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Identification of Factors Affecting the Travel Time Reliability of Public Bus Transportation - A Case Study Along Federal Road F0050-Route Kluang-A/Hitam-B/Pahat

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ABSTRACT

Public transportation provides basic mobility services to various types of facility actions including those involving education, employment, medical care, and recreation. The general goal of this study was to develop a model with respect to travel time. Public bus transport which connects two cities, A/Hitam- B/Pahat), was selected to conduct this study. Factors such as departure delays, route length, delays at marked traffic light intersections, delays at bus stops, and bus speeds were collected using observation methods. SPSS is a methodological tool used for statistical analysis. The results of the analysis showed a strong positive correlation of '0.942' between travel time and route length, a moderate positive correlation of '0.697' between travel time and delay at marked traffic light intersections, a weak correlation of '0.272' between travel and departure time. delay with a significance level of 0.05. The determination coefficient showed a great regression explanatory power with R2 = 0.954. and (P <0.001). SPSS is also used to examine the data and generate models.

Keywords: Model development, reliability travel time, public bus, delay time, SPSS

INTRODUCTION

Public transport provides a fundamental mobility service of mobility to different types of actions involving education, employment, medical care, and recreation. It likewise assists minimizing traffic congestion, oil consumption, and vehicle emissions which is an advantage for both non-riders and riders. Malaysia is one of the substantial developing nations in Southeast Asia, transportation in Malaysia plays a vital role in economic influence, the value of time increased due to modern day busy routines (Ambak et al. 2016). Rapid economic growth and population growth have been able to improve and extension of the current system in transportation. In addition, Malaysia has well-developed transport networks and efficient rail links (Rohani et al. 2013).

Travel time reliability is a measurement to assess the contrasts between the expected travel time and the actual travel time; in general, the bigger the distinction between expected travel time and the actual travel time, the lower the reliability is. the fixed number of factors that directly affect travel time reliability are route length, number of signalized intersections, speed, delay at bus stops, departure delay, bus lane, traffic congestion, weather conditions, etc. (Susilawati 2010; Zhu et al. 2021).

Due to the increase in economic growth in developing countries like Malaysia, with a population of 32.6 million, is estimated in 2019. Increased from 32.4 million compared to 2018. The total population comprises 29.4 million there has been rapid urbanization and increase in traffic growth that increased private vehicles which means more congested streets, thus effecting the reliability travel time of the bus (Department of Statistics Malaysia Official Portal 2020). Traffic congestion poses a major concern to the reliability of the bus travel time. Many factors affect the reliability of bus travel time, such as Inadequate green time, pedestrian crossings, and overdevelopment. Although many travelers face traffic delay caused by congestion and (Kala and Warwick 2015; Zhu et al. 2021).

One of the most important drivers of public transportation quality is reliability in travel time reliability. To benefit both passengers and operators, many improvements in trip-time reliability are required (Ma et al. 2015). Noorfakhriah et al. (2011) reported that the lack of punctuality and certainty of the scheduled departure and arriving times considered as most issues affect the travel time reliability of public bus transportation.

To address these gaps, this article aims to determine the differences between the actual travel time and the expected travel time, to identify factors that affect the reliability of bus travel time, and to develop model with speed, delay at traffic lights, departure delays, route length, and delay at bus stops to travel time. The significance of this article is to identify factors that affect the reliability of public bus travel time, the findings of this study gave an overview of the mitigations and solutions to overcome the unreliability of bus travel time unreliability such as public transportation must be flexible, convenient, safe, reliable, efficient, and integrated. However, more passengers are needed to use public bus transports.

Public Transportation (PT) in urban areas has expanded more unmistakably in recent years to improve sensibility and the idea of civilized life. (Bok and Kwon 2016; Gkiotsalitis and Stathopoulos 2016). Travel Time Reliability (TTR) quality is characterized as the consistency of a given outing's movement time. Reliability is a proportion of stability of the service quality. The idea of reliability is derived from reliability engineering, and it is a significant index for measuring the execution of arbitrary network execution (Zhang et al. 2019).

The idea of travel time can be simply stated as the time required to travel from one point to another (Carrion and Levinson 2012). As a result of the high rate of congestion and delays within the cities, the travel time becomes more and more frequent and severe. Furthermore, the uncertainty of travel time schedule is accompanied by feelings of stress and anxiety (Peer et al. 2012). Therefore, the travel time reliability (TTR) term has been considered as a key indicator for assessing traffic performance (Engelson & Fosgerau 2011; & Susilawati 2012).

The reliability of travel time TTR is one of the the key determinants of quality of service in public transport. The required improvements in travel time reliability to produce benefits for both passengers and operators are also defined as the unpredictably varying travel time (Kou et al. 2017). The authors, on the other hand, offered a variety of TTR definitions. TRR, for example, is the portion of a designated delivery that is late, according to Wigan et al. (2000). The TTR was defined by Cambridge Systematics (2001) as a measure of the expected journey time range and gave a quantitative measure of the predictability of travel time predictability (Godoi et al. 2021).

The travel time distribution (TTD) has generally been generally used to portray the traffic conditions on highways and help to dissect travel time (TTR). With the help of advanced traffic sensing technologies and advanced traffic monitoring (Chen and Fan 2020). Urban bus transit corridors (BTC) usually have a huge volume of city traffic running some bus routes (Qiu et al. 2020). Efficient operation of bus networks is vital for urban centres. Unfortunately, factors such as congestion hamper adherence to advertised schedules, leading to reliability issues and unfair passenger loads. In particular, bus bunching has been identified as a significant reliability dilemma that affects both operators and users. (Chioni et al. 2020).

Even though all types of vehicle classes, such as motorcycles, public buss transit, small cars, and lorry are applicable to these TTR definitions, improving the TTR of public transit service is a key priority and primary focus of the authorities of cities in the world. This is due to the fact that public transit represents a key indicator of the efficiency of urban road networks inside the cites (Kang et al. 2017). Furthermore, the best method adopted from the strategies planners to fight congestion is encourage the people to use public transit (Yao et al. 2014). Besides this, one of the most importance factors to choose the public transit mode of use from the users is TTR. As long as the schedule travel time of the public transit is reliable, as this increases the demand to use the public transit of people (Rajabi-Bahaabadi et al. 2019; Yao et al. 2014).

According to Fan and Gurmu (2015) Traffic congestion is expanding with disturbing velocity and consistently presenting danger to the personal satisfaction of individuals in numerous nations around the world over recent years. It increases air pollution, fuel use, travel time, and decreases mobility and accessibility. Feng investigated that each traffic light stop sign adds an average of 12–16 s to the bus travel time of the bus. Zhang & Chen (2019) investigated that the impact of weather on traffic has been accepted as a fact in transportation engineering. The issue of estimated travel time and speed is additionally present in rush hour congestion demonstrating. To make the most exact portrayal of traffic streams (Birr et al. 2014). As a result, most of the studies of evaluate, analysis, and improve TTR have been conducted in public transit mode.

According to a various studies established, there are many factor's affecting the TTR for public bus transit such as traffic congestion, speed, route length, number of signalized intersections, time of day, rout type, day of the week, delay at bus stops, departure delay, bus lane, passenger boarding and alighting, direction, stops on the routes (Diab & El-Geneidy, 2012; Figliozzi et al. 2012; Slavin et al. 2013).

However, few studies have addressed the signalized intersections on bus travel time (Feng, 2014). Furthermore, the signal timing design with geometric characteristics was adopted for these studies by different values for the characteristics of urban roads characteristics (Feng, 2014). In this study, a model was developed to assess the impact on signal intersection according to the characteristics of the Malaysian urban road's characteristics. The aim of this study is to develop a model with speed, delay at traffic light, departure delays, route length, and delay at bus stops to travel time.

METHODOLOGY

The data collection was used as an observation method to achieve the objective of the study. However, observation is a systematic way of collecting data by observing the cycle of public buses cycle and factors that affect its travel time to achieve research objectives. Figure 1 shows the Research flow chart to provide more visualized information regarding the structure of this research. This research aims to develop knowledge about the reliability of public bus transportation travel time.

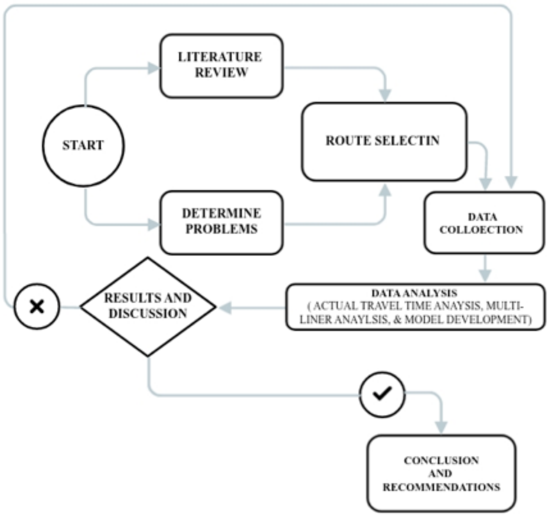

FIGURE 1. Research flow chart

SITE SELECTION

Two routes have been selected to obtain the data needed for this study to figure out the factor that affects the reliability of the travel time reliability of public transportation but transportation in Batu Pahat Johor. In addition, the selected routes are varied in location and length to obtain significant outcomes. The first route is from Batu Pahat bus station to Ayer Hitam bus terminal, according to Johor Motor it is named as route 56. The distance from Batu Pahat, Johor, to Ayer Hitam is 34.2 km and the expected travel time is approximately 52 minutes. The second route according to Causeway is named Route 50DD covering medium distance inside Johor, especially Batu Pahat, from Ayer Hitam bus terminal to Kluang bus station. With 22.7km and the expected travel time of about 35 minutes, as these Both routes together named as Federal Road F0050-Route Kluang-A/Hitam- B/ Pahat. Distance and travel time are average data collected from some bus transport companies that operate trips along these routes. Figures 2 and 3 illustrate the location of both routes.

FIGURE 2. Route 56 Batu Pahat - Ayer Hitam

FIGURE 3. Route 50DD Ayer Hitam - Kluang

POPULATION AND SAMPLING

According to Kumar (2019), sampling can be separated into mixed sampling design, nonprobability non-random sampling, and probability random sampling. Defined nonprobability non-random sampling collection was utilized in this paper, as well as Judgmental testing or sampling also called as purposive sampling (Khalifa et al. 2020). Purposive sampling is a source choice tool broadly utilized in ethnobotany Though, the utilization of this technique is not enough clarified in many studies. The purposive sampling procedure, additionally called the sampling of judgment, is the purposeful decision of an informant because the qualities the informant holds. It is a non-sporadic strategy that does not need a set number of informants or basic speculations. (Khalifa et al. 2013), The data for this study were collected in two weeks for each selected route during peak and peak-off hours. The sampling chosen to be in clear and non-rainy weather, random trips during peak hours, almost all bus stops, and traffic signal delays were observed and recorded.

RESEARCH INSTRUMENTS

Field data collections are carried out at selected sites using various equipment such as stopwatch, to count the time for each signalized intersection, and google map Global Positioning System (GPS) to measure the distance and determine the estimated departure and arrival time of buses from departure bus stations to destination bus station. Moreover, hand phone was used to take photos during the data collection phase, notes, and pen to record the delay time at traffic lights and bus stops.

DATA COLLECTION

Data were collected by taking a bus from origin to destination. It was carried out for two weeks for each route at different times of the day, especially morning and evening during weekdays and weekends. In this study, the actual departure and arrival times were recorded for each observed bus trip. However, other factors such as dwell time, arriving to bus stops, and leaving bus stop intervals were recorded at each bus stop by stopwatch, dwell time depends on the number of boarding and alighting passengers at bus stop; therefore, number of boarding and alighting passengers was recorded manually by sitting near the bus door. The estimated travel time of the buses was collected from the (official websites of Causeway Link Express, Johor Motor 2020), where it shows the bus trip frequencies and the departure and arrival times for each trip. According to the frequency and progress of the bus given on the website of those bus companies, the frequency between trips is 20 minutes.

Delay at traffic signals was recorded manually using stopwatch to count the interval of bus waiting at each traffic signal in case when bus arrives at the traffic signal and it is in red phase, this affects the travel time and might lead to delay of bus at arrival time.

The departure delay of the buses was recorded manually during observation and data collection. A stopwatch instrument was used to count delays of buses once it occurs by starting to count the duration from the estimated scheduled time of departure to the actual departure of the bus for each bus trip for the examined bus routes.

In this study, the length of the route of each of the examined routes was collected by checking the distance between the bus station of bus departure and the destination of bus trip. For the first route (route 56) from Batu Pahat to Ayer Hitam, it was recorded that the length of this route is 34.2 km, and the second route (route 50DD) length is 22.7 km.

The number of bus stops leads to delays in bus trip due to bus stopping activity, for each stopping activity; bus experiences three factors which are arriving and decelerating before stopping, dwelling time and leaving after stopping. The first and third factors were collected manually by counting the duration of delays duration using stopwatch, dwell time was determined according to the number of boarding and alighting.

The dwell time is the duration for serving passengers, which was determined by using Equation (1) according to (Levinson, 1983).

$$DT = 5.0 + 2.75\ BA \tag{1}$$

DT: Dwelling time
B: Number of boarding passengers
A: Number of passengers who boarded the bus

The actual bus speeds were measured according to the length of the route length and actual travel time, where the length of the route length is divided by the actual travel time to determine the actual speed. Route length collection is previously explained; however, actual travel time is recorded during data collection and observation for each route. The records of actual travel time showed averages of 40 and 58 minutes for Route 56 and Route 50DD, respectively

DATA ANALYSIS

This part of the study was carried out to achieve the stated objectives for this investigation, by finding out the factors affecting travel time reliability, travel time was taken as a dependent variable, and factors were found during data collection that appear to influence bus travel time reliability, and they were taken as independent variables.

The descriptive analysis was used to manage the data and to present quantitative descriptions in a suitable form of dependent and independent variables.

Multiple linear regression was used to predict the value of a variable based on the value of two or more variables. The variable needed to be predicted is called the dependent variable, which is travel time. The variables are used to predict the value of the dependent variable and are called the independent variables which are speed, delay at traffic light, departure delay, rout length, and delay at bus stops. ANOVA was used to analyse the difference between the mean of the group means and their associated procedures. The descriptive analysis was displayed to describe the data and the result was presented.

RESULT AND DISCUSSION

In this study, the hypothesizes tests between the factor of travel time factor with speed, delay at the traffic light, departure delay, route and delay at bus stop factors. All hypotheses were rejected (travel time factor with speed, traffic light, departure delay, and route length), except the hypothesis of traveling time with delay at bus stop hypothesis was accepted.

The following is a summary of the findings of the investigation. To begin, there is data reliability, which includes correlation tests such as Pearson correlation tests and Cronbach's Alpha.

Second, descriptive statistics are required for all factors. Finally, use the multiple linear regression model test to illustrate concerns about the concerns with estimating model and structural model. Getting the data ready for analysis, also known as data screening in the SPSS statistical software, entails a number of processes that must be completed to ensure that the data are free of missing values and are input accurately.

Cronbach's Alpha for all six items was "0.795", according to the reliability test. As a result, the data in the model were accurate, stable, and well-fitting.

Correlation analysis is considered as a useful method that allows us to find whether there is a correlation among the positive and negative dependent and independent variables in this analysis. In addition, correlation analysis would be used to illustrate the extent of the relationship between the researcher variables. Moreover, Gogtay et al. (2017) stated that this analysis was considered as a term used to refer to the relationship or correlation among two or more variables.

The bus trip might be subjected to delays due to various factors such as delays in traffic signals, and bus stops. This delay causes a bus delay. To achieve the objective of this study which is comparing expected travel time and the actual travel time of each bus on the selected route. Figure 4 shows the result of comparing both expected and actual travel time for bus route 56 during a two-week period of observation.

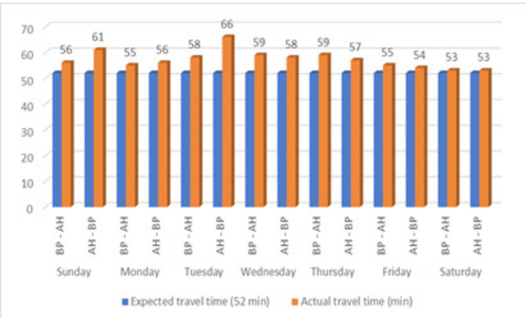

FIGURE.4. Expected and Actual Travel Time of bus route 56 Batu Pahat - Ayer Hitam

During the first week of observation of route 56, it was noticed that most buses on this route leave the bus station at the same time of the expected departure; however, some other buses depart at a delay of maximum three minutes Figure 4,thus the departure delay is not the main reason that causes arrival delay moreover, arrival delays are majorly noticeable on trips from Ayer Hitam to Batu Pahat, while the longest delays are observed on Tuesday and Thursday evening trips from Ayer Hitam to Batu Pahat, in contrast. At the second week of data on route 56 a significance delay with an average of 7–8 minutes along the week. The maximum observed delay is 14 minutes, which occurred on Tuesday evening trip from Ayer Hitam to Batu Pahat, this delay is due to weather conditions and evening traffic congestion as shown in Figure 5 (Fan & Gurmu 2015).

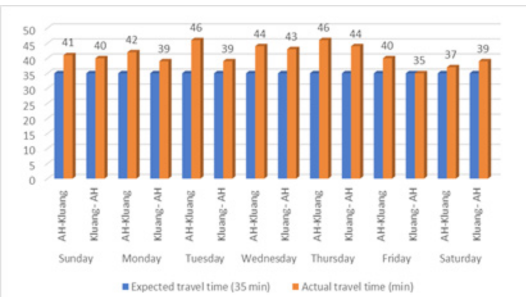

FIGURE 5. Expected and Actual Travel Time of bus route 56 Batu Pahat - Ayer Hitam

The second route is 50DD which is from the Ayer Hitam bus terminal to the Kluang bus station with distance of 22.4 km/h according to Google Maps measurement, the estimated and actual travel time for this route was compared and analysed by using Microsoft Excel, the actual speed and delay duration were also determined.

Figure 6 shows that the estimated travel time is fixed at 35 minutes, it can be noticed that the average delay of bus arrival at the bus station varies between 6 minutes and 11 minutes as a maximum delay which is on Tuesday and Thursday at the trip Ayer Hitam to Kluang. Figure. 6. On Friday, the minimum accurate travel time was recorded for the bus, this happened due to the low capacity of the road on weekend. Figure 6 shows the comparison of the estimated and actual travel time of the bus in route 50DD for the first week.

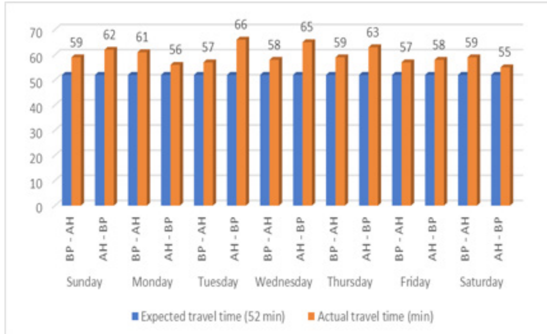

FIGURE. 6. Expected and Actual Travel Time of Bus route 50 DD Ayer Hitam – Kluang

During the second week of the observation of route 50 DD there was a significant delay with an average of 3 – 4 minutes throughout the week. The maximum observed delay is 8 minutes, which occurred on Wednesday night trip from Kluang to Ayer Hitam, this delay is due to night traffic congestion Figure 7.

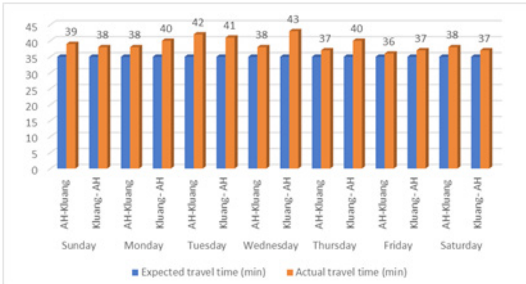

FIGURE 7. Expected and Actual Travel Time of Bus route 50 DD Ayer Hitam – Kluang

Thus, it indicated that the actual travel time increased than expected travel time due to many factors (bus speed, traffic light, departure delay, route length and delay at bus stops in Batu Pahat Town, Johor Bahru.

Correlation analysis is a useful method that will allow one to find if there is a correlation among the positive or negative dependent and independent variables in this research.

The result of this study noted that the mean and standard deviation of the travel time factor was correspondingly higher than factor: other the speed factor, the route length factor, delay at traffic light, delay at bus stop, and departure delay factors, respectively, as shown in Figure 8. This indicated the travel time (dependent variable) increased when the delay at traffic light, departure delay, delay at bus stop, and route length (independent variable) decreased.

However, the travel time decreased when the speed was increased.

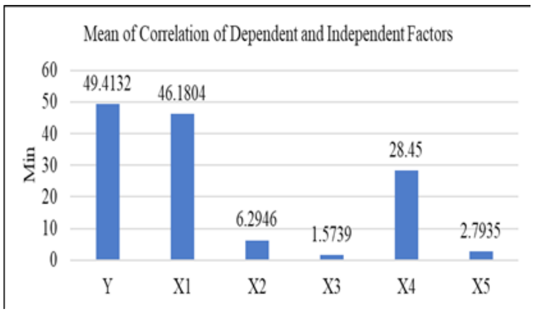

FIGURE 8. Mean of correlation-dependent and independent factors

According to Table 1 the dependent variable (travel time factor) is indicated to have a moderate negative relationship with the independent variables (speed factor) and moderate positive relationship with the delay factor at traffic light and departure time. However, the dependent variable (travel time factor) appears to have a strong positive relationship with the length factor, as the correlation coefficient values between the travel time factor and the the speed factors and delay at bus stop factor are '-0.538' and "-0.475," respectively, and a suitable indirect correlation is significant at the level of 0.05 level (2-tailed) (P=0.001, P=0.001). Furthermore, the departure time of "0.272" is a poor direct correlation that is not significant (P=0.067), and the travel time factor is shown to have a moderately positive relationship with the traffic light delay factor because the value of the correlation coefficient value is "0.697" and a moderately positive correlation is significant at the level of 0.05 level (2-tailed) (P0.001). Furthermore, the correlation coefficient value of "0.942" indicates that the travel time factor has a strong positive relationship with the route length factor, and this correlation is significant at the 0.05 level (2-tailed) (P0.001).

TABLE 1. Correlations between travel time with speed, route length, traffic light delay, departure delay, and delay at bus stop delay factors

No		Y	X_1	X_2	X_3	X_4	X_5
Y	Pearson Correlation	1	-0.538**	0.697**	0.272	0.942	-0.475**
X_1	Pearson Correlation	-	1	-0.105	-0.166	-0.426**	0.030
X_2	Pearson Correlation	-	-	1	0.109	0.669**	-0.357*
X_3	Pearson Correlation	-	-	0.109	1	0.083	-0.109
X_4	Pearson Correlation	-	-	-	-	1	-0.531**
X_5	Pearson Correlation	-	-	-	-	-	1

**. Correlation is significant at the 0.01 level (2-tailed). N=46 for each.

Y= Travel Time, X_1= Speed Factor, X_2= delay at Traffic Light, X_3=Departure Delay, X_4=Route Length, X_5= delay at Bus Stop.

Multilinear regression requires normal-distributed input data (Sarstedt et al. 2020). Figures 9, Figure 10, Figure 11, and Figure 12, show the normally distributed of the data in this paper. Normality can be assessed by achieving skewness and kurtosis values (Naser et al. 2017). The normality of the 6 items was checked, and there is no violation of the result. Thus, all the variables in this paper are classified as normally distributed.

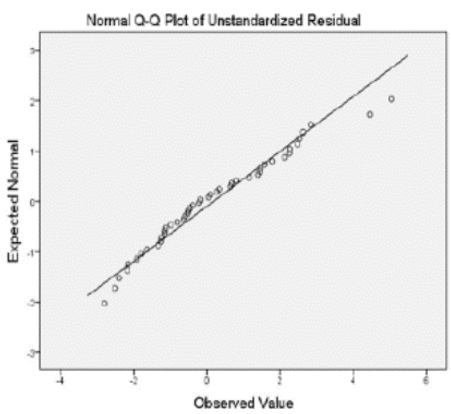

FIGURE 9. Normal Q-Q plot of the unstandardized residual

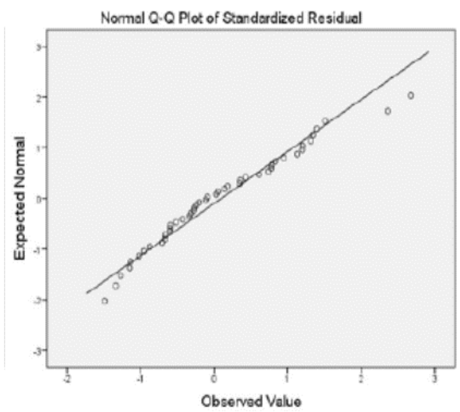

FIGURE 10. Normal Q-Q plot of the standardized residual

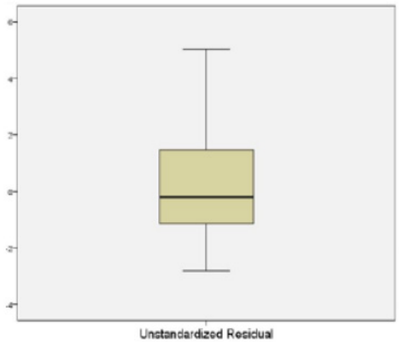

FIGURE 11. Boxplot of unstandarized residual

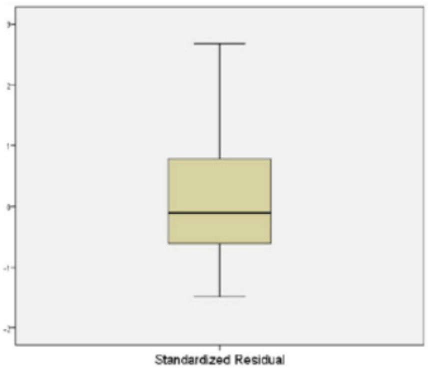

FIGURE 12. Boxplot of standardized residual

Multiple linear regression analysis is a powerful statistics method which allows one to understand and examine the relationships among the dependent variable is related to the independent variables Sarstedt et al. (2017), and to explore the forms of these relationships (between two or more variables of interest). Thus, multiple linear regression will help to describe the correlation between two or more independent variables and one continuous dependent variable on the predictive analysis side. Furthermore, in the current study, multiple linear regression analysis will be used to determine whether independent variables predict a specific dependent variable. Similarly, these analyses will help to determine the amount of variation in the dependent variable.

As shown in Table 2, the summary model of a linear regression yields R =0.977 for the independent variables speed (X1), delay in the traffic signal (X2), departure delay (X3), route length (X4), and delay at bus stop (X5), suggesting that the variance in the independent variable is significant. If the additional independent variables have low explanatory power or the degrees of freedom become too tiny, the adjusted coefficient of determination (adjusted R2) may decrease.

TABLE 2. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.977[a]	0.954	0.948	2.15437

This statistical method is very useful for comparing the number of independent variables with equations, varying sample sizes, or both (Hair et al. 2014). However, the coefficient of determination (R2) can range from 0 to 1, with R2=0.954 in this study. If the regression model is correctly estimated and applied, the examiner can assume that the higher the value of R2, the greater the explanatory power of the regression and, as a result, the better the prediction of the dependent variable, as shown in Table 3.

TABLE 3. ANOVAa.

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3835.587	5	767.117	165.281	0.000[b]
	Residual	185.652	40	4.641		
	Total	4021.239	45			

As indicated in Table 3, one-way analysis of variance was used to determine the effects of the dependent factor on the five independent factors. The F value is 165.281, which shows that the independent variables' explanatory power of the independent variables is high. As shown in Table 3, the dependent factor (travel time) has a highly significant effect on the five independent factors (speed, traffic light delay, departure delay, route length and delay at bus top) (P0.001). The degrees of freedom (df) are a measure of how restricted the data are to reach a certain level of prediction.

The result of this present study noted that the travel time factor influenced by speed, delay at traffic lights, departure delay, route length, and delay at bus stop factors and significant interaction between factors (P_<_0.001). For example, travel time increased when the speed factor decreased (Kathuria et al. 2020).

The structural model is the second most important step in the analytical process. The structural model can be represented once the measurement model has been confirmed by stating the relationships between the constructs. The structural model, according to Hair et al. (2014), provides a link between the variables' details. The standardised regression coefficient for beta factor A allows for a direct comparison of the relative descriptive power of the dependent variable of different coefficients. Whereas regression coefficients are expressed in terms of the associated variable's units, making comparisons impossible, beta coefficients are based on standardised data and can be clearly compared.

The evaluation of the structural model shown in Table 4 provides an indication of the hypothesizes tests and the relationship between the factor of travel time factor with speed, delay in the traffic light, departure delay, route and delay at bus stops.

TABLE 4. Model Coefficientsa

Variables	B	Std. Er	t-value	Sig.	VIF
(Constant)	22.977	7.370	3.117	0.003	
Speed	-0.368	0.086	-4.304	0.000	1.470
delay at Traffic Light	1.171	0.342	3.422	0.001	1.986
Departure Delay	1.046	0.224	4.672	0.000	1.060
Route Length	1.209	0.097	12.399	0.000	3.114
delay at Bus stop	0.018	1.180	0.015	0.988	1.520

The relationship between the speed factor and travel time factor was (β=-0.368, t=-4.304, P=0.000), the relationship between the delay at traffic light factor with the travel time factor was (β=1.171, t=3.422, P=0.001), the relationship between the departure delay factor and the travel time factor was (β=1.046, t=6.672, P=0.000), and the length of the relationship between the route length and the travel time factor was (β=1.209, t=12.399, P=0.000) The dependent variable (travel time factor) had a moderate to strong positive correlation with speed, delay at traffic lights, departure delays , and the length variables, which was significant at the level of 0.05 level (2-tailed). as shown in Table 1.

However, the relationship between travel time and bus stop delay (β=0.018, t=0.015, P=0.988) seems that the value of the correlation coefficient value between the travel time factor and the bus stop delay factor is '-0.475', which is a substantial negative correlation at the level of 0.05 level (2-tailed) (P=.001).

CONCLUSION

In short, the expected and actual bus travel time were compared for two selected routes. A field survey and observation were carried out on two major bus routes namely bus Route 56 and 50DD.

Bus delays have been found to occur during departure of buses from bus stations and arrival to the destinations. These delays occur due to several factors that influence the reliability of the bus travel time. The independent factors tested are bus speed, delay at traffic light delay, departure delay, route length, and delay at bus stops, while the dependent factor was travel time reliability.

The results showed that travel time has a strong positive relationship with the length of the route length with correlation coefficient '0.942' and this correlation is significant at the level of 0.05 level with (P=0.000). Furthermore, the one-way ANOVA test was utilized to determine the effects of the dependent factor on the five independent factors. The F statistic was found to be 165.281, indicating that the explanatory power of the independent variables is high. and the travel time factor significantly affected by the independent factors and the significant interaction between factors.

A structural model was developed to indicate the hypothesize tests and the relationship between dependent and independent factors. The results of the model development were a moderate to strong positive correlation that was significant at the 0.05 level.

The results of this study might provide fundamental information for future researchers in the field of traffic and transportation engineering to create ways to solve the problem of public bus delays and minimize the probability of delay in bus arrival delay at bus stations. Future studies are recommended to study the effect of delay at the bus stop deeply focusing on dwell time.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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DECLARATION OF COMPETING INTEREST

None

REFERENCES

Ambak, K., Kasvar, K. K., Daniel, B. D., Prasetijo, J., & Ghani, A. R. A. 2016. Behavioral intention to use public transport based on theory of planned behavior. *MATEC Web of Conferences* 47.

Birr, K., Jamroz, K., & Kustra, W. 2014. Travel time of public transport vehicles estimation. *Transportation Research Procedia* 3(July): 359–365.

Bok, J., & Kwon, Y. 2016. Comparable measures of accessibility to public transport using the general transit feed specification. *Sustainability* (Switzerland) 8(3).

Carrion, C., & Levinson, D. 2012. Value of travel time reliability: A review of current evidence. *Transportation Research Part A: Policy and Practice* 46(4): 720–741.

Chen, Z., & Fan, W. D. 2020. Analyzing travel time distribution based on different travel time reliability patterns using probe vehicle data. *International Journal of Transportation Science and Technology* 9(1): 64–75.

Chioni, E., Iliopoulou, C., Milioti, C., & Kepaptsoglou, K. 2020. Factors affecting bus bunching at the stop level: A geographically weighted regression approach. *International Journal of Transportation Science and Technology* 9(3): 207–217.

Diab, E. I., & El-Geneidy, A. M. 2012. Understanding the impacts of a combination of service improvement strategies on bus running time and passenger's perception. *Transportation Research Part A: Policy and Practice* 46(3): 614–625.

Engelson, L., & Fosgerau, M. 2011. Additive measures of travel time variability. *Transportation Research Part B: Methodological* 45(10): 1560–1571.

Fan, W., & Gurmu, Z. 2015. Dynamic Travel Time Prediction Models for Buses Using Only GPS Data. 4(4).

Feng, W. 2014. PDXScholar Analyses of Bus Travel Time Reliability and Transit Signal Priority at the Stop-To-Stop Segment Level.

Figliozzi, M., Feng, W., Lafferriere, G., & Feng, W. 2012. A Study of Headway Maintenance for Bus Routes: Causes and Effects of "Bus Bunching" in Extensive and Congested Service Areas. July, 68.

Gkiotsalitis, K., & Stathopoulos, A. 2016. Demand-responsive public transportation re-scheduling for adjusting to the joint leisure activity demand. International Journal of Transportation Science and Technology, 5(2), 68–82.

Godoi, F. C., Prakash, S., & Bhandari, B. R. 2021. Final report Final report. Review of 3D Printing and Potential Red Meat Applications, 23 February 2021: 1–61.

Gogtay, N. J., Deshpande, S. P., & Thatte, U. M. 2017. Principles of regression analysis. *Journal of Association of Physicians of India* 65(APRIL): 48–52.

Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. 2014. Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review* 26(2): 106–121.

Kala, R., & Warwick, K. 2015. Congestion avoidance in city traffic. *Journal of Advanced Transportation* 49(4): 581–595.

Kang, C. C., Khan, H. A., Feng, C. M., & Wu, C. C. 2017. Efficiency evaluation of bus transit firms with and without consideration of environmental air-pollution emissions. *Transportation Research Part D: Transport and Environment* 50: 505–519.

Kathuria, A., Parida, M., & Sekhar, C. R. 2020. A Review of service reliability measures for public transportation systems. *International Journal of Intelligent Transportation Systems Research* 18(2): 243–255.

Khalifa, N. A., Zulkiple, A., & Ogab, M. (2020). The impact of different road damage factors on the pavement of local roads (JKR U2/U3) in Malaysia. *International Journal of Pavement Research and Technology* 13(3): 240–246.

Khalifa, N. A. & Zulkiple, A. A simple method on measuring road pavement damage for access road. *International Journal of Engineering Research & Technology* 2(9): 510–514.

Kou, W., Chen, X., Yu, L., Qi, Y. & Wang, Y. 2017. Urban commuters' valuation of travel time reliability based on the stated preference survey: A case study of Beijing. *Transportation Research Part A: Policy and Practice* 95: 372–380.

Kumar, R. 201). Research Methodology Ranjit kumar (Eng) 7.08 MB (p. 655).

Levinson, H.S. 1983. Analyzing transit travel time performance. Transportation Research Record, 1–6.

Ma, Z., Ferreira, L., Mesbah, M., & Hojati, A. 2015. Modeling bus travel time reliability with supply and demand data from automatic vehicle location and smart card systems. transportation research record. *Journal of Medicine the Transportation Research Board* 2533(1): 17-27.

Naser, M. M., Zulkiple, A., Al bargi, W. A., Khalifa, N. A., & Daniel, B. D. 2017. Modeling the pedestrian gap crossing index in mixed traffic condition. *Journal of Safety Research* 63: 91–98.

Noorfakhriah, Y. and Napiah, M. 2011. Public transport: Punctuality Index for Bus Operation. *World Academy of Science, Engineering, and Technology* 60.

Peer, S., Koopmans, C. C. & Verhoef, E. T. 2012. Prediction of travel time variability for cost-benefit analysis. *Transportation Research Part A: Policy and Practice* 46(1): 79–90.

Qiu, Y. Zheng, L., Du, Y., & Jiang, S. 2020. Performance evaluation of transit signal priorities in the bus transit corridor based on data envelope analysis. *International Journal of Transportation Science and Technology* 9(4): 322–333.

Rajabi-Bahaabadi, M., Shariat-Mohaymany, A. & Yang, S. 2019. Travel time reliability measures accommodating scheduling preferences of travelers. *Transportation Research Record* 2673(4): 708–721.

Rohani, M. M., Wijeyesekera, D. C., & Karim, A. T. A. 2013. Bus operation, quality service, and the role of bus provider and driver. *Procedia Engineering* 53: 167–178.

Sarstedt, M. Ringle, C. M., & Hair, J. F. 2020. Handbook of Market Research. In Handbook of Market Research (Issue September).

Slavin, C., Feng, W., Figliozzi, M. & Koonce, P. 2013. Statistical study of the impact of adaptive traffic signal control on traffic and transit performance. *Transportation Research Record* 2356: 117–126.

Susilawati, S. 2010. Travel Time Reliability Measurement for Selected Corridors in the Adelaide Metropolitan Area. *Journal of the Eastern Asia Society for Transportation Studies* 8: 86–102.

Taylor, M. A. P., & Susilawati. 2012. Modelling travel time reliability with the burr distribution. *Procedia - Social and Behavioral Sciences* 54: 75–83.

Wigan, M., Rockliffe, N., Thoresen, T., & Tsolakis, D. 2000. Valuing long-haul and metropolitan freight. *Journal of Transportation and Statistics* 83–89.

Yao, B., Hu, P., Lu, X., Gao, J. & Zhang, M. 2014. Design of the transit network based on travel time. *Transportation Research Part C: Emerging Technologies* 43: 233–248.

Zhu, Z., Mardan, A., Zhu, S., and Yang, H., 2021. Capturing the interaction between travel time reliability and route choice behavior based on the generalized Bayesian traffic model. *Transportation Research Part B: Methodological* 143: 48-64.

Zhang, R., Li, L., & Jian, W. 2019. Reliability analysis in the railway transport chain. *International Journal of Transportation Science and Technology* 8(2): 192–201.

Zhang, X., & Chen, M. 2019. Quantifying the impact of weather events on travel time and reliability. *Journal of Advanced Transportation*.