Determination of Total Labor Plant 1 using Workload Analysis (WLA) Method In Compound Fertilizer’s Industry

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Abstract. The compound fertilizer’s industry did trading as a first business in compost using Mahkota brand which is a subsidiary of Wilmar Group Indonesia, which became one of the largest agribusiness companies in the world. The results of preliminary observations show that the number of activities and methods of work done by each operator varies. Thus, the calculation workload against any worker in Plant 1 using Work Load Analysis (WLA) to calculate the percentage of productivity using the Work Sampling method. Furthermore, the excellent determination rating factor value using Westinghouse. The high determination Allowance values using tables Industrial Labor Organization (ILO). The results of the workload calculation show that the workload accepted by six workers is high because the value is above 100%. Proposed recommendations for improvements presented in connection with high workload conditions is to increase the number of workers as much as two workers so that the number of workers in Plant 1 is eight workers.

1. Introduction
Humans are the main assets in the organization so that human resources (HR) must be managed and utilized fully. HR is the biggest asset of the organization. HR supports the ability of workers to support overall economic and social development, including intellectual workability and physical work. HR does not mean only helping the people and the ability of the employee. Talent, competence, ideas, energy from employees, productivity, and the performance of the organization collected were identified as HR from the company [1]. Organizations or companies that are just developing well cannot be separated from human resources within the organization/company. The role of human resources (HR) in the company is significant because HR is carrying out all activities to meet the objectives of the company. With efficiency and productivity, companies can find out how to optimize the resources used and know the targets that have been carried out by the company. With human resource planning, companies can determine the number of employees needed to run a company system efficiently [2].

This industry is one of the companies engaged in the compound fertilizer production process in Dumai, Pelintung. The company was first established since 1999 and conducts fertilizer trade as the company approves Mahkota brand which is a subsidiary of the Wilmar Group Indonesia which is one of the largest agribusiness companies in the world.
Workload is one of the key factors in working efficiency that affects work productivity. The amount of oxygen used by the body is one of the loading indicators during work [3]. The method used in this study is the Workload Analysis (WLA) method because this method is suitable for analysing the workload of workers at this industry. WLA is one way that can be used to calculate the amount of workload caused by activities carried out. This study will analyse several causes of increased work and improve improvements to reduce high workloads. Besides, the workload that must be received by workers can also be used to determine the number of workers who need to be approved by the company [4-5].

2. Workload Analysis

Job analysis is the procedure for determining the duties and skill requirement of a job and the kind of person who should be hired for it. Job analysis produces information used for writing job specifications and job descriptions [6]. This is a systematic activity to collect, assess, and integrate information related to tasks within the organization or some information about the characteristics of a particular position. This analysis is done to learn about workloads and possible obstacles that arise during work, and function as foundations of all human resource management activities in the organization. Some activities that are based on the results of job analysis are restructuring the quality of incentive enhancements, human resource planning, design work, training, career development, and evaluation system work. Job analysis is a process, method, and technique for obtaining some work data that is treated as job information and presented to fulfill work programs and as feedback for organization and governance. Local governments must have job analysis documents so that the human resource system can function correctly. Job analysis allows one to identify job descriptions and specifications. As a result, existing human resources can be allocated appropriately to each unit, and this will ensure the type of work that is effective and efficient so that unit performance can be optimal. There are ten essential reasons why job analysis in an organization needs to be carried out. Job analysis aims to (1) evaluate challenges from the environment that can affect one's work; (2) avoid unnecessary job requirements that can lead to job discrimination; (3) expressing elements of work that can help or ignore the quality of work life; (4) planning the future needs of human resources; (5) match compatibility between job applicants and vacancies; (6) define the type of training for new and experienced employees; (7) determine plans for developing potential employees; (8) determine realistic work standards; (9) assign employees in appropriate positions where they can use their skills effectively; (10) giving fair rewards to every official.

Employee workload can also be calculated through job analysis. This workload must be by the needs of the service unit. Thus, employee management is applied every time an evaluation to improve the service unit is carried out. As a result, planning the formation of employees will be by workloads and vacancies. In general, job vacancies are the number of employees needed in public organizations to build high-quality services. Each employee must receive the correct amount of workload. Therefore, realizing maintaining the high performance of a service, local governments must implement their total employees and workload, so that it is the same between workload and performance. Preferably, a prosperous workload, which is not equivalent to the number of existing employees, will result in poor performance. On the other hand, too little workload will reduce the efficiency of a post. This will be a loss for the regional government as a service unit. This is why employee planning needs to be done in the management of local government apparatus resources. Human resource planning has a close relationship with the issue of human resource allocation which includes the number, type or qualifications of skills and expertise.

Workload analysis is a methodology to determine the time, effort and resources necessary to carry out the product department’s operations, resulting in identifying the organization’s actual needs of human resources both in terms of quality, and develop these resources to achieve the goals and strategies that the organization wants to achieve in the various work sites [7]. In other words, workload analysis aims to ensure the number of employees needed is by some workloads and specific responsibilities given to employees. Workload analysis is an activity carried out to identify the number and qualifications of
the employees required to realize organizational goals. In line with an opinion, Minister of Home Affairs Regulation Number 12 of 2008 states that workload is a set or number of activities that must be completed by a unit or official within an organization for a specified period. Besides, workload measurements are also considered as management techniques for obtaining information about specific positions or jobs. This is solved through a systematic research and evaluation process. This work information will be useful in improving the apparatus whether it is in institutions, government or human resources. Workload analysis calculates the time and ability of employees to complete tasks. Not much attention is paid to workload so that problems that arise are often seen as a result of low work motivation and lack of incentives. Besides, the volume of work in institutions is often unstable; there is too much workload at one time and too little at a later time. Therefore, workload analysis will be important in studying the workload of each position and the lowest work unit. Finally, the right amount of work volume imposed on a unit can be known, and this will later be useful in interpreting strategic policies in the future [8].

3. Methodology

The steps in conducting this study is as follows.

1. Field Study

   Field studies conducted to obtain information on the general picture and the actual condition of the company.

2. Literature review

   Studies conducted to obtain and understand the theories related to problem-solving. Sources of literature come from books, journals, and a study of previous research with the main topic.

3. Formulation of the problem

   Based on the literature study and field studies will be known existing problems can be formulated so that the problems being studied.

4. Determining Objectives

   Determining the purpose of the research is used to describe any goal to be achieved by the holding of the study.

5. Data collection

   The data collected for this study included primary data, and secondary data include:
   a. A general overview of the data firm
   b. The data structure of the organization
   c. Data on the number of workers today
   d. The data job description of each worker
   e. Data productive and non-productive operator.
   f. Data rating factor
   g. Data allowance.

6. Data processing

   Data processing is performed in this study, namely:
   a. Calculate the percentage of productive and non-productive at work sampling method.
   b. Determine the rating factor by the method of Westing House System.
   c. Determine allowance by using tables ILO.
   d. Calculate the workload with WLA methods.
   e. Determine the number of workers.

7. Analysis and Conclusions

   Analysis and conclusions made in this study, namely:
   a. Analyze the percentage of productive and non-productive individual operators
   b. Analyze workload conditions related to the cause of high workload.
   c. Analyze related to the number of workers which will compare the number of workers that exists today with the number of workers based on workload.
d. Conclude is a final summary that can answer the formulation of the research conducted and provide research advice.

4. Result

4.1. Productive and Non Productive Activities
Definition of non-productive activity is an activity that does not generate added value in improving the quality and speed of task completion process, while the productive activity is an activity that corresponds to a predetermined job description and this activity was to create a product or service.

When calculating the workload used to calculate the number of workers needed, productive activities are used as a mere activity by the job description of each machine operator. The activities carried out by workers in Plant 1 can be seen as follows:

1. PLC Operator
   Activities that included part of the work of the PLC operator can be seen as follows:
   a. Controlling Plant condition
   b. Filling logsheet and logbook
   c. Noting the results of laboratory analysis

2. Granulator Operator
   Activities that included part of the work of the operator granulator can be seen as follows:
   a. Checking the inlet and outlet chute granulator
   b. Checking burner
   c. Clean the work area

3. Process Screen Operator
   Activities that included part of the work of the operator screen process can be seen as follows:
   a. Process control screen
   b. Clean the work area
   c. Check chute outlet screen and polishing

4. Feeder and Recycle Operator
   Activities that included part of the work of the feeder and recycled the operator can be seen as follows:
   a. Checking the inlet feeder and recycle
   b. Clean the work area
   c. Controlling the smooth feeding of raw material
   d. Coordinating the feed material

5. Final Product and Cyclone Operator
   Activities that included part of the work of the final product and operator cyclone can be seen as follows:
   a. Check the outlet conveyor
   b. Physical checking product
   c. Feeding white clay
   d. Moving cooling bay tripper
   e. Controlling cyclone engine
   f. Controlling machine dryer
   g. Controlling cooler fan engine
   h. Clean the work area

6. Feeding Operator
   Activities that included part of the job of feeding the operator can be seen as follows:
   a. Monitoring the raw material feeding activity
   b. Tally feeding
   c. Filling logsheet and logbook feeding
   d. Work area
The entire activities outside the job description above, including the activities of non-productive.

4.2. Adequacy and Uniformity Test Data
Test the adequacy of the data is performed to determine whether the data collected is adequate or qualified specified accuracy. If the data collected is not sufficient, it is necessary to increase the amount of data. Test the adequacy of the data is done with the value of $S$ is 5%; the calculation formula can be seen as follows:

$$N' = \frac{k^2(1 - \bar{p})}{s^2 \bar{p}}$$

(1)

Where:
- $N'$ = the number of observations that need to be done
- $\bar{p}$ = the percentage of productive
- $S$ = level of accuracy
- $k$ = the price index of the level of confidence is taken (1.96)

If $N' \leq N$, the data is said to be sufficient.

The calculation of the adequacy of test data for PLC operator is as follows:

$$N' = \frac{1.96^2(1 - 0.8551)}{(0.05^2)(0.8551)} \approx 260.3896 = 261$$

The number of observations (N) is 276, and the results of the calculation (N') is 261, it can be seen that $N' \leq N$, the data for the PLC operator is said to be sufficient. The results of the adequacy of the data for other workers can be seen in Table 1.

| Workers                              | N  | N'  | Information |
|--------------------------------------|----|-----|-------------|
| PLC Operator                         | 276| 261 | Sufficient |
| Granulator Operator                  | 276| 108 | Sufficient |
| Process Screen Operator              | 276| 108 | Sufficient |
| Feeder and Recycle Operator          | 276| 174 | Sufficient |
| Final Product and Cyclone Operator   | 276| 134 | Sufficient |
| Feeding Operator                     | 276| 154 | Sufficient |

Uniformity test data is done in advance by defining UCL and LCL. UCL and LCL calculation can be done with the following formula:

$$UCL = \bar{p} + k \sqrt{\frac{\bar{p}(1 - \bar{p})}{n}}$$

(2)

$$LCL = \bar{p} - k \sqrt{\frac{\bar{p}(1 - \bar{p})}{n}}$$

(3)

where:
- $\bar{p}$ = The average percentage of productive time
- $n$ = Number of observations performed per cycle working time
- $k$ = Price index of the amount depends on the level of trust

$k = 1.96$ (95% confidence level)

UCL and LCL calculation PLC Operator are:

$$\bar{p} = \frac{0.8587 + 0.8478 + 0.8587}{3} = 0.8551$$

$$UCL = 0.8551 + 1.96 \sqrt{\frac{0.8551(1 - 0.1449)}{276}} = 0.9560$$
The value of the proportion of productive time during the observation is shown in the control map shown in figure 1.

Based on the calculations above, the uniformity test data for other operators can be seen in table 2.

| Workers                  | % P Day 1 | % P Day 2 | % P Day 3 | UCL     | LCL     | Information |
|--------------------------|-----------|-----------|-----------|---------|---------|-------------|
| PLC Operator             | .8587     | .8478     | .8587     | .9560   | .7542   | Uniform     |
| Granulator Operator      | .9348     | .9348     | .9348     | 1.0451  | .8245   | Uniform     |
| Process Screen Operator  | .9457     | .9457     | .9130     | 1.0451  | .8245   | Uniform     |
| Feeder and Recycle Operator | .8587 | .913     | .9239     | 1.0045  | .7925   | Uniform     |
| Final Product and Cyclone Operator | .9783  | .8913    | .8913     | 1.0289  | .8117   | Uniform     |
| Feeding Operator         | .9022     | .9239     | .9022     | 1.0167  | .8021   | Uniform     |

The results of calculations uniformity test data for 6 operators indicates that all data has been uniformly having been among the Upper Control Limit (UCL) and the Lower Control Limit (LCL).

4.3. Productivity, Rating Factor and Allowance

After testing the adequacy of the data and uniformity test data then calculating the percentage of productivity rating factor along with great value and allowance. The results of the calculation of the rate of productivity, rating factor, and the allowance of each worker can be seen in the following table 3.

| No. | Type of activity                        | Frequency |          |          |          |          |
|-----|----------------------------------------|-----------|----------|----------|----------|----------|
| 1.  | Control plant conditions                | Day 1     | 64       | 52       | 40       |          |
| 2.  | Filling logsheet and logbook           | Day 2     | 9        | 18       | 26       |          |
| 3.  | Noting the results of laboratory analysis | Day 3   | 6        | 8        | 13       |          |
| 4.  | Activities outside the job description |          | 13       | 14       | 13       |          |

| Productivity (%) | 85.87 | 84.78 | 85.87 |
| Rating Factor    | 0.13  |       |       |
### Table 4. Percentage Productivity, Rating Factor and Allowance Granulator Operator

| No. | Type of activity                              | Frequency | Day 1 | Day 2 | Day 3 |
|-----|----------------------------------------------|-----------|-------|-------|-------|
| 1.  | Checking the inlet and outlet chute granulator | 39        | 32    | 34    |       |
| 2.  | Refuel                                       | 6         | 7     | 6     |       |
| 3.  | Clean the work area                          | 11        | 21    | 24    |       |
| 4.  | Checking burner engine                       | 30        | 26    | 22    |       |
| 5.  | Activities outside jobdesc                   | 6         | 6     | 6     |       |

#### Allowance (%)
14.2

### Table 5. Percentage Productivity, Rating Factor, and Allowance Process Screen Operator

| No. | Type of activity                        | Frequency | Day 1 | Day 2 | Day 3 |
|-----|----------------------------------------|-----------|-------|-------|-------|
| 1.  | Check chute outlet screen and polishing | 65        | 57    | 41    |       |
| 2.  | Process control screen                  | 16        | 16    | 24    |       |
| 3.  | Clean the work area                     | 6         | 14    | 19    |       |
| 4.  | Activities outside the job description  | 5         | 5     | 8     |       |

#### Productivity (%)
94.57 94.57 91.30

#### Rating Factor
0.07

#### Allowance (%)
38.5

### Table 6. Percentage Productivity, Rating Factor, and Allowance Feeder and Recycle Operator

| No. | Type of activity                        | Frequency | Day 1 | Day 2 | Day 3 |
|-----|----------------------------------------|-----------|-------|-------|-------|
| 1.  | Controlling the smooth feeding of raw material | 32        | 35    | 34    |       |
| 2.  | Checking the inlet feeder and recycle   | 37        | 36    | 35    |       |
| 3.  | Coordinating the feed material          | 2         | 6     | 11    |       |
| 4.  | Work area                               | 8         | 7     | 5     |       |
| 5.  | Activities outside jobdesc              | 13        | 8     | 7     |       |

#### Productivity (%)
85.87 91.30 92.39

#### Rating Factor
0.01

#### Allowance (%)
36.3

### Table 7. Percentage Productivity, Rating Factor, and Allowance Final Product and Operator Cyclone

| No. | Type of activity                        | Frequency | Day 1 | Day 2 | Day 3 |
|-----|----------------------------------------|-----------|-------|-------|-------|
| 1.  | Check the outlet conveyor               | 22        | 11    | 46    |       |
| 2.  | Controlling cooler fan engine           | 10        | 12    | 6     |       |
| 3.  | Physical checking product               | 8         | 7     | 3     |       |
| 4.  | Feeding white clay                      | 15        | 11    | 4     |       |
| 5.  | Engine control cyclone                  | 8         | 14    | 6     |       |
6. Controlling machine dryer  
7. Clean the work area  
8. Move cooling bay tripper  
9. Activities outside jobdesc  

| No. | Type of activity                     | Frequency |
|-----|--------------------------------------|-----------|
|     |                                      | Day 1 | Day 2 | Day 3 |
| 1.  | Controlling the raw material feeding activity | 44    | 41    | 49    |
| 2.  | Filling logsheet and logbook feeding  | 4     | 11    | 7     |
| 3.  | Tally feeding                        | 17    | 8     | 9     |
| 4.  | Clean the work area                  | 11    | 13    | 14    |
| 5.  | Controlling feeding spillage         | 7     | 12    | 4     |
| 6.  | Activities outside jobdesc           | 9     | 7     | 9     |

Productivity (%)  

| Rating Factor 0.01  
| Allowance (%) 39.5  

Table 8. Percentage of Productivity, Rating Factor and Operator Feeding Allowance

| No. | Operator                  | Workload (%) | Average (%) |
|-----|---------------------------|--------------|-------------|
|     |                           | Day 1 | Day 2 | Day 3 |    |
| 1.  | PLC Operator             | 106.73 | 105.38 | 106.73 | 106.28 |
| 2.  | Granulator Operator      | 139.41 | 139.41 | 139.41 | 139.41 |
| 3.  | Process Screen Operator  | 140.14 | 135.31 | 138.53 | 138.53 |
| 4.  | Feeder and Recycle Operator | 128.74 | 136.89 | 138.52 | 134.72 |
| 5.  | Final Product and Cyclone Operator | 150.11 | 136.77 | 136.77 | 141.22 |

4.4. Workload Calculation with Work Load Analysis (WLA)

Workload, preferably close to 100% or under normal conditions. The workload of 100% means that for 8 hours workers were able to work continuously in normal conditions.

Operator Workload PLC

Workload Day 1  

\[
= (\% P \times (1 + \text{Rating Factor})) \times (1 + \text{Allowance})  
= (0.8587 \times (1 + 0.13)) \times (1 + 0.1)  
= 1.0673 = 106.73\%  
\]

Workload Day 2  

\[
= (\% P \times (1 + \text{Rating Factor})) \times (1 + \text{Allowance})  
= (0.8478 \times (1 + 0.13)) \times (1 + 0.1)  
= 1.0538 = 105.38\%  
\]

Workload Day 3  

\[
= (\% P \times (1 + \text{Rating Factor})) \times (1 + \text{Allowance})  
= (0.8587 \times (1 + 0.13)) \times (1 + 0.1)  
= 1.0673 = 106.73\%  
\]

On average Workload (% WL1)  

\[
= \frac{\text{Workload Day 1} + \text{Workload Day 2} + \text{Workload Day 3}}{3}  
= \frac{106.73 + 105.38 + 106.73}{3} = 106.28\%  
\]

Table 9. Workload Each Operator
Based on the average workload per worker above, the overall productivity of workers' activities can be calculated as follows:

Total Operating Expenses

\[
\text{Total Operating Expenses} = \%WL_1 + \%WL_2 + \%WL_3 + \%WL_4 + \%WL_5 + \%WL_6
\]

\[
= 106.28\% + 139.41\% + 138.53\% + 134.72\% + 141.22\% + 139.27\%
\]

\[
= 799.43\%
\]

On average Workload Each Workers (Actual)

\[
\text{On average Workload Each Workers (Actual)} = \frac{\text{Workload Total}}{\text{Number of workers}} = \frac{799.43}{6} = 133.24\%
\]

4.5. Determination of Number of Workers Recommendation

Based on the above problems, the average workload per worker is 133.24% where the average workload of the workload exceeds the limit of 100% so that the necessary repairs workforce so that the workload of each worker can be reduced. Calculation of the recommended amount of labor can be seen as follows:

On average Workload Each Workers (Recommendations) = \text{Workload Total} / \text{Number of Workers} = 99.93% = \frac{799.43}{8}

Based on the calculation above, it can be concluded that the amount of labor that recommended in Plant 1 is eight workers with an average workload per worker was 99.93%.

5. Conclusion

The conclusion of the discussion above is as follows.

1. The workload of PLC operator, granulator operator, process operator screen, feeder and recycle the operator, the final product and cyclone operator, and the operator feeding in a row is 106.28%, 139.41%, 138.53%, 134.72%, 141.22%, and 139.27%. The average workload per worker is 133.24%.

2. Improvements were made to the number of workers at Plant 1 is the addition of a workforce of 2 people. With a total workforce of 8, then the average workload per worker in Plant 1 was 99.93%.

3. Every job done equalization jobdesc so with the addition of two workers, then jobdesc each operator has the same workload.

References

[1] Y Adityawarman. 2015 Jurnal Manajemen dan Organisasi, Vol VI, pp 35-36.
[2] Yanti Helianty. 2014 Jurnal Online Institut Teknologi Nasional, Vol. 1, pp 251.
[3] Tarwaka. 2004. Ergonomics For Work Safety and Health and Productivity, Ergonomi untuk Keselamatan, Kesehatan Kerja dan Produktivitas, 1st ed., (Surakarta: UNIBA Press)
[4] Ridwan Arif. “Analisa Beban kerja dan Jumlah Tenaga Kerja yang Optimal pada Bagian Produksi dengan Metode Workload Analysis (WLA) di PT. Surabaya Perdana Rotopack”. Edisi Ketiga. Jawa Timur: Universitas Pembangunan Nasional Veteran. 2012.
[5] Rahmat RF, Herly E T, Siregar B, Syahputra M F and Sitompul O S 2018 RFID presence monitoring system as an input to measure the workload of employee International Conference on Computer Applications and Information Processing, pp 1-6.
[6] G Dessler. 2006 Human Resources Management, Pearson International Edition
[7] P Dasgupta and Roy. 2013 International Journal of Applied Research and Studies (iJARS), 2-5.
[8] E Cahyasari. Jurnal Ilmiah Administrasi Publik (JIAP), Vol. 2, pp 59-64, 2016.

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