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Mental Analysis Workload on Solar Street Lighting Workers

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Abstract. The workload for each scope of work has different responsibilities. The workers will face working hours, loads, remember many patterns, and frustration when doing a special task. Solar street lighting (PJU TS) installation project is affected by various risks. NASA TLX as a tool to measure the workloads. The analysis not only using NASA TLX but also using statistical testing. The Mental Demand (MD) has score 325 (the highest score) due to considerable mental activity. The Performance (P) has a score close to zero that categorized quite well. Regression and correlation analysis between mental demand and duration of work show the direction of positive relationships. More experienced makes more MD scores. That is because every PJU installation project has different criteria. The solution is bookkeeping and mind mapping regarding the type of PJU TS. Each PJU TS has the book as a guide in the field.
Keywords: NASA TLX, Mental Workload, Worker, Productivity

1. Introduction

Every job has a characteristic. The different characteristics make workers facing working hours, workload, and frustration [1]. The rule is required to confirm safety, health, comfort, and productivity in the long term [2]. Workload excessive make physically tired, mentally tired, and emotional reactions [3]. Emotional reactions such as headache, indigestion, and easily angry. Workload evaluation as a tool to review and develop human machine interface, comfort, satisfy, efficiency, and safety at the workplace [2].

The decrease in work productivity levels can be caused by fatigue of workers[4]. Factors that affect productivity workers are individual factors such as age (25%), sex (15%), and years of work (10%), and more than 50% affected by workload and fatigue[5].

Solar Street Lighting (PJU TS) projects are affected by risk and failure to reach the target [6]. Risk frequency and risk impact depend on project specifications, location, and special conditions [6]. Either risk that occurs is a work accident. Work accident that related to PJU TS ever occurred in the Tangerang city. Badan Penyelenggara Jaminan Sosial (BPJS) as an insurance provider government, has to immediately follow up and checks, so they can categorize the occurrence as a work accident [7].

Workload evaluation can be used for PJU TS because the project needs strong physic and good cognitive to make the schedule of solar cells panel installation and assembly. Solar cell panel has many types depending on customer needs. Data collection in this study was carried out by observation of technicians who have worked directly into the installation of PJU TS (study case at Wonosobo).

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2. Methodology

This research collected and processed the data using NASA TLX.

2.1 Data Collection

Data collection was done by the NASA TLX method which was used to analyze the worker's mental workload. NASA TLX has six indicators [8]:

a. Mental Demand (MD)
   MD measure perceptual and mental activity that needed to see, remember, and find something that related. It is categorized from low to high score, the good categorize is a high score.
b. Physical Demand (PD)
   PD measuring physical activity such as pull, push, etc.
c. Temporal Demand (TD)
   TD is measuring time pressure (slowly or quickly) that can make fatigue.
d. Performance (P)
   P is measuring success or failure to complete projects. Score of P that nearly zero score makes a very good categorized.
e. Frustration level (FL)
   FL is measuring unsafe, despair, offense, or distraction works while doing the task.
f. Effort (EF)
   EF is measuring hard work relating to performance level.

MD, PD, TD, FL, EF has categorized from low to high score and good categorize is a high score.

2.2. Data Processing

Data processing was performed to determine the mental workload value of each technician by the NASA TLX method and the Statistical test. NASA TLX steps [8]:

a. The weighting section was choosing an indicator that causing mental workload.
b. The rating section was giving a score for the selected indicator.
c. Weighted workload (WWL) sums the six indicators using weight and rate.
d. The average of WWL is the average score of the total pairing tail indicator from weighting section.

Interpretation score using Table 1.

Table 1. The Interpretation Score of NASA TLX [8]

Workload	Value
Low	0-9
Medium	10-29
Somewhat high	30-49
High	50-79
Very high	80-100

The last step was analysis using scores of interpretation and statistic test (regression and correlation test).

3. Result and Discussion

The total respondents were 16 people. Respondent's profiles were shown in Table 2. The result of collected and processed data using NASA TLX has shown in Table 3.

Table 2. Respondent Profile

Category				Total
Age				
≤ 20	21-30	31-40	41-50	
2	12	1	1	16
Period Working (year)				

1 - 5	10-Jun	≥ 10	
14	1	1	16

The workers who have the longest working period is a site manager, they have the responsibility to match the project schedule. They not only work as a supervisor, but also work as a technician. They work as supervisors to control work and as technicians to do tasks that can't be done by others. People can become the site manager is workers who have to from the internal company that has a project. The others are freelancers who have experienced works as a technician in the PJU TS project. Some freelancers are recruited from residents around the project.

Table 3. The Result of Interpretation Score

Category	Total	Average
MD	5200	325,0
PD	1780	111,3
TD	3010	188,1
P	620	38,8
EF	3860	241,3
FR	220	13,8
Average of WWL	61,2	
Interpretation	High	

Score interpretation is high base on [8]. MD was in first place with a score of 325. The reason was the workers need high mental activity and perceptual to see, remember and find. High mental activity needed to match with the PJU TS installation type following the consumer demand. All of the workers doing planning, implementing, and supervising PJU-TS installation work. The type of installation scopes are panel, timer, and wire, while additional work including changes in location from the original plan.

EF had a score of 241,3 in second place. The workers must be done on schedule and deadline. TD has a score of 188,1, it can happen because the worker was required to complete various jobs quickly, well, and correctly. Therefore, the temporal demand was quite high. PD has a score of 111,3 because the worker needed strong physical. The score of performance is quite good because the score approaches 0 or a small score. In the last place is FR with a score of 13,8. Mostly the weather factor is causing FR but the score shows that it does not affect the worker's condition.

Statistical test show regression and correlation result between MD and period working has positive value (Table 4) [9]. Workers who have more periods of working need more MD. Period working can make them confuse with PJU TS type because they have to remember each type in every project. Regression formula couldn't become a predictor because the coefficient value was not significant.

Table 4. Correlations

		Period Working	MD
Pearson Correlation	Period Working	1	0,069
	MD	0,069	1
Sig. (1-tailed)	Period Working	.	0,4
	MD	0,4	.
N	Period Working	16	16
	MD	16	16

The suggestion is doing mind mapping when arranging a project plan. The mind mapping can be used as a document that will be guiding when installing the project.

4. Conclusion

MD is a big factor in this research with a score of 325. Regression analysis has shown that MD and working periods have a positive relationship, but the coefficient is not significant.

The workers need big mental demand and perceptual using mental activity such as see, remember, and find to matching the type PJU TS installation. To reduce work fatigue due to mental demand, companies can do the following [10]:

- Monitoring, standardizing, evaluating, and controlling the work environment regularly and continuously. It can be done using mind mapping and make book as a work guideline.
- The establishment of fatigue control organizations that are followed by an administration that orderly, and continuous improvement.
- Updating regulation and procedure Health and Safety Environment.
- Every three months conducting education and training for management and workers. The company can give training by face to face or online training to supervisors about their stress at work or upgrading skills[11].
- The company can give technology to fixed employees. It will give them experience and efficiency in communication to avoid their unpredictability at work [12].

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