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**ORIGINAL ARTICLE**

# Correlation between Individual Factors and Mental Workload with Work Fatigue in Nilam Terminal Surabaya

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## ABSTRACT

**Introduction:** Work fatigue can be caused of excessive workload and work capacity such as age and tenure. This study aimed to analyze the strength of the correlation between individual factors and mental workload with work fatigue on the Surabaya Patchouli Terminal crane operator. **Methods:** The study design is a cross sectional. The sampling technique taken was total sampling so that all populations were a sample of 30 people, consisting of CC and RTG operators in Nilam Terminal Surabaya. The independent variables are individual factors including age and years of service obtained from the questionnaire, mental workload which is assessed based on the NASA-TLX questionnaire, while the dependent variable is work fatigue measured using a reaction timer. The collected data were then analyzed using the Spearman correlation. **Results:** The results show 23 operators (76.7%) experienced heavy work fatigue and 7 operators (23.3%) experienced moderate work fatigue. **Conclusion:** The strongest correlation is mental workload with work fatigue and the weakest correlation is age with work fatigue. Meanwhile, correlation tenure with work fatigue is in between. It is recommended to provide psychological consultation once a week for operators.

**Keywords:** container crane, individual factors, rubber tyred gantry, workload, work fatigue

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## INTRODUCTION

Work accidents are very harmful for worker health (Alves *et al*., 2020). Besides having emotional consequences, psychological, and social effects, work accidents are still problems of public health that are costly for firms and the state (Amponsah-Tawiah and Mensah, 2016). The International Labour Organization (ILO) states that there are more than 250 million cases of workplace accidents and more than 160 million workers get an occupational disease each year (Haworth and Hughes, 2012). In addition, 1.2 million workers died because of work accidents and illness at work. Based on the latest estimation from ILO in 2018, each year more than 1.8 million deaths occur due to work in Asia and the Pacific. Even two-thirds of fatality in the world occur in Asia. Overall, more than 2.78 million people die each year because of work accidents or diseases. Furthermore, there are around 374 million occupational accidents and diseases that are not fatal each year, resulting in workers' absence (International Labour Organization, 2018).

Figure 1 shows that work accidents in Indonesia increased by around 50.010 cases in 2017 to 2018. The number of the labor force from February 2019

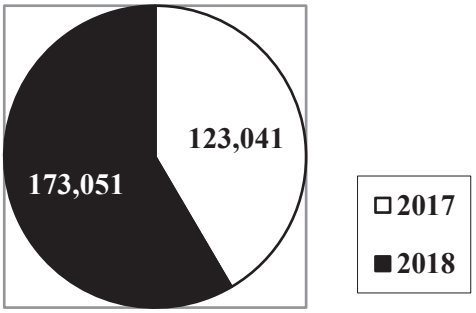


**Figure 1.** Work Accidents Number in Indonesia

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to February 2020 in Indonesia has increased by 1.658 people (Central Statistics Agency, 2020). Every worker always has risk potential of danger to occupational accidents or occupational disease. The magnitude chance for work accidents and diseases hinges on the kind of output, the substances, and technology used, the composition and establishing environment as well as the grade of management of the company. Work accidents can occur because of two factors, unsafe action (behavior) and unsafe condition. Unsafe action can be a high contributor as the cause of work accidents and fatigue, both physical and mental (Tarwaka, 2019). Fatigue can lead to decreased productivity so the company will suffer losses. Fatigue is a non-specific symptom that decreases work efficiency and reduces one's physical strength and endurance to continue the work activities that must be done (Wan *et al*., 2017).

According to a survey conducted by the International Labour Organization (2013), of 58,118 samples studied approximately 18,828 samples got fatigued and around 32.8% affected work productivity. Fatigue is one of the national health problems in Indonesia. Work fatigue itself is also national health problem in Indonesia. As many as 67.3% or 35 construction workers in a company in the city of Semarang experience work fatigue (Anggorokasih, Widjasena and Jayanti, 2019). In addition, research by Amalia *et al*. (2017) shows there are 35 container crane operators (83.3%) in Terminal Petikemas Surabaya in the mild fatigue category. Fatigue is defined as a pattern that arises in a situation that generally occurs in every individual who is no longer able to carry out their activities (Maslach and Leiter, 2016). Fatigue can be caused by monotony of work, work environment, lack of clarity of responsibilities, body physiology, conditions of illness suffered by workers, as well as the intensity and duration of physical and mental work (Jauhari, 2019).

Ages can involve ability, conditions, and body capacity to carry out daily activities. The increase of age will also be followed by the process of decreasing the function and ability of the body organs. Decreasing the function and ability of these organs will cause workers to experience fatigue easily (Tarwaka, 2019). Comin and Pauli (2018) stated that workers who have worked between a year and ten years can adapt and socialize with their work and environment.

Based on the ergonomic balance theory by Tarwaka (2019), fatigue can be caused by work pressure that is excessive workload and work capacities such as age and work period. Every work activity creates a workload. The workload is the difference between the capacity or workers' ability and the demands of the work that must be done (Tarwaka, 2019). The workload can be divided into two: physical and mental workload. The physical workload is workload that involves physical energy to human muscles which functions as a source of energy. Meanwhile, mental workload is an activity that includes interpretation, perception, and mental processes of information accepted by the sensory organs for decisions or processes to remember past information (Tarwaka, 2019).

PT. Pelabuhan Indonesia III (Persero) is a state-owned company followed in the management of general ports in seven Indonesian provinces. One of the operational areas of PT. Pelindo III is the East Java Regional. There are four operational areas in the East Java Region, namely Tanjung Perak Port, Gresik Port, Tanjung Tembaga Port, and Kalianget Port. Tanjung Perak Port is a domestic container center in Indonesia that has 72 domestic shipping routes to and from Tanjung Perak Port (Pelindo III, 2018). The flow of containers in 2018 was recorded at 5.3 million TEUs. This number has increased by 8.5% compared to the previous year (Pelindo III, 2018). The container loading and unloading operational area at Tanjung Perak Port is the Nilam Terminal.

Based on the field observation result in the preliminary study, the container loading and unloading process at the Nilam Terminal is carried out using tools called Container Crane (CC) and Rubber Tyred Gantry (RTG). The function of a container crane is to move cargo in the form of containers from the ship to the dock or vice versa. Meanwhile, the RTG functions to move containers from the dock to the stacking yard or vice versa. CC and RTG are operated by an operator. The height of the CC tool reaches 30 to 40 meters above sea level while the RTG height reaches 15 meters. CC and RTG operators at Nilam Terminal work on a shift system, morning shift (shift II), afternoon shift (shift III), and night shift (shift I). The morning shift starts at 08.00 - 16.00, the afternoon shift 16.00 - 00.00, and the night shift from 00.00 - 08.00. The work process of the CC and RTG operators is almost the same, sitting statically with their head down and their hands operating the buttons on the tools.

Based on the interview result, the information was obtained that CC and RTG complained of

fatigue after working. The fatigue is felt in the neck to the back. Furthermore, the mental workload experienced by the operator is high. CC operators have done more mental activities while working that require focus and concentration. If they just lose focus for a while, you risk a work accident that can endanger yourself and others' safety. In addition, the risk of equipment damage is also the responsibility of CC operators and there is a monthly target that must be achieved so that the mental workload of CC operators is quite high. Therefore, the aim of this study is to analyze the strength of the correlation between individual factors and mental workload with work fatigue on Surabaya Nilam Terminal crane operators.

## METHODS

This study is quantitative study and a cross-sectional design. Based on the data collection method, this study is included in observational research because it does not give special treatment to the object of research. In addition, this is entered into analytical research because of its aim of analyzing the strength of the relationship of individual factors and mental workload with work fatigue on the Surabaya Nilam Terminal crane operators.

The quantity of sample in this study is also 30 people consisting of Container Crane (CC) and Rubber Tyred Gantry (RTG) operators in Surabaya Nilam Terminal because this study used total sampling. Independent variables are individual factors including age and years of service, as well as mental workload. Besides that, the dependent variable is work fatigue.

The primary data were used in this study. Data related to work fatigue were collected using a reaction timer. Mental workload data were obtained using the NASA-TLX questionnaire, and individual factor data (age and years of service) were obtained based on the questionnaire. The collected data were then processed with the SPSS application, then analyzed using univariate and bivariate analysis. Univariate analysis is to determine the frequency distribution of each variable while bivariate analysis uses Spearman correlation to determine the strength of the correlation between variables.

This research was conducted at Pelindo III Tanjung Perak Port, namely Surabaya Nilam Terminal during March 2021. In addition, this research has passed the ethical test at the Faculty of Dentistry, Airlangga University with number 037/HRECC.FODM/I/2021.

## RESULT

### Individual Factors of the Workers

The individual factors in this study consist of the characteristics of age and years of service. Characteristics of age are categorized into four. Meanwhile characteristics of years of service are categorized into three which are less than five years, five until ten years, and more than ten years. Individual factors are measured by questionnaire. Data related to the ages of 30 crane operators at the Surabaya Nilam Terminal are as follows. Table 1 shows that the most dominant age of Surabaya Nilam Terminal crane operators is 35-44 years, which is 19 people. Table 2 indicates that the most dominant working period for Surabaya Nilam Terminal crane operators is more than 10 years, which is 17 people.

### Mental Workload of the Workers

Workloads consist of physical workload and mental workload. Mental workload is measured by NASA-TLX questionnaire and categorized into low, moderate, high, and very high. Data related to mental workloads from 30 crane operators at the Surabaya Nilam Terminal are as follows. Table 3 shows that the mental workload of the Surabaya Nilam Terminal

**Table 1.** Distribution of Ages at Crane Operators of Terminal Nilam Surabaya in 2021

| Ages (years) | Frequency (n) | Percentage (%) |
|---|---|---|
| 25-34 | 5 | 16.7 |
| 35-44 | 19 | 63.3 |
| 45-54 | 5 | 16.7 |
| 55-64 | 1 | 3.3 |
| **Total** | 30 | 100 |

**Table 2.** Distribution of Years of Service at Crane Operators of Terminal Nilam Surabaya in 2021

| Service (years) | Frequency (n) | Percentage (%) |
|---|---|---|
| <5 | 3 | 10 |
| 5-10 | 10 | 33.3 |
| >10 | 17 | 56.7 |
| **Total** | 30 | 100 |

crane operator which is most dominant is very high, which is 21 people.

### Work Fatigue of the Workers

Work fatigue is measured by using reaction timer and categorized into four which are normal, low, moderate, and high. Data related to work fatigue from 30 crane operators at the Surabaya Nilam Terminal are as follows. Table 4 shows that the most dominant work fatigue of the Surabaya Nilam Terminal crane operator is high, which is 23 people.

**Table 3.** Table 3. Distribution of Mental Workload at Crane Operators of Terminal Nilam Surabaya in 2021

| Mental Workload | Frequency (n) | Percentage (%) |
|---|---|---|
| Moderate | 1 | 3.3 |
| High | 8 | 26.7 |
| Very High | 21 | 70 |
| **Total** | 30 | 100 |

**Table 4.** Distribution of Work Fatigue at Crane Operators of Terminal Nilam Surabaya at 2021

| Work Fatigue | Frequency (n) | Percentage (%) |
|---|---|---|
| Moderate | 7 | 23.3 |
| High | 23 | 76.7 |
| **Total** | 30 | 100 |

### Correlation Between Individual Factors with Work Fatigue

Table 5 shows that the strength of the relationship between individual factors in the form of age and work fatigue on the Surabaya Nilam Terminal crane operator is very weak with a contingency coefficient of 0.037. While the strength of the relationship between individual factors in the form of tenure with work fatigue on the Surabaya Nilam Terminal crane operator is weak with a contingency coefficient of 0.294.

### Correlation Between Mental Workload with Work Fatigue

Table 6 shows that the relationship between mental workload and work fatigue on the Surabaya Nilam Terminal crane operator is strong with a contingency coefficient of 0.632.

## DISCUSSION

### Individual Factors of the Workers

Most of the Surabaya Nilam Terminal crane operators are aged 35-44 years. Commonly, 35-44 years old is categorized in productive age. The

**Table 5.** Correlation Between Individual Factors with Work Fatigue

| Individual Factors | Group | Work Fatigue | | | | Total | | Coefficient Contingency |
|---|---|---|---|---|---|---|---|---|
| | | Moderate | | High | | | | |
| | | n | % | n | % | N | % | |
| Age | 25-34 | 1 | 20 | 4 | 80 | 5 | 100 | 0.037 |
| | 35-44 | 5 | 26.3 | 14 | 73.7 | 19 | 100 | |
| | 45-54 | 1 | 20 | 4 | 80 | 5 | 100 | |
| | 55-64 | 0 | 0 | 1 | 100 | 1 | 100 | |
| Years of Service | <5 | 1 | 33.3 | 2 | 66.7 | 3 | 100 | 0.294 |
| | 5-10 | 4 | 40 | 6 | 60 | 10 | 100 | |
| | >10 | 2 | 11.8 | 15 | 88.2 | 17 | 100 | |

**Table 6.** Correlation Between Mental Workload with Work Fatigue

| Individual Factors | Group | Work Fatigue | | | | Total | | Coefficient Contingency |
|---|---|---|---|---|---|---|---|---|
| | | Moderate | | High | | | | |
| | | n | % | n | % | N | % | |
| Mental Workload | Moderate | 0 | 0 | 1 | 100 | 3 | 100 | 0.632 |
| | High | 6 | 75 | 2 | 25 | 8 | 100 | |
| | Very High | 1 | 4.8 | 20 | 95.2 | 21 | 100 | |

youngest age of a Nilam Terminal crane operator is 27 years old. Meanwhile, the oldest age of Nilam Terminal crane operator is 55 years old. The company regulates the limit to end employment at 56 years old. A person's age can affect her or his daily activities. The older someone is then the more physiological changes. Physiological changes in the body can be in the form of decreased body functions such as breathing, hearing, memory decline, and the ability to make decisions (Tarwaka, 2019).

Ages are classified by four categories based on Ministry of Public Health (2013). Besides that, the categories start from 25-34 years old because the youngest operators is 27 years old and over to 55-64 years old because the oldest operator is 56 years old.

The working period of Surabaya Nilam Terminal crane operators at most is more than 10 years. According to the HSSE officer of Nilam Terminal, it can be caused by being a crane operator is difficult because they have to have an SIO (Permit to Work). So, most of the crane operators have years of service more than ten years. Rahmawati and Tualeka (2019) explain that workers who have long tenure will have adaptability to solve all kinds of problems and situations in the workplace. According to Comin and Pauli (2018), workers with a longer working period have a better ability to adapt to problems and the surrounding environment.

Years of services are classified by three categories based on Marfuah (2021) which are <5 years, 5 – 10 years, and >10 years. Besides that, the categories start from <5 years because the shortest years of services of operators is two years, which means less than 5 years. And the longest years of services of operators is more than twenty years which is included in the more than 10 years category. The population of operators is small so the writers categorize the years of service just in three categories.

**Mental Workload of the Workers**

The mental workload for Surabaya Nilam Terminal crane operators is very high. The outcome of this study is the same as research established on reagent workers in the PT. Meares Soputan Mining, namely the mental workload on these workers is high (Lua, 2015). In addition, research conducted by Kakerisa *et al*. (2019) also obtained the result that the mental workload received by the production workers of PT. Fajar Utama Intermedia Ambon branch is very high. In research conducted by Triminingsih (2018) it also shows that the mental workload on the train driver crew DAOP VII Madiun PT. KAI (Persero) is tough. In addition, research conducted by Zain (2019) also stated that the mental workload experienced by the crane operators of PT. Sinar Samudera Abadi amounted to 61.18% with 10 operators included in the overload category.

The very high mental workload on the Surabaya Terminal crane operator can be caused by the work activity as the operator uses more mental activity than physical activity (Lua, 2015; Triminingsih, 2018; Kakerisa, Soleman and Prasetyo, 2019). These mental activities include focus, concentration, remembering, thinking, and so on. To lift and move containers, high accuracy and focus are required when loading and unloading containers (Pratama, 2014; Amalia, Wahyuni and Ekawati, 2017). In addition, operators have a high responsibility for the safety of themselves, others, and the CC and RTG tools themselves. If the operator is not focused while working, it can threaten the safety of themselves and others who are below. The safety of CC and RTG equipment itself is also the responsibility of the operator. If there is damage to the equipment, the operator must compensate for all the damage so the operator must be careful when working.

The operator has a target per month that must be achieved. In addition, there is also a premium for operators who are able to achieve predetermined targets. So that the operator will make every effort to achieve good work performance so that the target can be achieved (Pramuditta and Kunaefi, 2016; Amalia, Wahyuni and Ekawati, 2017). A very high mental workload will affect the psychological and physical condition of workers which can cause fatigue for workers. Fatigue at work can cause work productivity to decrease (Kakerisa *et al*., 2019).

**Work Fatigue of the Workers**

The work fatigue of Surabaya Nilam Terminal crane operators is heavy. This study is the same as the research by Asriyani and Karimuna (2017) where the fatigue of work in the factory workers of PT. Kendari Industrial Cocoa is heavy (47.8%). In addition, Amalia *et al*. (2017) stated that as many as 35 container crane operators (83.3%) at Surabaya Container Terminal experienced moderate fatigue.

Heavy work fatigue in the Surabaya Nilam Terminal crane operator is caused by a very high mental workload. Workers must concentrate and focus during work. In addition, the operator's eight hours of work can also cause fatigue. Nilam

Terminal has four Container Crane (CC) tools and one Rubber Tyred Gantry (RTG) tool. Meanwhile, the number of CC operators in each group is from one to six and the RTG operator is only one person in each group. This insufficient number of operators can also cause work fatigue because workers cannot take turns to work or rest (Soedirman and Suma'mur, 2014).

Feelings of fatigue experienced by workers do not only occur when work ends, but work fatigue can also be experienced during work even before working time (Suma'mur, 2014). According to Tarwaka (2019), there are several impacts or risks that may occur if workers experience work fatigue. These impacts include a decrease in work motivation, a decrease in performance, make many mistakes while working, low work productivity, low work quality, occupational diseases, work stress, work accidents, and injuries.

**Correlation Between Individual Factors with Work Fatigue**

Age is the length of life expressed in years, starting from the date of birth of the respondent until the date the research was carried out. Based on Table 5, information is obtained that as many as one operator aged 25 - 34 years experienced moderate work fatigue and as many as four people experienced severe fatigue. Heavy and moderate work fatigue is mostly experienced by operators with an age range of 35 - 44 years where five people experience moderate fatigue and 14 people experience severe work fatigue. In the age range of 45 - 54 years, one operator experienced moderate work fatigue and four operators experienced severe fatigue. Meanwhile, at the age of 55 - 64 years, only one worker experienced severe fatigue.

The result of this study states that the strength of the correlation between age and work fatigue on the Surabaya Nilam Terminal crane operator is very weak with a contingency coefficient of 0.037 and a positive direction. This is the same as study by Rahmawati and Tualeka (2019) in which the relationship between age and work fatigue in PT. Kerta Rajasa in the loom circulator unit is weak. In addition, research also shows that the direction of the connection between age and work fatigue in PT. Karias Tabing Kencana is positive. The positive direction shows that the older you get, the more fatigue you get.

The working period is the time calculated from the time the worker first started working until the research was carried out. According to Suma'mur (2014), the longer the working period of a person, the easier it will be to adapt to the work environment and easier to deal with problems that exist in the workplace. A total of one operator who has a working period of less than five years experienced moderate work fatigue and two people experienced heavy work fatigue. Meanwhile, there are four operators with a working period of 5 to 10 years with moderate work fatigue and six people with severe fatigue. Operators who have a work period of more than 10 years and experience moderate work fatigue are two people and 15 people are overworked.

The results of the analysis show that the strength of the correlation between tenure and work fatigue on the Surabaya Nilam Terminal crane operator is weak with a contingency coefficient of 0.294 in a positive direction. Likewise Rahmawati and Tualeka (2019) found the connection between tenure and work fatigue in PT. Kerta Rajasa in the loom circulator unit is very weak. However, this study contradicts the research conducted by Kusgiyanto, Suroto and Ekawati (2017) that there isn't a correlation between tenure and work fatigue on workers making lumpia skin in Semarang (p value = 0.967).

The outcomes illustrate that the level of operators who have a longer service life is more tired. In this case, tenure is able to have an impact on workers both positive and negative impacts. The positive impact occurs if the longer a person works, he will have a better work experience. Conversely, a negative impact occurs when the longer a person works, it will cause boredom and fatigue, especially with repetitive and monotonous work activities such as crane operators (Prayogi *et al*., 2020a).

This can happen because all crane operators have an SIO (Operating Permit) permitting to work so the workers have been given special training to operate cranes. Therefore, workers who have a longer working period or not, both have the same abilities and can do their jobs well so that the work fatigue experienced is relatively the same (Amalia, Wahyuni and Ekawati, 2017; Prayogi, *et al*., 2020b).

**Correlation Between Mental Workload with Work Fatigue**

Workload can be interpreted as the distinction between the capacity of workers and the task demands of the work. Meanwhile, according to Tarwaka (2019), workload is something that arises

as a result of the interaction between job demands, skills, behavior, work environment, and workers' perceptions. Sometimes workload is operationally defined on factors such as the demands of the job or the effort made to carry out the job. Human work is physical and mental so that each has a different level of loading. Too high and excessive loading may use excessive energy and cause overstress, while the intensity of loading that is too low will cause a feeling of saturation or understress (Tarwaka, 2019).

Each individual worker has the ability to relate to the workload. Some of them may be more suited to the physical or mental workload. However, this study has proven that the mental workload of the respondents was very high (70%) and most of the workers experienced severe work fatigue (76.7%).

The result shows that the strength of the relationship of mental workload and work fatigue on the Surabaya Nilam Terminal crane operator was strong with a contingency coefficient of 0.632 and a positive direction. The positive direction means which the higher the mental workload received by the worker, the heavier the work fatigue experienced by the worker. Based on Table 6, information is obtained that as many as 20 operators who received very high mental workloads experienced heavy work fatigue and two people experienced moderate work fatigue. Operators who receive high mental workload and experience moderate work fatigue are six people and two operators experience heavy work fatigue with high mental load.

This study is the same as the study by Ardiyanti, Wahyuni and Jayanti (2017) that there is a connection between mental workload and work fatigue on nurses and midwives at Mlati II Yogyakarta puskesmas. Research carried out on machinists UPT Crew KA Blitar Daop VII Madiun PT. KAI (Persero) also shows that the relation of mental workload and work fatigue is strong with the contingency coefficient = 0.637 (Triminingsih, 2018). The same thing happened to the research conducted by Hidayah, Musyarofah and Widjasena (2018) which shows there is a significant correlation of work fatigue and mental workload on workers in the operational section of PT. Pertamina DPPU Semarang (p value = 0.040).

In this era of technology, a lot of work is done using machines, from very simple machines to the use of high-tech machines. Increased automation and mechanization in machines often increases working speed. This increase will make the work monotonous and less interesting to do. So that the psychological burden experienced by workers will be more dominant (Tarwaka, 2019). One of the jobs that require high mental activity is as a heavy equipment operator because it requires focus and concentration while working.

CC and RTG operators at Nilam Terminal receive a very high mental workload because they require mental activity while working (Ardiyanti, Wahyuni and Jayanti, 2017). The operator must be able to insert the iron into the hole in the corner of the container above a height of tens of meters so that the container can be lifted by the tool and can be moved. In addition, the responsibility as an operator is also big, namely being responsible for the safety of themselves, others who are below, as well as the CC and RTG tools themselves. In addition, there is a premium for the operator if the operator is able to achieve the predetermined target.

Very high mental workload on the operator has a correlation with the incidence of work fatigue. The higher the workload received by the operator, the heavier the work fatigue experienced by the operator. This study successfully proves the theory of ergonomic balance by Tarwaka (2019) that is, job demands or workload have a relationship with work performance, namely work fatigue (Dewi and Wibawa, 2016; Rahmawati and Tualeka, 2019).

## CONCLUSION

Based on the outcomes of this study, it finds that many of the Surabaya Nilam Terminal crane operators are aged between 35-44 years with a service period of more than 10 years. The mental workload experienced by the Surabaya Nilam Terminal crane operator is very high. In addition, the fatigue of work experienced by the Surabaya Nilam Terminal crane operator is heavy. The relationship between individual factors in the form of age and work fatigue on the Surabaya Nilam Terminal crane operator has a very weak relationship strength with a positive direction. In addition, the relationship between tenure and work fatigue on the Surabaya Nilam Terminal crane operator also has a weak relationship strength with a positive direction. Meanwhile, the relationship between mental workload and work fatigue on the Surabaya Nilam Terminal crane operator has a strong relationship with a positive direction.

Therefore, it is recommended to provide psychological consultation once a week for operators

and socialization about the importance of the rest time by the shift manager and HSSE team during safety briefing. Besides that, management should increase the number of operators and provide a comfortable bed for them.

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