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Workload Analysis of Production Workers at PT Mitra Maharta: Applying the NASA-TLX and Full-Time Equivalent Methods

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Abstract:

Combine Harvester is one of the products of PT Mitra Maharta that requires high work demands and accuracy in the production process. Workers in the production division tend to cause uneven workloads due to intensive labor demands and the obligation to work with high accuracy. Therefore, measurements of the workloads experienced by workers are needed. The NASA-TLX and FTE (Full Time Equivalent) methods were used to measure the workloads of 14 production workers. Some workers have an average WWL value from the range of 64 - 84.33 with the categories "High" to "Very High" in the NASA-TLX calculation, while in the FTE method calculation, they have an FTE index value from the range of 0.79 - 1.32 with the categories "Underload", "Normal", and "Overload". Recommendations from this study include task restructuring and reallocation of human resources, additional manpower, as well as policies such as adequate rest time and training to improve worker efficiency.

Keywords: *Full Time Equivalent, NASA-TLX, Workload*

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1. Introduction

Workload has a major influence on work productivity, namely the higher the workload, the more work productivity will decrease (Darmasari, 2022; Nugroho, 2021; Trisnawaty & Parwoto, 2021). For employee work productivity to be improved, companies need to pay attention to workloads that are following with employee abilities (Gunawan & Sriathi, 2019; Purnami & Utama, 2019). The workload given is not only related to work overloads but can also be related to too little or insufficient work done (Ananda & Suliantoro, 2022; Hadi et al., 2022).

PT Mitra Maharta is a company that operates in the production and distribution of agricultural machinery. As an effort to support agriculture in Indonesia, various agricultural machinery equipment have been produced to improve technology in

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agricultural land management and to compete in the market with various competitors. PT Mitra Maharta has several products, namely Combine Harvester, Tractor, Vertical Dryer, and Rice Milling Unit.

A Job at PT Mitra Maharta that tends to cause uneven workload is in the Combine Harvester production division due to intensive labor demands and the obligation to work with high accuracy. This is supported by the reason that there are workers who complain of fatigue due to carrying out their duties. Based on interviews with workers in the production department, it was found that there were complaints about too high workloads felt by workers.

Therefore it is necessary to measure the workload experienced by workers in the production department, to understand the extent of the workload borne by workers so that work can be adjusted to the optimal number of workers according to the existing workload (Fithri & Anisa, 2017; Kusumah, 2021). The Full Time Equivalent (FTE) method is used in this case because this method can estimate labor requirements based on the number of working hours needed to complete a particular job (Cecep, 2019; Kurniawan et al., 2022). In addition, the application of the NASA-TLX method to evaluate the level of workload felt by workers subjectively can be used by companies (Nadhim & Apsari, 2023; Putra et al., 2023).

Previous research has shown that the FTE and NASA-TLX methods are useful tools for investigating and evaluating workload. A study by Kustian & Asyari (2024) used these two methods in measuring workload in the PPC division at PT ABC to be able to help identify certain areas that need further attention to improve operational efficiency and performance. In addition, research conducted by Hafizah & Azwir (2022) also used the FTE and NASA-TLX methods to provide deep insight into the importance of understanding workload in achieving the optimal performance of employees in the Professional Certification Center section in one of the Indonesian State-Owned Enterprises.

From the review of these studies, it appears that the integration of FTE and NASA-TLX methods is effective in analyzing workload in various industrial contexts. This research is expected to apply this approach appropriately to measure the workloads of Combine Harvester production workers at PT Mitra Maharta and analyze the optimal number of workers based on the existing workload capacity.

2. Theoretical Bakground

NASA-TLX

The NASA-TLX (National Aeronaustics Space Administration Task Load Index) method is widely used for measuring workload. This technique was created by Sandra G. Hart, a member of the Aerospace Human Factors Research Division at NASA Ames Research Center in Moffett Field, California, and Lowell E. Staveland, who is from San Jose State University, in 1988. NASA-TLX is comprised of two sections: the overall workload is divided into six subjective categories displayed on a single page, making up one part of the mental questionnaire inquiring about physical demands, time pressure, task performance, perceived effort, and needed assistance. Subjects should review the description of each subscale before assigning a ranking. Each task is scored using a 100-point scale with increments of 5 points. The duty load index is derived from combining these ratings. Every description gives a summary to assist participants in answering more precisely (Hart & Staveland, 1988; Schuff et al., 2011).

FTE

FTE (Full Time Equivalent) is a method used to calculate workload based on working time (Bakhtiar et al., 2021). The FTE method can be used to calculate the number of people in a population or organization. By measuring how long it takes to complete a job, the FTE method converts that time into an FTE index value (Hasibuan et al., 2023). FTE aims to translate the number of labor hours into people needed to complete a particular job (Kusmindari & Setiawan, 2021). By converting workload hours into the number of people needed to complete a particular job, FTE seeks to make the process of measuring work easier (daniel et al., 2022)

3. Methodology

Mitra Maharta using 2 workload measurement methods, namely the NASA-TLX (National Aeronaustics Space Administration Task Load Index) and FTE (Full Time Equivalent) methods. The research steps begin with an initial literature study to broaden the understanding of the theories to address the problem, followed by a field study to obtain information on conditions at the research location. The formulation of the problem is based on the context of the company's problems, and the appropriate method is chosen to solve the problem. Furthermore, the research objectives were determined based on the problem formulation, namely to measure the workloads of workers and analyze the optimal number of workers following with the existing workload.

Data was collected using the NASA-TLX pairwise comparison questionnaire and rating of indicators by workers. Selected indicators were calculated and continued to weigh the score on each indicator. Then the determination of the product value is followed by calculating the average Weighted Workload (WWL) by summing the product value of each indicator for each respondent and dividing it by the number of indicator pairs. Based on this, the workload is then categorized from low to very high (Andivas et al., 2023).

Table 1. Classification of NASA-TLX Workload Categories

WWL Average	Workload Categories
0 – 9	Very Low
10 – 29	Low
30 – 49	Moderate
50 – 79	High

80 – 100	Very High

Interviews were also conducted with company managers and workers to gather information about tasks or job descriptions and working time. Then the FTE index value is calculated to determine the workload and categorize it into underload, normal, and overload (Rachmuddin et al., 2021).

Table 2. Classification of FTE Workload Categories

FTE Index	Workload Categories
0 – 0,99	Underload
1 – 1,28	Normal
> 1,28	Overload

4. Empirical Findings/Result and Discussion

The NASA-TLX method has six indicators that are assessed, namely mental needs (KM), physical needs (KF), time needs (KW), work performance (PK), frustration level (TS), and effort (U). Using six groups of indicators, the assessment is carried out based on the weight of each indicator. Followed by rating by respondents on a scale of 0-100 on each of these indicators (Meri et al., 2023). The calculation of product value is done by multiplying the weighting results by the rating on each indicator (Zidan et al., 2024). In using the NASA-TLX questionnaire, 14 respondents were involved, which corresponded to the number of Combine Harvester production employees at PT Mitra Maharta.

Table 3. NASA-TLX Data Recapitulation

Division		Weighting						Rating						Product Value					
		KM	KF	KW	PK	TS	U	KM	KF	KW	PK	TS	U	KM	KF	KW	PK	TS	U
R1	Cutting	3	2	0	4	2	4	70	70	60	95	60	80	210	140	0	380	120	320
R2	Bending	4	1	3	3	2	2	90	65	80	90	75	90	360	65	240	270	150	180
R3	Welding	2	2	1	2	3	5	90	80	70	90	80	85	180	160	70	180	240	425
R4	Grinding	1	4	1	4	1	4	50	80	70	90	50	80	50	320	70	360	50	320
R5	Lathe Machining	2	1	4	2	5	1	80	70	90	85	80	75	160	70	360	170	400	75
R6	Machining	3	2	1	3	2	4	80	60	75	80	70	85	240	120	75	240	140	340
R7	Machining	1	4	1	4	2	3	60	80	70	85	60	75	60	320	70	340	120	225
R8	Painting	2	3	0	5	1	4	50	60	50	70	50	70	100	180	0	350	50	280
R9	Body Assembly	3	2	2	4	1	3	80	70	80	80	60	90	240	140	160	320	60	270
R10	Body Assembly	2	3	2	1	3	4	70	75	70	80	70	75	140	225	140	80	210	300
R11	Body Assembly	2	4	3	3	0	3	75	75	80	75	50	80	150	300	240	225	0	240
R12	Body Assembly	1	3	1	5	1	4	70	75	80	70	60	85	70	225	80	350	60	340
R13	Bucket Assembly	3	3	3	1	0	5	75	80	80	75	70	90	225	240	240	75	0	450
R14	Bucket Assembly	1	3	2	3	2	4	70	80	75	75	70	85	70	240	150	225	140	340

The calculation of weighted workload (WWL) is done by summing the product values for each respondent. The average WWL is used to classify the workload category. Obtained by dividing WWL by the total weight of the indicator (Silalong et al., 2024).

Table 4. NASA-TLX Workload Calculation

Respondent	Division	WWL	WWL Average	Categories
R1	Cutting	1170	78	High
R2	Bending	1265	84,33	Very High
R3	Welding	1255	83,67	Very High
R4	Grinding	1170	78	High
R5	Lahte Machining	1235	82,33	Very High
R6	Machining	1155	77	High
R7	Machining	1135	75,67	High
R8	Painting	960	64	High
R9	Body Assembly	1190	79,33	High
R10	Body Assembly	1095	73	High
R11	Body Assembly	1155	77	High
R12	Body Assembly	1125	75	High
R13	Bucket Assembly	1230	82	Very High
R14	Bucket Assembly	1165	77,67	High

The FTE index calculation is done by adding the total activity time and allowance, and then dividing by the total time available (Nurriza et al., 2024). The total time available in PT Mitra Maharta in one year is 289 days. In one working day, there are 8 working hours for workers. The total available time can be converted into 2312 hours in one year or 138720 minutes in one year.

In a real situation, a worker cannot work non-stop. So an allowance value is needed which is a special time for purposes such as personal needs, unwinding, and other needs that are unexpected by workers (Matiro et al., 2021).

Table 5. Allowance

Respondent	Division	Allowance Categories Based on ILO Table												∑ %
		A	B	C	D	E	F	G	H	I	J	K	L	
R1	Cutting	5	4	2	0	7	0	5	2	5	1	1	2	34
R2	Bending	5	4	2	0	5	0	5	5	2	4	1	2	35
R3	Welding	5	4	2	2	3	0	5	5	5	1	4	2	38
R4	Grinding	5	4	2	2	3	0	5	5	5	1	4	2	38
R5	Lahte Machining	5	4	2	2	2	0	5	2	5	1	4	2	34
R6	Machining	5	4	2	2	2	0	5	2	5	1	4	2	34
R7	Machining	5	4	2	2	2	0	5	2	5	1	4	2	34
R8	Painting	5	4	2	0	5	0	5	2	2	1	1	2	29
R9	Body Assembly	5	4	2	2	7	0	5	2	5	4	4	2	42
R10	Body Assembly	5	4	2	2	7	0	5	2	5	4	4	2	42
R11	Body Assembly	5	4	2	2	7	0	5	2	5	4	4	2	42
R12	Body Assembly	5	4	2	2	7	0	5	2	5	4	4	2	42
R13	Bucket Assembly	5	4	2	2	7	0	5	2	5	4	4	2	42
R14	Bucket Assembly	5	4	2	2	7	0	5	2	5	4	4	2	42

Information on worker activity times in the Combine Harvester production division was obtained through interviews with the company manager to understand the job descriptions carried out by each worker. In addition, interviews were also conducted with related workers and observations about routine activities carried out by these workers.

Table 6. FTE Workload Calculation

Division	Workers	Total Activity Time (minutes)	FTE Index	Categories
Cutting	1	95083	1,03	Normal
Bending	1	126873	1,26	Normal
Welding	1	129761	1,32	Overload
Grinding	1	102306	1,12	Normal
Lathe Machining	1	110400	1,14	Normal
Machining	2	171379	1,58	Underload
Painting	1	73406	0,82	Underload
Body Assembly	4	449973	3,66	Underload
Bucket Assembly	2	221374	2,02	Normal

A Comparison of workload measurement results with the NASA-TLX and FTE methods can be seen in Table 7 as follows.

Table 7. Recapitulation of NASA-TLX and FTE Value Results

Respondent	Division	Rerata WWL	Kategori NASA-TLX	Indeks FTE	Kategori FTE
R1	Cutting	78	High	1,03	Normal
R2	Bending	84,33	Very High	1,26	Normal
R3	Welding	83,67	Very High	1,32	*Overload*
R4	Grinding	78	High	1,12	Normal
R5	Lahte Machining	82,33	Very High	1,14	Normal
R6	Machining	77	High	0,79	*Underload*
R7	Machining	75,67	High	0,79	*Underload*
R8	Painting	64	High	0,82	*Underload*
R9	Body Assembly	79,33	High	0,92	*Underload*
R10	Body Assembly	73	High	0,92	*Underload*
R11	Body Assembly	77	High	0,92	*Underload*
R12	Body Assembly	75	High	0,92	*Underload*
R13	Bucket Assembly	82	Very High	1,01	Normal
R14	Bucket Assembly	77,67	High	1,01	Normal

Summary of workload data measured by the NASA-TLX and FTE methods shows variations in results between respondents and the type of work performed. The first respondent (R1) who works in the cutting section has an average weight workload (WWL) of 78 in the "High" category and an FTE index of 1.03 in the "Normal" category. The second respondent (R2) in bending was recorded as having an average WWL of 84.33 in the "Very High" category and an FTE index of 1.26 in the "Normal" category. The third respondent (R3) in the welding section had an average WWL of 83.67 in the "Very High" category and an FTE index of 1.32 which indicated "Overload". The fourth respondent (R4) at the grinding site had the same average WWL as R1, namely 78 and an FTE index of 1.12, both categorized as "Normal". The fifth respondent (R5) in the lathe machining section had an average WWL of 82.33 in the "Very High" category and an FTE index of 1.14 in the "Normal" category. The sixth and seventh respondents (R6 and R7), both of whom work in the machining section, have an average WWL of 77 and 75.67 respectively, categorized as "High" with an FTE index of 0.79 which means they are at "Underload". The eighth respondent (R8) in the painting section had an average WWL of 64 which was categorized as "High" and an FTE index of 0.82 which was categorized as "Underload". The next four respondents (R9 to R12), who worked in body assembly, had average WWLs ranging from 73 to 79.33, all categorized as "High", with an FTE index of 0.92, indicating "Underload". Finally, the last two respondents (R13 and R14) in bucket assembly had an average WWL of 82 and 77.67, categorized as "Very High" and "High", with an FTE index of 1.01, indicating the "Normal" category for both respondents.

From Table 7, it is known that there are 7 workers with "High" workload in the NASA-TLX method in the "Underload" state in the FTE method. Then 3 workers with a "High" workload on the NASA-TLX method are in a "Normal" state on the FTE method. And 3 workers with a workload of "Very High" on the NASA-TLX method in a state of "Normal" on the FTE method. As well as 1 worker with a "Very High" workload on the NASA-TLX method in a state of "Overload" on the FTE method.

The use of the NASA-TLX and FTE methods in this study showed differences in psychological workload and work capacity in workers in various work areas. Most respondents showed an average level of WWL that fell into the "High" to "Very High" category, indicating a high level of job demands. In particular, the bending, welding, lathe machining, and bucket assembly sections showed the heaviest workload levels in the "Very High" category. Differences in work capacity requirements can be seen from variations in the FTE index values. Some respondents, such as those in welding, experience "Overload", while others, especially in machining and body assembly, experience "Underload". This situation reflects possible imbalances in the division of responsibilities and unbalanced allocation of human resources in some areas of work. Measurement of workload with the NASA-TLX and FTE methods is very likely to get different workload results. This is in line with the research of Hafizah & Azwir (2022) also Kustian & Asyari (2024) due to differences in calculations in these methods. Measuring workload with the NASA-TLX method, is done subjectively based on workers personal feelings and perceptions, which assesses the level of effort associated with performing one or more tasks. Whereas in the FTE method, the factor calculated as the workload is the length of time needed to complete a task. Thus, the more time it takes to complete it, the higher the workload perceived by the worker.

In this study, the significant differences in results were particularly evident for workers in the machining, painting, and body assembly sections, where the condition of these workers in terms of the FTE method was "Underload" but the NASA-TLX method showed that these workers had a "High" workload. While the other sections are in a state of "Normal" and "Overload" indicating that they have a range of "High" and "Very High" workloads.

One recommendation that can be given is to restructure specific tasks to reduce workload in overly busy sections and optimize potential in less busy sections. This suggestion is in line with the concept of human resource management which emphasizes the need for workload balance to improve employee performance (Ramadani et al., 2024; Yanti et al., 2023). Additional labor or recruitment can be done with a note that further attention needs to be paid to whether the workload occurs continuously or only temporarily to decide to add part-time or full-time workers (Wicaksono & Fadlillah, 2021). In this study, additional workers can be added to the welding section because the third respondent (R3) has a "Very High" workload in the NASA-TLX method and "Overload" in the FTE method. In addition, improving the welfare of employees through policies that ensure adequate rest periods, training to improve work productivity, and occupational health and safety programs are very important in reducing levels of fatigue and work stress (Achmar et al., 2022; Ramadhan et al., 2024).

5. Conclusions

This research successfully provides an in-depth insight into the distribution of workload at PT Mitra Maharta using the NASA-TLX and FTE methods. The findings show that there are different variations in workload measurements with both methods. Some workers have an average WWL value from the range of 64 - 84.33 with the categories "High" to "Very High" in the NASA-TLX calculation, while in the FTE method calculation, they have an FTE index value from the range of 0.79 - 1.32 with the categories "Underload", "Normal", and "Overload". Recommendations focus on restructuring tasks and reallocating human resources to achieve a more optimal balance. However, this study only used a quantitative and subjective approach which may only partially reflect the actual situation in the field. In future research, it is recommended to include qualitative methods to gain a deeper understanding of workload and worker well-being. Long-term research can also support the understanding of how workload changes and the effectiveness of interventions based on the recommendations from this study.

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