Analysis of mental workload indicators among railway crossing guards in Yogyakarta City

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ABSTRACT

Background: Mental workload is the workload which results from the performed works, is seen from the performed works, and develops cognitively (within mind). The mental activities are also dominated by the jobs with a high level of alertness, such as what is found among railway crossing guards. This study aims to analyze the mental workload indicators among railway crossing guards in Yogyakarta City.

Method: The study was conducted using a qualitative descriptive approach. The guideline to conduct interviews and to measure mental workloads was NASA – TLX (National Aeronautics and Space Administration – Task Load Index), with the procedures consisting of weighting, rating, and calculation of mental workloads. The population was all of the railway crossing guards in Yogyakarta City consisting of as many as 32 respondents.

Results: The results of the study showed that 26 respondents experienced a high level of mental workloads, 4 respondents experienced a moderately high level of mental workloads, and 2 respondents experienced an extremely high level of mental workloads (subjectively).

Conclusion: The aspects of mental workloads elaborated in this study were Mental Demand (MD), Physical Demand (PD), Temporal Demand (TD), Performance (P), Frustration Level (FL), and Effort (E). The most influencing aspect on mental workloads of railway crossing guards was the Performance aspect, with a value of 5473, since this aspect required high responsibility for the job.

1. Introduction

Transportation is a highly important and strategic means in expediting the economy, strengthening national unity, and influencing all aspects of people's life. One of the businesses providing transportation services is PT Kereta Api Indonesia (KAI) (Persero) or Indonesian Railway Company Ltd, a company managed by the Government and engaged in land transportation with railway trains as the mode of transportation. Railway train is a means of transportation in the form of

a vehicle with motion power, running either by itself or connected with other vehicles, which moves on railways (YPKKKA, 1995).

Until now, fatal accidents continue to take place at level railway crossings where motor vehicles are hit by passing trains. Whereas, to avoid crash accidents between trains and other motor vehicles, PT KAI has provided crossing gates in accordance with the prevailing regulations (Kemenhub, 2007; Tim Redaksi Nuansa Aulia, 2009). Each gate is serviced by a railway crossing guard employed by PT KAI to watch the guard post and operate railway crossing (PT KAI, 2008). With the presence of railway crossing gate, it is expected that trip of the trains is not interrupted by various types of vehicles or other road users passing the crossings. Railway crossings in Operational Area VI (DAOP VI) Yogyakarta have been implemented with machine system thoroughly (PT KAI, 2008).

Based on the observation conducted on the railway crossing guards in Yogyakarta City, it was known from their information that the job of a railway crossing guard was not easy and not without risks. It was a job with a high level of responsibility since an error at a railway crossing may cost people's lives (Hidayat, 2009).

There are 7 posts of railway crossing in Yogyakarta City where each of them is serviced by 3-4 officers (guards). The officers are divided into 3 work shifts, i.e. morning shift of 06.00 – 14.00, afternoon shift of 14.00 – 22.00, and night shift of 22.00 – 06.00. These railway crossing posts are located at a number of spots, i.e. post 737 at Soragan, post 739 at HOS Cokroaminoto Street, post 349 at Timoho Street, post 350 at Munggur Street, posts 352 and 352-A at Lempuyangan, and posts 3-A and 3-B at Yogyakarta Main Railway Station (Stasiun Besar Yogyakarta).

The extent of the responsibility psychologically influences the performance of the officers (Setyowati et al., 2014). The problem which is frequently encountered by the officers and even can make them stressed is the occurrence where people forcefully trespass the gate crossbar. This kind of problem will make the officers extremely worried about the occurrence of accidents (Hidayat, 2009). However, such a problem might also be caused by the negligence of the officers themselves. Railway crossing officers have a number of psychological limitations. This study aims to identify the sequence of indicators from the most to the least importance on the mental workload among the railway crossing guards in Yogyakarta City.

2. Method

This was a qualitative study with a descriptive method. The study was conducted at the locations of railway crossing posts. The population of the study were all the guarding officers of railway crossings in Yogyakarta City with as many as 32 people. All of the officers have fulfilled their professional skill qualifications as required by PT KAI (Persero), have worked for more than 5 years, and were available to be appointed as respondents. The study took place at 7 guarding posts. These were all the posts in Yogyakarta City.

The tool used in the study was a questionnaire which was adopted from an instrument developed by *National Aeronautics and Space Administration – Task Load Index* (*NASA – TLX)*. The method was developed by Sandra G Hart from *NASA – Ames Research Center*, and Lowell E. Staveland from San Jose State University, in 1981 (Human Performance Reasearch Group, 1987). The methods which have been most used and proven to come out with good results are *NASA – TLX,* and *Subjective Workload Assessment Technique (SWAT)* (Edison, 1999). Studies by Hart and Staveland and by Hill et al showed that *NASA – TLX* was better in the aspect of sensitivity compared to *SWAT*, especially in conditions of relatively low mental workloads (Hart & Staveland, 1998). The interview guidelines applied in this study was adopted from the previous studies (Gustanto, 2011; Simanjuntak, 2010).

From the collected data, workload calculation was made using weighting and rating. In the weighting step, one descriptor was selected for each pair of descriptors which was considered more dominant in the work by a subject. Data of the selected descriptors were processed to obtain the weight of each of the descriptors to be used in the next step.

Data analysis was done in three steps. The first was weighting. The second was rating with the calculation of Weighted Workload (WWL). The results of weighting and rating were combined to obtain the scores of mental workloads.

The first step was weighting. This was the step of presentation of 15 pairs of descriptors, which were subsequently done (answered) by the subjects (the officers) by drawing circles on the descriptor pairs which were considered more dominant according to their experience. The descriptors were: Mental Need (MN), Physical Need (PN), Time Need (TN), Performance (P), Frustration Level (FL), and Effort (E). These six descriptors were to be selected by the railway crossing officers according to their opinions on which ones were more dominant in mental workload.

The questionnaire was filled (answered) by 32 respondents of railway crossing officers. The results from these 32 respondents were grouped based on the descriptors and their weighting. After the weighting scores of these 32 respondents were obtained, the next step was the scoring or rating.

The second step was rating. After the weighting scores of these 32 respondents were obtained, the next step was the scoring or rating. Rating was the step after the weighting. In this step, the rating was done on a scale of 1-100 for each of the descriptors (with the six factors of MN, PN, TN, P, FL, and E) according to the workloads experienced by the respondents in doing their jobs. It was done by giving questions according to *NASA – TLX* analysis questionnaire. Upon the completion of the rating, the following step was the calculation of the mental workload of each of the railway crossing officers who were the subjects of the study.

The third step was the calculation of mental workload. Upon the completion of the rating of the 32 respondents, the questionnaire result of each respondent was calculated for the workload according to the workload formula or   *Weighted Workload (WWL).*

3. Results and Discussion

3.1. Results

The results of the study were explained in a chronological order with the first step (weighting), second step (rating), and third step (calculation of mental workload) calculated using the formula of:

WWL = Weighting x *Rating*

Subsequently, data processing was done by combining the weighting and the rating.

$$\text{Average WWL} = \frac{Weighting \; x \; Rating}{15}$$

The results showed that the mental workload was in a high range with quite a big number (Table 1).

Table 1. Mental Workload

Range	Mental Workload	n
0 – 9	Low	0
10 – 29	Medium	0
30 – 49	Moderately High	4
50 – 79	High	26
80 – 100	Extremely High	2

It was found out from the study on the railway crossing officers in Yogyakarta City that the descriptors had a high level of mental workloads. This could be seen from the categories of the mental workloads, i.e. low 0-9, medium 10-29, moderately high 30-49, high 50-79, and extremely high 80-100.

Upon the examination using the *NASA – TLX* analysis, it was found that the respondents with high mental workload (50-79) were 26 people, whereas those with moderately high mental workload (30-49) were 4 people, and those with extremely high mental workload (80-100) were 2 people.

Based on the table of the results of combination of weighting and rating, it was known that they suited the workload categories. The results of the study on the railway crossing officers in Yogyakarta City show that the job involves a high level of alertness (Table 2).

Table 2. Workload Categories

Mental workload descriptors	Total
Mental Need (MN)	5171
Physical Need (FN)	4357
Time Need (TN)	4931
Performance (P)	5473
Frustration Level (FL)	4352
Effort (E)	5026

Therefore, it can be seen that the order of workload from the highest to the lowest among all the officers for the descriptors was as follows: Performance (P) 5437, Mental Need (MN) 5171, Effort (E) 5026, Time Need (TN) 4931, Physical Need (PN) 4357, and Frustration Level 4352.

3.2. Discussion

Based on the calculation, it was found that the analysis of mental workload among the railway crossing officers in Yogyakarta City had resulted in the order of the six descriptors from the highest to the lowest as follows: P = 5473, MN = 5171, E = 5026, TN = 4931, FN = 4357, and = FL = 4352. This result showed that high responsibility for work performance (descriptor P) became the highest workload. Meanwhile, with regard to the frustration factor (descriptor FL), it was shown that the respondents did not have frustration during work, but they tended to experience anxiety.

The results of this study were different from the previous studies (Gustanto, 2011; Simanjuntak, 2010) that railway crossing officers in Yogyakarta City had a high level of mental workload in the factor of performance responsibility and had the tendency to experience anxiety during work. This is different from other types of jobs such as university lecturer or factory worker. For railway crossing officers, anxiety related to the occurrence of failure or human error in their daily tasks has become a mental workload which continues to appear in their minds.

The six descriptors in this study were explained one by one. The first was Mental Need (MN). The Mental Need among the railway crossing officers obtained a score of 5171. Mental Need sat in second highest place after Performance. This is due to the fact that the tasks of a railway crossing officer are not easy and categorized as heavy tasks and require optimum performance since they are related to the safety of people. Therefore, the resulting score based on the mental need among the railway crossing officers in Yogyakarta City was high.

The second was Physical Need (PN). Physical Need sat in fifth place out of the six descriptors with a score of 4357. This showed that the job as a railway crossing officer was not a problem for the respondents and also did not require a lot of physical activities in the work. The job required higher accuracy and responsibility so that physical activities did not score so high with regard to the mental workload in this study. Theoretically, this job is decided more by the sense of providing service or dedication with a high level of responsibility and risks (Simanjuntak, 2010), whereas the pay or salary is relatively low.

The third was Time Need (TN). The descriptor which sat on the fourth place in this study was Time Need. Based on the combination results, Time Need got a score of 4931. Time Need described the extent of pressure in relation with time in doing the job. The respondents mentioned that the time required to do the job as railway crossing officers was enough, because in one week an officer worked for 5 days, or not more than 40 hours per week.

The fourth was Performance (P). The results of the study on the railway crossing officers in Yogyakarta City showed that the score of Performance was higher than the other five descriptors. This was because the railway crossing officers had a high level of job responsibility in doing their job.

The fifth is Frustration Level (FL). The last in the order among the descriptors was Frustration Level with a score of 4352. This was because the respondents did not feel frustrated at work, but had the tendency to experience anxiety, especially when they worked in the morning shift from 06.00 to 14.00 which was the most crucial shift since a great number of vehicles passed during the shift. If an officer fails to open and close the crossbar on time, people would be in danger.

The sixth was Effort (E). Based on the results of the study, Effort descriptor sat in third position among the railway crossing officers with a score of 5026. The result was based on the total number of respondents consisting of officers in Yogyakarta City. This showed that effort was an important element in doing a job, especially in the job of guarding railway crossings. The effort made by the officers was moderately high. This could be seen from the performance results of every railway crossing officer where the score of performance descriptor was the highest.

The ranks of mental workloads among the railway crossing officers in Yogyakarta City consisted of 3 levels, i.e. moderately high mental workload, high mental workload, and extremely high mental workload. High level of mental workload was found in 26 respondents, moderately high level of mental workload in 4 respondents, and extremely high level of workload in 2 respondents. Most of the railway crossing officers experienced high level of mental workload as could be seen from the results of weighting and rating of the 6 indicators of mental workload.

In addition, the extent of mental workload could be influenced by other factors such as age, service years, work motivation, and other external factors such as physical factors like work facilities, work conditions, work attitude, and work supporting equipments (Notoatmodjo, 2010; Hariyono et al., 2010). All the factors used in solving the problem have fulfilled various aspects, both theoretically and practically, with the norms available in the *NASA – TLX* tool whose formula will be continuously developed (Hart, 2006).

4. Conclusion and Suggestions

It is concluded from the analysis of mental workload among the railway crossing guarding officers in Yogyakarta City that, from the six available descriptors, the rank order from the highest to the lowest is as follows: Performance (P), Mental Need (MN), Effort (E), Time Need (TN), Physical Need (PN), and Frustration Level (FL).

It is suggested that the Manager of Operational Area VI of PT KAI (Persero) Yogyakarta (DAOP VI PT KAI (Persero) Yogyakarta) execute "work system plans" and provide appropriate and sufficient rest time to the railway crossing guarding officers in Yogyakarta City. In order to avoid or to minimize a high level of mental workload, the officers should work with relaxed feeling and mind, and minimize issues which may disturb other activities outside the work, and keep focused on the work.

Acknowledgment

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