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Preliminary Investigation of Workload on Intrastate Bus Traffic Controllers

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Abstract. The daily routine of bus traffic controller which involves high mental processes would have a direct impact on the level of workload. To date, the level of workload on the bus traffic controllers in Malaysia is relatively unknown. Excessive workload on bus traffic controllers would affect the control and efficiency of the system. This paper served to study the workload on bus traffic controllers and justify the needs to conduct further detailed research on this field. The objectives of this research are to identify the level of workload on the intrastate bus traffic controllers. Based on the results, recommendations will be proposed for improvements and future studies. The level of workload for the bus traffic controllers is quantified using questionnaire adapted from NASA TLX. Interview sessions were conducted for validation of workload. Sixteen respondents were involved and it was found that the average level of workload based on NASA TLX was 6.91. It was found that workload is not affected by gender and marital status. This study also showed that the level of workload and working experience of bus traffic controllers has a strong positive linear relationship. This study would serve as a guidance and reference related to this field. Since this study is a preliminary investigation, further detailed studies could be conducted to obtain a better comprehension regarding the bus traffic controllers.

1. Introduction

Bus service is the most common public transportation used to cater passengers for shorter journeys on conventional roads. The government initiated privatization projects in land transport to embark these major developments in transportation fields. These developments had brought bus services to a much more systematic management to ensure smooth bus journeys for the passengers. Thus, bus traffic controllers were appointed to help manage and maintain the flow as well as safety of the bus operations.

The daily routine of bus traffic controllers which involves high mental processes would have a direct impact on the level of workload. Bus traffic controller involves directing the operations of public transport in an effective, efficient, cost effective manner [1]. The level of mental workload on bus traffic controllers could affect the overall performance, productivity and safety of the fleet daily operations [2]. To date, the level of workload on the bus traffic controllers in Malaysia is relatively unknown.
unknown. Understanding the level of workload of bus traffic controllers had ensured that they are always under appropriate and optimum degree of stress [3]. Excessive workload on intrastate bus traffic controller would affect the control and efficiency of the system.

The objectives of this study include identifying the level of workload on the intrastate bus traffic controllers. Based on the results, recommendations will be proposed for improvements and future studies.

2. Methodology
In order to obtain information for this study, several techniques were used to identify the level of workload. A study of past literature review were done to obtain information involving the workload and tasks conducted by traffic controllers. A comparison of issues, methodologies and areas of study were done and a discussion of the results regarding workload and tasks conducted by traffic controllers was tabulated. Established questionnaires were adapted to determine the level of workload on bus traffic controllers. Questionnaires survey were distributed to gather information and for data collection purposes. Ten point rating scale was used in order to quantify the workload of the bus traffic controllers. Interviews were conducted to the bus traffic controllers as well as the management.

Level of workload was quantified through Nasa TLX questionnaires and interview sessions with the bus traffic controllers were done. All questionnaires for this study were adapted from previous researches based on literature review of past studies related to mental workload of the traffic controllers. Psychometric scale was used to help quantify the result of the questionnaire. For this study, the questionnaire was adapted from NASA TLX: Task Load Index. Generally, NASA TLX is a subjective workload assessment tool with multi-dimensional rating procedure that derives an overall workload score based on a weighted average of ratings [4]. Subjective workload assessments from NASA TLX on the bus traffic controllers were used. There were questions regarding mental demands, physical demands, temporal demands, own performance, effort and frustration which were filled by the bus traffic controllers. The data collected was being used to assess the level of workload of the participants of this questionnaire. For the level of workload, a set questionnaire which was adapted from NASA TLX was used. Sixteen respondents were chosen to be a part of this survey and the demography of the respondents were obtained via questionnaire as well. Next, interview sessions was done with the bus traffic controllers to obtain validation on the raw rating obtained. Graphical data were generated to represent the level of workload. Two-tailed hypothesis testing and linear regression method was also used to analyse workload with several factors such as age, marital status and years of working experience of the bus traffic controllers.

3. Results and Discussion
The first section of the questionnaire was a subjective assessments on the bus traffic controllers. Subjective assessment were done to obtain the demographic information of the respondents. For the next section of the questionnaire, the level of workload was measured using a ten point rating scale. Respondents were required to identify the level of workload with reference to their job based on each criterion as stated in NASA TLX. Graphical methods were done to analyse the level of workload.

3.1. Demography of Respondents
There are a total of thirty three officers working in shifts. These officers are in charge of the daily operation of the bus travelling in order to serve the community to mobilise around the city. Thus, it will ensure the daily operations can be much more efficient and systematic. There are a total of twenty four bus traffic controllers and only sixteen were selected to be part of the respondent of this study. Table 3.1 shows the demographic information of the sixteen respondents.
Table 3.1: Demography of the Respondents

| Ref | Gender | Marital Status | Working Experience |
|-----|--------|----------------|--------------------|
| A01 | Male   | Married        | 10-20 years        |
| A02 | Male   | Single         | 1-5 years          |
| A03 | Male   | Single         | 5-10 years         |
| A04 | Male   | Married        | 5-10 years         |
| A05 | Female | Married        | <1 year            |
| A06 | Male   | Single         | <1 year            |
| A07 | Male   | Married        | 1-5 years          |
| A08 | Female | Single         | <1 year            |
| A09 | Female | Single         | 1-5 years          |
| A10 | Female | Married        | 1-5 years          |
| A11 | Female | Single         | 1-5 years          |
| A12 | Male   | Single         | 1-5 years          |
| A13 | Male   | Married        | 5-10 years         |
| A14 | Female | Single         | 5-10 years         |
| A15 | Female | Single         | 1-5 years          |
| A16 | Female | Married        | 5-10 years         |

As shown in the table, there are a total of eight males and eight females involved in this particular study. Besides, there are a total of seven and nine married and single respondents respectively. For working experience, there are a total of three respondents who just joined the company, having working experience of less than a year. Next, there are a total of seven, five and one respondents who have worked for one to five years, five to ten years and ten to fifteen years respectively.

3.2. Analysis on the Level of Workload

NASA TLX is a subjective workload assessment tool with multi-dimensional rating procedure used to identify the level of workload for the bus traffic controllers. Based on NASA TLX, an overall workload score was derived based on a weighted average of ratings for various criteria. There criteria included mental demands, physical demands, temporal demands, own performance, effort and frustration based on the perception of the respondents. Table 3.2 shows the sample calculation of workload.

Table 3.2: Sample Calculation of Workload

| Scale Title          | Weight (W) | Raw Rating (RR) | Adjusted Rating (AR) (Weight x Raw) |
|----------------------|------------|-----------------|-------------------------------------|
| Mental Demand (MD)   | 3          | 8.5             | 25.5                                |
| Physical Demand (PD) | 0          | 2.5             | 0                                   |
| Temporal Demand (TD) | 2          | 9               | 18                                  |
| Performance (P)      | 3          | 5               | 15                                  |
| Effort (E)           | 4          | 9               | 36                                  |
| Frustration (F)      | 3          | 7               | 21                                  |
| Sum of “Adjusted Rating” |          |                 | 115.5                               |
Table 3.3 shows tabulation of workload for the respondents. It can be deduced that the highest and lowest value for mental demand is 37.5 and 3 respectively. The mean value for the mental demand as the source of workload is 21.16. Next, the source of workload for bus traffic controllers is not from physical demand as the mean value for the physical demand workload is zero. From an overall of sixteen respondents, none of the respondents felt that physical demand contributes to their level of workload.

The mean value calculated for the temporal demand as the source of workload is 16.5. For performance, the peak value is 42.5 and this value is highest when compared to the highest value of other criteria. The mean value for performance as the major contribution of workload is 20.72. Next, the mean value for effort as the source of workload is 27.78. For frustration as the source of workload, the value of mean calculated is 17.44.

Figure 3.1 shows the average workload for the sixteen respondents representing the bus traffic controllers. Only eight respondents exceeded the mean value which is 6.91.

Table 3.3 : Tabulation of Workload

| Ref | MD | PD | TD | P  | E  | F  | Sum of AR | WR |
|-----|----|----|----|----|----|----|-----------|----|
| A01 | 25.5 | 0  | 18 | 15 | 36 | 21 | 115.5     | 7.7 |
| A02 | 13  | 0  | 12 | 34 | 25 | 18 | 102       | 6.8 |
| A03 | 9   | 0  | 28.5 | 18 | 34 | 38 | 127.5     | 8.5 |
| A04 | 21  | 0  | 17 | 28 | 35 | 5.5 | 106.5     | 7.1 |
| A05 | 25  | 0  | 5  | 20 | 15 | 5  | 70        | 4.67|
| A06 | 3   | 0  | 20 | 28 | 30 | 2.5 | 83.5      | 5.57|
| A07 | 36  | 0  | 27 | 13 | 42.5 | 7.5 | 126      | 8.4 |
| A08 | 22.5 | 0  | 5  | 5  | 20 | 25 | 77.5      | 5.27|
| A09 | 16  | 0  | 22.5 | 42.5 | 34 | 7.5 | 122.5     | 8.17|
| A10 | 15  | 0  | 4  | 35 | 38 | 24 | 116       | 7.73|
| A11 | 18  | 0  | 6  | 40 | 32 | 7.5 | 103.5     | 6.9 |
| A12 | 20  | 0  | 18 | 7.5 | 7.5 | 40 | 93        | 6.2 |
| A13 | 15  | 0  | 24 | 28.5 | 20 | 30 | 117.5     | 7.83|
| A14 | 30  | 0  | 15 | 10 | 22.5 | 20 | 97.5      | 6.5 |
| A15 | 37.5 | 0  | 15 | 2.5 | 15 | 20 | 90        | 6   |
| A16 | 32  | 0  | 27 | 4.5 | 38 | 7.5 | 109       | 7.27|

Figure 3.1 : Average Workload for Each Bus Traffic Controller
Figure 3.2 shows the bar chart for mean value based on each criterion of workload according to the ranking from the highest to the lowest. As observed from the chart, the highest criterion is effort followed by mental workload, performance, frustration and temporal demand. The physical workload is the lowest ranking with zero value. The average for the mean of each criterion is calculated and the value is 17.27.

Figure 3.3 shows the chart for the criterions involved for workload of intrastate bus traffic controllers. Generally, it can be deduced that the respondents felt effort is the main source of workload.
as bus traffic controllers. A lot of effort and determined attempt as well as vigorous mental exertion are necessary while carrying out the given tasks. This is in line with the research done by Corradini [5] regarding air traffic controllers which mentioned that effort is significant in order to keep high vigilance levels for different traffic conditions.

As mental demand is the second highest order, the job as bus traffic controllers would need high mental processing capability or resources. This may include adding up multiple tasks and various social forms of communication with respective personnel during the daily routine. Besides, mental demand include job which deal with numbers, words, concepts, decision making and complex cognitive tasks. This is in accordance with the previous research done which mentioned the integration of various complex information, coordination and communication will result in a significant increase of subjective mental workload [3].

Next, performance which mean the accomplishment of a given task as the source of workload is ranked third. Performance is deemed to be the fulfilment of an obligation as well as the responsibilities of a job. Having high value of performance as a source of workload would mean the respondents are unsatisfied and felt far short from perfect according to the level of accomplishment for the given task. Having low value of performance would mean the respondents felt the level of accomplishment is close to perfect and are highly pleased as well as contented. Since performance is ranked third, this study shows that he level of performance as the source of workload fluctuates for different bus traffic controllers. In fact, a previous research done by Tobaruela [6] has shown performance varies for different individuals.

Frustration is ranked forth as the major source of workload. Frustration is highly related to the inability to change or achieve a certain goal or standard and often leads to the feeling of being upset, anger, annoyed as well as disappointment. When complexity increased, the consequence of frustration may increase as well [7]. This is highly related to the bus traffic controllers where frustration often ended up with the prevention of progress and success. Constant perceived resistance to the fulfilment of individual will may come from both internal and external factors. Internal causes of frustration may arise from challenges in fulfilling personal goals and individual desires. External frustration involve conditions outside of an individual and are commonly related to the conflict with colleagues or management as well as environmental and surrounding factors.

Temporal demand is ranked fifth as the source of workload which mean that the respondents felt there is sufficient period to complete daily routine [4]. The rate where certain tasks would have to be done in adequate amount of time is relatively reasonable and is not the major factor for workload.

Finally, physical demand is ranked last. Having a value of zero would mean the activities which require high amount of energy for pushing and pulling of arm or leg controls is almost negligible. The daily routine of bus traffic controllers do not highly involve lots of walking, climbing, body balancing, stooping, kneeling, crouching, crawling, handling or lifting heavy objects. This is in accordance with the research done by Corradini [5] where physical workload is not as significant as mental workload for air traffic controllers.

3.3. Average Workload vs Gender

Based on the graph and the average workload calculated, the hypothesis generated for the first analysis is to identify if gender would affect workload. Two-tailed hypothesis is used with the significance level 0.10.

\( H_0: \mu_1 = \mu_2 \) Gender does not affect workload.

\( H_1: \mu_1 \neq \mu_2 \) Gender does affect workload.

The number of female sample, \( N_f = 8 \) and the number of male sample, \( N_m = 8 \). The mean value which is obtained for female, \( \mu_1 = 6.55 \) and mean for male, \( \mu_2 = 7.26 \). Standard deviation calculated for female, \( s_1 = 1.219 \) and for Male, \( s_2 = 1.040 \). From the calculation, the t-value is 1.25543 and the p-value is 0.229872. Since \( \alpha = 0.10 \) and the value of p is 0.230 which is greater than \( \alpha \), the p-value is not significant. Since p-value is not significant, we accept \( H_0 \). Thus, it can be concluded that gender of bus traffic controllers does not affect workload.
3.4. Average Workload vs Marital Status

The second hypothesis generated is to identify if marital status would affect workload. Two-tailed hypothesis is used with the significance level 0.10.

\( H_0: \mu_1 = \mu_2 \) Marital status does not affect workload.

\( H_1: \mu_1 \neq \mu_2 \) Marital status does affect workload.

The number of single respondents, \( N_1 = 9 \) and the value of mean, \( \mu_1 = 6.64 \). Next, the number of married respondents, \( N_2 = 7 \) with the mean value, \( \mu_2 = 7.24 \). Standard deviation calculated for single respondents, \( s_1 = 1.109 \) and for married respondents, \( s_2 = 1.212 \). From the calculation, the t-value obtained is -1.02953 and the p-value is 0.320688.

Since \( \alpha = 0.10 \) and the value of p is 0.321 which is greater than \( \alpha \), the p-value is not significant. Since p-value is not significant, we accept \( H_0 \). Thus, it can be concluded that marital status of bus traffic controllers does not affect workload.

3.5. Average Workload vs Working Experience

The final factor which was analysed is the working experience of the respondents. The average workload based on the working experience is calculated and tabulated as shown in Table 3.4.

| Working Experience (Years), \( x \) | \( \bar{x} \) | Average Workload, \( y \) |
|-------------------------------------|-------|----------------|
| <1                                 | 0.5   | 5.14          |
| 1-5                                | 3     | 7.18          |
| 5-10                               | 7.5   | 7.44          |
| 10-20                              | 15    | 7.7           |

Linear Regression method was used to study the relationship between these two factors.

Best-fit values

Slope, \( \beta_1 = \frac{16.92}{121.5} = 0.1393 \) \hspace{1cm} (2)

Y-Intercept, \( \beta_0 = \frac{27.46}{4} - 0.1393 = 6.73 \) \hspace{1cm} (3)

Overall Equation, \( Y = 0.1393x + 6.73 \) \hspace{1cm} (4)

Based on the data obtained from best fit values and overall equation, the linear regression line for the average workload and working experience of the bus traffic controllers is obtained and shown in Figure 4.16.
Based on the graph in Figure 3.4, it can be observed that as working experience (X) increases, the average workload (Y) increases as well. Thus, it can be concluded that average workload of the bus traffic controller is proportional to the working experience.

Linear correlation coefficient is commonly used to study the relationship between two variables. By using this coefficient, the strength of the linear association between the dependent and independent variable could be calculated. The value of $r$

\[
(5) \quad r = \frac{16.92}{1.5(4.108)} = 0.757
\]

Since the value of $r$ is 0.757, it can be concluded that average workload and working experience of bus traffic controllers has a strong positive linear relationship.

4. Conclusion
In conclusion, the level of workload for the bus traffic controllers was able to be identified through NASA TLX. Validation on the level of workload was done during interview sessions through one to one comparison of each criterion in NASA TLX.

There were a total of sixteen respondents who were chosen to be part of this study. Based on these sixteen respondents, this study indicated that the mean value of workload in this study is 6.91 which is relatively high. Based on the analysis of each criterion in NASA TLX, effort is the major source of level of workload for the respondents having a value of 27.78, followed by mental demand at 21.16, performance at 20.72, frustration at 17.44 and temporal demand at 16.5. Physical demand has no effect on the level of workload as the value is zero. This study also showed that workload is not affected by gender and marital status. Level of workload and working experience of bus traffic controllers with Rapid Bus Sdn Bhd has a strong positive linear relationship. Since gender and marital status does not affect the level of workload, equality on the task distribution to the bus traffic controllers should be implemented. Based on the aspect of human sustainability, understanding the level of workload would ensure the preservation and quality of life of the bus traffic controllers. This may lead to job satisfaction and improve the overall performance of the company.

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