Workload Analysis for Laboratory and Sample House Employees in Mining Industry Using Full-Time Equivalent

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Abstract
In the mining company case study, the volume of mining was increasing and the workload of laboratory and sample house employees was also increasing. It is important to investigate the physical workload after production increasing. The purpose of this study is to analyze and evaluate the physical workload for laboratory and sample house (LSH) departments. Full-Time Equivalent (FTE) is used to determine the level of the physical workload. The job description and the competences of employees will be used to understand, calculate, and evenly distribute the physical workload. Furthermore, data is collected through several methods such as discussions, interviews, questionnaires, and observation. The result of the study can provide the best strategy for reducing the unbalance of the physical workload at LSH and this study can be used to determine the cost and impact of recruiting employees based on an analysis of workforce planning as well as for workers, workers can avoid mistakes and can work safely.

1. Problem Description
Human resources are the company's main assets in improving the quality of products or services. One of the strategies used to achieve effectiveness and efficiency includes increasing the productivity of human resources (HR). Human resource management plays an important role in operations in the laboratory. To help companies increase productivity, it is expected that all departments in the company are involved in achieving this goal, including the laboratory and sample house areas.

In supporting the operations of PT Vale Indonesia Tbk (PTVI), the company has the laboratory and sample house to analyze sample mining and process plants (dryer, kiln, furnace, and converter). The sample house serves to prepare the sample before it is analyzed in the laboratory. Samples are generally made in powder form. Meanwhile, the laboratory is tasked with analyzing all samples of material processed both from the factory (process plant) and mining. The main role of the laboratory and the sample house Process Technology is to produce reliable, reproducible, accurate, and on-time test results.

In addition, LSH influences the decision making of plant operations in the mining, dryer, kiln, furnace, and converter areas. Then, the LSH is required to maintain or even increase productivity as increasing of the number of tests and samples in the area.

Therefore, to achieve maximum productivity in the LSH, LSH must understand, calculate, and evenly distribute the workload according to the competencies and responsibilities of each employee. Based on research in Slovakia, 56% of industries consider human resources to increase productivity. Effective workload planning by optimizing the capacity of workers must be done to increase productivity (Indrawati et al. 2018).

However, LSH is experiencing several issues regarding workload optimizing. First of all, LSH has an increase in workload with a broader spectrum of parameters with an unchanged number of workers (or even a smaller number of workers) and must still provide results that are consistent with an increase in turnaround times and of the highest quality. Then, increasing the company’s annual production would cause an increase in the number of samples to be prepared and analyzed. Based on the results of the Management Review in 2018 and the planned change in the volume of work from customer requests in 2019, there is an increase in the number of samples. Table 1 reveals the increases in the number of samples between 2018 and 2019:

Table 1. The enhancement of volume sample.

No	Type of sample	2018	2019	Enhancement
1	Exploration	306,327	524,160	71.11%
2	Mining production	250,129	348,768	39.44%
3	Dryer	31,461	36,624	16.41%
4	Kiln	19,392	25,787	32.98%
5	Furnace	29,824	31,248	4.77%
6	Converter	11,331	18,144	60.13%
7	Packaging	13,494	14,400	6.71%
8	EHS	10,452	16,896	61.65%
9	Utilities	7,500	9,024	20.32%
10	Number of workers	56	56	0.00%
Total				**313.52%**

Another issue is that because there is no quantitative tool for making decisions about adding manpower at LSH, they have never calculated mental and physical workload in the last 10 years. From the researcher's observations, some workers also feel physically exhausted when doing some work. Hence, LSH should carry out workload assessment.

The most widely used methods for calculating or analyzing physical workloads are the Full-Time Equivalent (FTE). FTE purposes to set the workload time to be the number of people needed to complete certain jobs (Sari et al. 2018). What is more, FTE is employed to adjust the workers workload so they can achieve their best performance. The expected adjustments from this research are the determination of number of optimal workers in the LSH. The method used to perform the FTE measurement is Stopwatch Time Study.

2. Full-Time Equivalent

Workload analysis aims to determine how the number of workers needed to complete the work and how much of an appropriate burden is delegated to one worker (Adawiyah and Sukmawati 2016). The full time equivalent (FTE) method is a method in which the task completion time of various jobs is compared to the available effective work time (Zainal and Ramadhanti 2019). FTE will provide information about the allocation of employee resources to complete work and time in each work activity that can be seen based on the results of direct work time measurement with the Stopwatch method. The Stopwatch method is a direct measurement of observed work-time that is commonly applied to jobs that are generally repetitive and short-lived (Indrawati et al. 2018).

The output of the FTE is the determination of the number of optimal workers to do the job. As a parameter to assess the worker's workload, according to Workload Analysis Guidebook by the State Employment Agency, when the FTE value is less than 1, it indicates that the work is under load. It is said to be overload when the FTE value is more than 1.28, while 1-1.28 is determined as the FTE value when the workload is normal (Suryoputro 2018). The steps to conduct FTE calculation are:

- Step 1 - Determine the Actual Time of Tasks

The actual time of laboratory and sample house activities are obtained from Stopwatch Time Study. Once the actual time is obtained, the uniformity test is conducted by using Minitab software. This test is done to know whether there are outlier data or not.

- Step 2 - Calculate the Normal Time

To calculate the normal time, it is important to consider the performance rating of the workers who do it. By using the Westinghouse Table, the workers' performance ratings are obtained from interviews with the manager, team leader, and chemist of laboratory and sample house.

The number of workers doing the activity will be considered to calculate the normal time of the activity. The following formulation is a normal time calculation when the activity is carried out by one person.

$$\text{Normal time} = \text{actual time} \times \sum(1+\text{Performance Rating})$$

- Step 3 - Calculate the standard time

Once the normal time is calculated, the standard time calculation is done by considering the allowance of each activity. The allowance percentage is obtained from the judgment of laboratory and sample house's manager, team leader, and chemist by taking into account the amount of energy expended, work position, work movements, eye fatigue, workplace temperature conditions, atmospheric conditions, and good environmental conditions.

Standard time = normal time x (100%)/(100%-allowance)

- Step 4 - Full-Time Equivalent (FTE) calculation

The next step is to calculate the workers' workload time by considering the frequency of each activity in a year or determining the effective working time of the workers. The frequency is obtained from the number of samples that are taken, analyzed, and prepared. Once the frequency is recorded, the workers' workload time can be calculated by multiplying the standard time with the frequency of each activity.

$$FTE = \frac{total\ working\ hours}{effective\ working\ time} = \frac{\sum (task\ completion\ time\ x\ task\ frequency)}{effective\ working\ time}$$

3. Results

3.1 Analysis of Workload Assessment using FTE

The task analysis is performed to determine the activities carried out by workers. To do this, work instructions for each activity at the laboratory and sample house are analyzed. According to documents, direct observations, and interviews, a list of workers' activities is made. Then, the actual time to conduct each activity is collected using Stopwatch Time Study (STS). STS is carried out to get the actual time of activities that have a repetitive cycle and is carried out during the data collection process.

After the actual time is collected, the normal time is calculated by considering the performance ratings of the workers that are determined by the Managers, Team Leaders, Chemists, and Senior Analysts of laboratory and sample house. Then, to calculate standard time, Allowances are considered. The allowances are determined based on the Sutalaksana's Allowances Recommendations which consider factors such as the amount of energy expended, work position, work movements, eye fatigue, workplace temperature conditions, atmospheric conditions, and good environmental conditions. After getting the standard time of activity from the worker, the next step is to multiply it by the frequency of each activity in which is done in one shift. Then, the frequency of one shift is multiplied by three to get the frequency per day. After that, multiplied by the effective working day in one year, which is 300 days to get the frequency per year of each activity.

By multiplying the standard time of each activity by the frequency in one year, the workload of workers in a year is obtained. To calculate FTE, additional data needed is the company's effective working time. Taking into account the number of workdays and days off in a year, as well as work time and rest time in a day. The company's effective working time is known to be 126,000 minutes a year. The FTE is then calculated by dividing the total working time by the company's effective working time. The results are presented in Table 2 and 3 which show that the workload of all worker activities in the laboratory and sample house.

The calculation from Table 2 shows that workers have a high workload when sampling and preparing EFF samples and also when preparing EFM, CS, and Scrap Bin Boat samples (plant sample), what is more, wet-dryer and environmental sampler also have a high workload. Meanwhile, the calculation from Table 3 shows that workers have a high workload on sample exploration smelting workers, x-ray workers and carbon (c), sulfur (s), and crystal water (xH2O) workers.

Table 2. Result of workload assessment by using fte at sample house.

No.	Activity	Total Workload Time (minutes)	FTE of the Company (minutes)	FTE	Workload
1	EFF	367275.63	126000	2.91	Overload
2	EFM	71677.48	126000	0.57	Overload
3	CS	90411.88	126000	0.72	
4	BIN BOAT	46048.36	126000	0.37	
5	DOS	127404.7891	126000	1.01	Optimal Load
6	DKF	5100.701194	126000	0.04	
7	DKP	127404.7891	126000	1.01	Optimal Load
8	PUGMILL	4136.254224	126000	0.03	
9	LOT	128862.6489	126000	1.02	Optimal Load
10	Wet-Dryer Sampler	133538.0026	126000	1.06	Overload
11	Environmental Sampler	57115.84385	126000	0.45	

Table 3. Result of workload assessment by using FTE at laboratory.

No.	Activity	Total Workload Time (minutes)	FTE of the Company (minutes)	FTE	Workload
1	Mining and Plant Worker	123412.162	126000	0.98	Under Load
2	Exploration Worker 1	147503.1383	126000	1.17	Optimal Load
3	Exploration Worker 2	147503.1383	126000	1.17	Optimal Load
4	Exploration Smelting Worker	211694.1394	126000	1.68	Overload
5	Cup Washing Worker	141933.2942	126000	1.13	Optimal Load
6	xH2O and C&S Worker	179301.3979	126000	1.42	Overload
7	LOI Worker	127698.6005	126000	1.01	Optimal Load
8	X-Ray Worker	217014.9412	126000	1.72	Overload

3.2 Recommendation of Number of Optimal Workers

To determine the optimal number of workers in the laboratory and sample house, the index value of the FTE needs to be considered. Workload classifications using the FTE state that normal workloads occur when the FTE score is between 1 and 1.28. To achieve the normal workload of workers, the number of workers is calculated as presented in Tables 4 and 5.

Table 4. Number of optimal workers at sample house.

No.	Activity	FTE	Number of Existing Work	Number of Optimal Technicians	Average FTE
1	EFF	2.91	1	3	0.97
2	EFM	0.57	1	2	0.83
3	CS	0.72			
4	BIN BOAT	0.37			
5	DOS	1.01	1	1	1.05
6	DKF	0.04			
7	DKP	1.01	1	1	1.04
8	PUGMILL	0.03			
9	LOT	1.02	1	1	1.02
10	Wet-Dryer Sampler	1.06	1	2	0.76
11	Environmental Sampler	0.45			
Total			6	10	

Table 5. Number of optimal workers at laboratory.

No.	Activity	FTE	Number of Existing Workers	Number of Optimal Workers	Average FTE
1	Mining and Plant Worker	0.98	1	1	0.98
2	Exploration Worker 1	1.17	1	1	1.17
3	Exploration Worker 2	1.17	1	1	1.17
4	Exploration Smelting Worker	1.68	1	2	0.84
5	Cup Washing Worker	1.13	1	1	1.13
6	xH2O and C&S Worker	1.01	1	1	1.01
7	LOI Worker	1.42	1	3	1.05
8	X-Ray Worker	1.72	1		
Total			8	10	

From the calculation of the optimal number of workers in the sample house, the results obtained are that the company requires 2 additional workers to take and prepare on the EFF sample and 1 additional worker to take and prepare on EFM, CS, and Scrap Bin Boat samples, as well as the company, needs 1 additional worker to take wet samples (dryer) and environmental samples (water). Although these tasks have sufficient rest, many workers feel physically exhausted when doing the task. This proves an indication that the workload of workers is overloaded and additional workers are required at the sample house.

While, from the calculation of the optimal number of workers in the laboratory, the company requires 1 additional worker for sample exploration smelting and also needs 1 additional worker for x-ray and C&S and xH2O analyzer. The additional worker must assist in these two areas. Some workers feel fatigued and lack of rest time when performing the task. This gives an indication that the workload of workers is overloaded and additional workers are needed at the laboratory.

To improve this condition, the company should increase the number of workers for each item according to the result of the FTE assessment. Totally, there should be an additional 2 workers at the laboratory. In the meantime, the sample house's workers should recruit 4 new workers.

4. Concluding Remarks

According to the research that has been conducted, it can be concluded as follow. Firstly, based on the calculation by using Full-Time Equivalent (FTE), it is known that workers at sample house who prepare EFF samples, plant (EFM, CS, and Scrap Bin Boat) samples and who take wet-dryer and environmental samples have an overload workload with FTE score of 2.91, 1.66 (0.57, 0.72, 0.37), 1.51 (1.06, 0.45) respectively. Meanwhile, the workers at the laboratory who do sample exploration smelting workers, x-ray samples as well C&S and xH2O samples have an overload workload with an FTE score of 1.68, 1.42, and 1.72 respectively. Secondly, the number of optimal workers is obtained from a calculation considering the FTE index. The result generated reveals that the company needs 4 workers at sample house, consists of 2 workers of EFF sample, 1 worker of plant sample (EFM, CS, and Scrap Bin Boat), and 1 worker of wet-dryer and environmental sampling while at the laboratory the company needs 2 workers, consists of 1 worker of sample exploration smelting and 1 worker of Xray, C&S and xH2O analyzer. The additional worker must assist in these two areas. Thirdly, with the existing number of technicians of 6 people and 8 people at sample house and laboratory respectively, the company needs to recruit 4 and 2 more workers at sample house and laboratory respectively so that their workers will have normal workload according to FTE classification, which is 1-1.28. Finally, the result of the FTE calculation at sample house and laboratory can provide the best strategy for reducing the unbalance of the physical workload and can be used to determine the cost and impact of recruiting employees based on an analysis of workforce planning.

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