 \text{ seconds}}$$

$$= 0.2751 \text{ Workers}$$

From the results of calculating the number of workers required for each activity element, all activity elements in each PMH are added up. The result of adding up the number of workers from all activities in each PMH is the number of workers required for each PMH. The result of adding up the labor requirements for PMH hand pallet and forklift is the number of delivery handling workers required. Table 12, is the result of calculating the number of workers needed to carry out the product delivery target to customers.

Table 12. Number of workers and workload in the delivery handling process

Code activity	Target	Standard Time (seconds)	Total Standard Time (seconds)	Total Working Time (seconds)	Number of Workers		Workload			
					Activities	PMH	Activities	PMH		
O-1	438	16.159	7077.843	25200	0.2809	5.700	0.0468	0.0359	0.0115	94.99%
T-1	438	12.408	5434.528	25200	0.2157					
O-2	438	3.982	1744.130	25200	0.0692					
O-3	438	16.929	7415.035	25200	0.2942					
T-2	438	62.777	27496.239	25200	1.0911					
O-4	438	107.539	47102.259	25200	1.8691		0.3115			
T-3	438	66.157	28976.941	25200	1.1499		0.1916			
O-5	438	3.001	1314.330	25200	0.0522		0.0087			
T-4	438	13.112	5743.008	25200	0.2279		0.0380			
O-6	438	25.855	11324.453	25200	0.4494		0.0749			
O-7	438	64.075	28065.051	25200	1.1137		0.3712			
O-8	438	58.922	25807.885	25200	1.0241	2.913	0.3414			97.11%
T-5	438	27.371	11988.398	25200	0.4757		0.1586			
T-6	438	17.254	7557.372	25200	0.2999		0.1000			

From the calculations, it was found that the number of workers needed to complete the delivery handling work with the PMH hand pallet was 5.70 people, rounded up to six workers with a workload of 94.99%. This means that to get a workload that is close to normal, it is necessary to add one more worker, from the previous five workers to six workers, bringing the total number of workers. according to the workload received by the worker. Likewise, for handling delivery with PMH forklifts, the labor requirement that is close to the normal workload is 2.91 workers, rounded up to three workers,

namely by adding one worker from the previous two workers.

CONCLUSION

Based on the calculations, it can be concluded that the delivery handling process activities are grouped based on the two Material Handling Equipment (PMH) used, namely the PMH hand pallet and PMH forklift. The PMH hand pallet activity has four work floors, ten activity elements, and five workers. The PMH forklift activity, has two work floors, four activity elements, and two workers. The delivery handling process is carried out continuously and sequentially, as shown in Table 4. Meanwhile, the standard time for the delivery handling process using PMH hand pallets is 327.920 seconds/cycle, and for PMH forklifts it is 167.623 seconds/cycle. The number of cycles/day is 438 times, in the 2023 period, the number of working days is 245 days, and the number of deliveries to customers is 1,872,844 master brake cylinder products. The workload for five workers on the PMH hand pallet was overloaded, namely, 113.991%, and the workload for two workers on the PMH forklift was also excessive, namely 145.67%. This has resulted in high overtime in the delivery handling process at company six workers, namely 94.99%. The number of workers required for PMH forklifts is three workers, so the workload is not excessive, namely 97.10%. So the total labor requirement for the delivery handling process is nine workers.

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