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Travel Time Reliability Measurement for Selected Corridors in the Adelaide Metropolitan Area

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Abstract: Travel time reliability has become an important factor in route choice analysis and is one of the key indicators for traffic performance measurement. Hence this study assessed the ten corridors of the Adelaide Metropolitan road network's travel time reliability by using the Buffer Time and Planning indices. The findings show that the Buffer Time indices for the selected corridors may significantly vary and for some corridors, they reach almost 100 per cent. Since the buffer time index seems to overestimate the travel time reliability measurement, a detailed assessment of the travel time distribution was also conducted. This analysis shows that none of the travel time distributions follow the normal distribution. However for some corridors the log normal distribution would fit the travel time distribution.

Key Words: *Travel time reliability, Buffer time index, normal distribution, log normal distribution*

1. INTRODUCTION

The transportation system has been generally accepted as one of the national economic pillars in accordance with its function to provide mobility to the community. In addition, the transportation system has also been recognised as one of the parameters in terms of evaluating the national development achievements. Hence, many studies have addressed the issue of transportation network performance improvement in order to obtain better transportation system. Since 1950, many travel demand studies have been conducted, and results applied extensively in many transportation system analyses. However, most of these studies assumed that the complex interconnection between transport infrastructure, environment and human factors can blend harmoniously so that the transportation system can run and operate at the fully control and good condition. However, as in any complex and dynamic system, there will be many factors which can adversely affect transport network performance. The different type of incidents, either short term (e.g. road crashes) or the long term (e.g. road works) can happen at any time and the effect of these incidents will lead to higher travel time variability and then generate great consequences to the community (Nicholson *et al.*, 2003). Additionally, a great demand for just in time services of mobility, in particular goods for manufacturers has also forced the great interest for transportation system reliability and for the concept of transportation system robustness. Therefore, in the last two decades the study about transportation system reliability has become a strong interest for research (Bell and Iida, 2003).

There has not been a commonly accepted definition of the transportation system reliability. It varies and depends on the measurement context. According to prior studies, transportation system reliability focuses on the probability of trips that can be successfully done at the specified time (the travel time reliability); trips can be successfully completed based on the remaining connectivity between an OD pair (connectivity reliability) as well as the trips that can be accomplished at certain level of the link capacity (capacity reliability) (Bell and Iida, 2003).

Extensive travel time reliability studies have been conducted. It has already been accepted that the travel time reliability can be denoted as the probability of successfully completing a trip within specified time interval (Iida, 1999). In addition, according to Lomax *et al* (2003), the travel time reliability refer to the level of consistency of transportation services for a mode, trip, route or corridor for a time period.

As has been discussed earlier that the need for more reliable transportation system has forced transport planners to study several aspects of transportation system reliability, the travel time reliability has been commonly accepted as the key indicator in assessing the transportation system performances. Parallel to the travel time reliability definition, the notion of the travel time reliability is more to the idea of traffic performance particularly from the user point of view. Some of the previous research investigated the road user's disutility of being late and being arrived earlier due to the unreliable travel time. By applying the amount of the extra travel cost which are needed during the extra travel time, some studies have reported the development of disutility model based on the logit choice model (Small *et al.*, 1999, Noland and Polak, 2002, Bates *et al.*, 2001).

In addition, reliable travel time is the key indicator of user's route choice. Many recent studies have investigated the traveler's behaviour under unreliable travel time conditions using the relationship between the traveler behavior and their response to the provision of travel information. Asakura (1999) concluded that the Stochastic User Equilibrium model can generate the user route choice behavior based on the different levels of information provision. This study analysed two different groups, the first group being the well informed users and the second the uninformed users. He concluded that providing better information can improve the transportation network reliability. In addition, according to traveler's behavior in a route choice survey, the greater the variance of travel time of selected links the less attractive it is (Tannabe *et al.*, 2007).

Additionally, Bogers and Lint (2007) investigated traveler behaviour on three different road types in The Netherlands under conditions of uncertainty, as well as the impact of providing traveler information on route choice. They concluded that the provision of traveler information has significant impact on effecting traveler's decision. In addition, travelers would choose the route with minimal travel time variance, based on their experience. It means that the routes that have high travel time reliability are not attractive for users. Indeed, according to Lomax *et al*'s review that the best alternative to measure the travel time variability and route choice behaviour under uncertainty condition is by using probe vehicles. Though this method was highly labourious and expensive, it is more realistic (Lomax *et al.*, 2003). Then Tannabe *et al* (2007) undertook an integrated GPS and web diary in Nara, Japan. This study found that the travelers might change their route for reducing the uncertainty of travel time.

The better understanding of travel time reliability and variability might assist transport planner to select proper transport policy in order to relieve the congestion problems as well as lessening the impact of different type of incidents (Recker *et al*., 2005). It can be said that, the more reliable the transportation system is, the more stable is its performance. Moreover, from a transport user's point of view, more reliable travel times mean more predictable journey times and improved activity schedules. In accordance with just in time services, reliable travel time will significantly increase the freight industry's performances to deliver goods (Recker *et al*., 2005).

With regard to the use of the travel time reliability as one of the key indicator in assessing the traffic performance, Chen *et al* (2003) and Lyman and Bertini (2007) have comprehensively analysed the application of the travel time reliability measurement. As the level of service method is more related to the technical aspect such as road design rather than the user's experience during their trip, Chen *et al* (2003) discussed the opportunity to replace the concept of level of service with the idea of the travel time reliability. In line with the Chen's idea, Lyman and Bertini (2007) investigated the use of the travel time reliability measure as the congestion measure. By analysing the twenty of the Regional Transportation Plan (RTP) from the 382 of the Metropolitan Planning Organization in US, the study found that none of the RTP used the travel time reliability measure as a congestion measure. In addition, this study also investigated the traffic performance in the Portland. As the data analysis used the Portland Transportation Archive Listing (PORTAL) data which gave the 20 second resolution count, speed and occupancy of more than 500 freeway locations since 2004, the data can be analysed both at the segment and corridor levels. The study focused on the Northbound five interstate corridors by extracting the data into five minute interval. By comparing the Buffer Index, the Travel Time index as well as the planning index for three consecutive years of daily travel time at the Portland Highway, data analysis showed that the three travel time reliability indices gave the same pattern along the roadway. Among the three different travel time reliability measures, the planning time index gave higher index than the buffer and travel time index thus it seems underestimate the travel time reliability for that corridor. Therefore, this study compared the Portland corridors by using the Buffer index and the travel time index to give the priority for the congestion relief, with the help of incident response systems, bottleneck improvements and better traveller information. Hence the current study has proposed ranking system to select the highest priority corridor. Another comprehensive study also reviewed the use of the travel time reliability measurement as the traffic performance measurement. Tannabe *et al* (2007) found that the appropriate functional hierarchy of road may be disturbed by the uncertainty of travel time. These findings suggest that a reliability index of travel time is very useful and important for evaluating both actual level of service (LOS) and functional hierarchy of road network.

This paper will focus on the measurement of traffic performance of selected corridors of Adelaide Road networks by using travel time reliability measure as reported in the previous studies. The buffer time and planning indices were calculated based on eight consecutive years of travel time data.

In order to have better view of the travel time variability, this study also looked into the travel time distribution for all the selected corridors. Previous travel time reliability studies assumed that the travel time distribution might follow the normal distribution. Indeed based on the confidence interval around the mean of the travel time they proposed the travel time reliability measurement. However, the travel time distribution does not closely fit with the normal distribution; instead the log normal distribution could provide a better fit to the study area data. Hence the Kolmogorov-Smirnov test and the Chi Square were selected as a test of goodness of fit.

The next section will discuss the development of the travel time reliability measurement. The third section will review the study area and the data collection techniques. The results of the data analysis and the discussion on the findings of this study are dealt in the section four. Conclusions and further study details are explained in the last section.

2. TRAVEL TIME RELIABILITY

According to different purpose of travel time reliability study, there are several travel time reliability surveys. By comparing different aspect of the travel time study and by considering the complexity of data collection as well the data analysis, Lomax et al. (2003) has reviewed the suitable assessment of travel time reliability. Based on the scope and the limitation of each method this paper suggested a different approach in terms of measurement travel time variability and travel time reliability. It is felt that the analysis of the archived traffic data is not appropriate for measuring the travel time reliability due to the lack of data constant and the lack of other attributes related with the traffic condition. However, the travel time data is easy to obtain. In addition, the micro simulation techniques have been used extensively, however according to Lin et al (2005) there are some limitations in the travel time microsimulation modeling as it requires highly calibrated data. In order to gain real life traffic condition, some travel time reliability research used the probe vehicle methods. Since this method requires extensive labour and only covers some of the study area or some of the road segments, it cannot be applied for assessing the travel time reliability on large road networks.

2.1 Travel time reliability measurement

As travel time reliability considers the distribution of travel time probability and its variation across the road network; the higher the travel time variance is, the lower will be the travel time reliability (Nicholson et al., 2003). It is also true that under ideal conditions travel time reliability would have a variance equal to zero. Indeed, the increase of its variance will therefore significantly reduce its reliability. However, the relationship between travel time variance and its reliability is not linear; hence it cannot be generally accepted that a double of travel time variance will lead to a half of its reliability. To conclude, the great travel time fluctuation will have significant impact on transport network reliability.

Indeed, Lomax et al (2003) also recommended some reliability measurements by examining the reliability and variability percentages (e.g., 5 per cent, 10 per cent and 15 per cent). Those approaches take into account the effect of irregular conditions in the forms of the amount of extra time that must be allowed for travelers. An additional five minute travel time which is obtained from the travelers experience as well as from the historical data might be the basic concept of the travel time reliability. By considering the extra travel time which is needed to arrive on time, the travelers will carefully manage their next trip. Indeed the high travel time variability will increase the road user's anxiety during their trip as they will be unsuccessful in arriving to their destination based on their original trip planning.

The first measurement is the percent variation which expresses the relationship between the amount of variation and the average travel time in a percentage measure.

$$\boldsymbol{Percent\ variation} = \frac{\boldsymbol{Standard\ Deviation}}{\boldsymbol{Average\ travel\ time}} \times \mathbf{100}\% \qquad (1)$$

The second is travel time buffer which adds the extra travel time of 95per cent trips in order to arrive on time.

$$\boldsymbol{Buffer\ time} = \mathbf{95}\boldsymbol{th\ percent\ travel\ time\ for\ a\ trip} - \boldsymbol{Average\ travel\ time} \qquad (2)$$

$$\boldsymbol{Buffer\ time\ index} = \frac{\mathbf{95}\boldsymbol{th\ percent\ travel\ time} - \boldsymbol{Average\ travel\ time}}{\boldsymbol{Average\ travel\ time}} \times \mathbf{100}\% \qquad (3)$$

The planning index is the additional travel time of 95% trips in order to arrive on time which is obtained from the 95^{th} percentile of the actual travel time.

$$Planning\ Index = 95th\ percent\ travel\ time\ for\ a\ trip \qquad (4)$$

Since the source of the travel time reliability is the high travel time variability due to some factors, the study about the travel time variability becomes a necessity. By recognizing the daily, the weekly and monthly travel time distribution, the pattern of the travel time variability can be identified. Richardson and Taylor (1978) discussed the travel time variability of the commuter journey in Melbourne based on the probe vehicle survey over two separate periods and have analysed the travel time runs for both inbound and outbound trips of the Melbourne Central Business District. This paper also examined the correlation between the unit travel time of each section of the route and the relationship between the travel time variability and the level of congestion. This study suggested that the travel time of each link of the route is independent of travel time on other links on the route. After comprehensively examining the travel time distribution of the study areas, this paper concluded that the travel time distribution might follow the log normal distribution.

As the research about the travel time reliability became an important, interesting research and relevant to improve the travel time reliability, Rakhal *et al* (2006) also conducted similar study. This research also came up with the similar conclusions that from both an operational point of view as well as from the field travel time observations, the log normal distribution is more appropriate as it is more realistic. However, for some technical reasons and to make computations simpler, the normal distribution for the travel time distribution has been adopted even though the statistical test of fit rejected that assumption.

In conjunction with the development of the travel time reliability measurement, El Faouzi et al (2007) have discussed the possibility of using the log normal distribution to measure path travel time data as a part of the travel time reliability metric. The previous study measured the path travel time by simply summing the link travel time. This paper argued that in real traffic condition, the variability of link travel time can be also considered as the source of the path travel time variability, by taking into consideration the variability of link travel time and then the comprehensive path travel time can be obtained. Statistical and mathematical theories were presented in order to measure the path travel time data based on the link travel time distribution which was already assumed to follow the log normal distribution. Since this method can be just applied for limited number of links, the refinement method is an interesting research area.

3. DATA ANALYSIS AND DATA FINDINGS

This section briefly discusses the characteristic of the study area, the data analysis and provides the findings.

3.1 The road network performance data analysis

The South Australian Department of Transport, Energy and Infrastructure (DTEI) has been collected the travel time data for 10 network sample roads of Austroads as a part of the road network performance measurement project. Travel time data was collected by using the GPS probe vehicle survey for three different times of day, AM peak, off peak and PM peak. The survey data is available for eight consecutive years since 1999. This data was collected during weekdays only, thus no travel time data for weekends. To supplement this data, further surveys were conducted, as part of this study, during March and July months for both inbound (towards CBD) and outbound traffic. As the ten corridors travel time data have been already collected by DTEI, we used those archived travel time data. However, in this paper, we only used the inbound traffic which (traffic going to Adelaide CBD) in the data analysis.

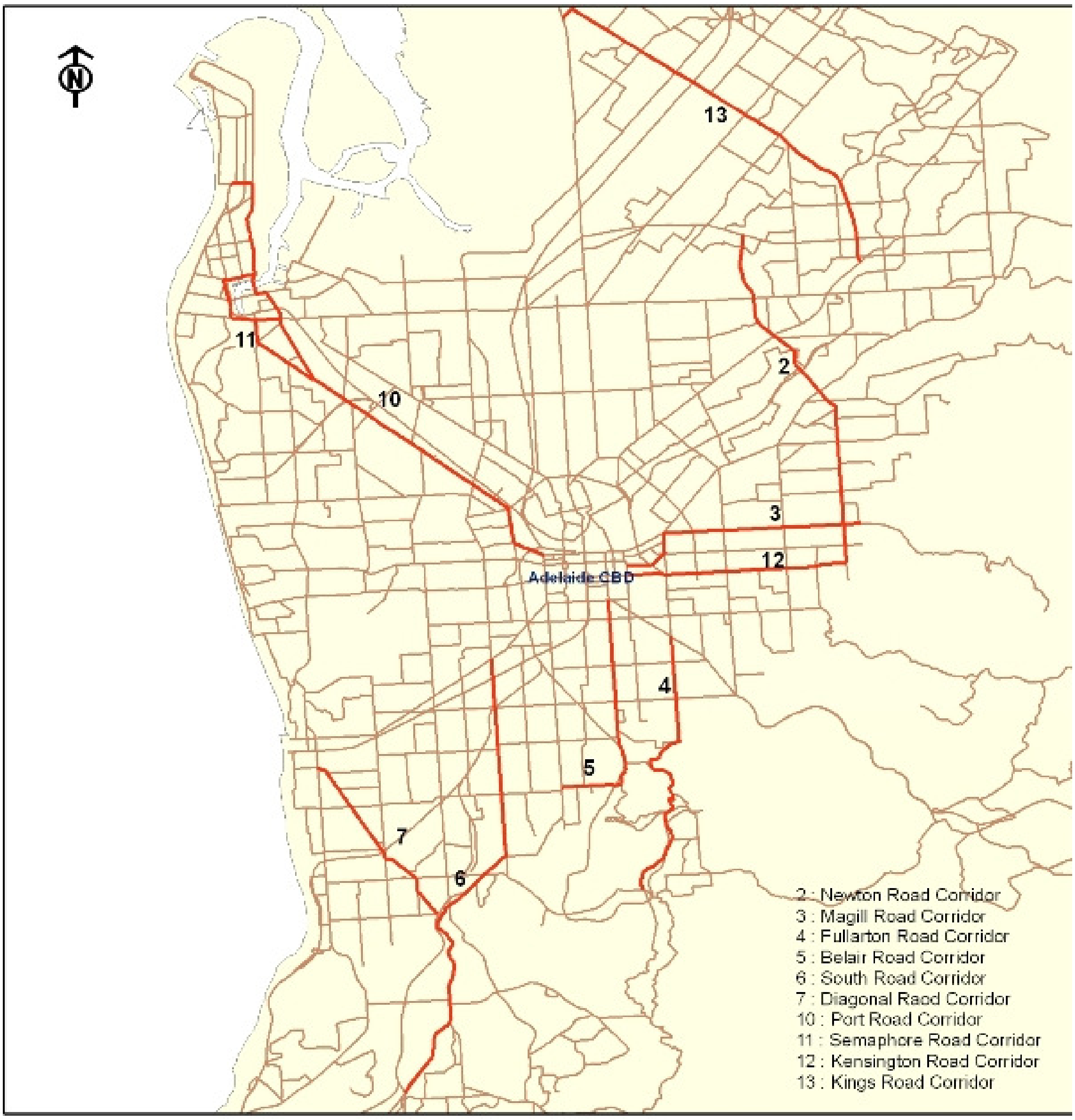

Figure 1 The ten selected corridors

The selected corridors are sprawling in the Adelaide metropolitan area. Some of the corridors such as the South Road and Port Road corridors are the busiest corridors that serve not only the commuter traffic but also the freight traffic. Most of the corridors are also the prominent corridors to reach the Adelaide CBD, some of them such as the Cross Road corridor as well as the Kings Road corridor serve the diagonal trips within the Adelaide metropolitan area as shown in the Figure 1.

The lengths of the corridor may vary, the shortest corridor is the Semaphore Road Corridor and the longest corridor is the Port Road corridor. In conjunction with the traffic characteristic, the traffic volumes are also various. The South Road and Port Road corridors are the most heavily trafficked of the ten corridors, and carry significant volumes of freight traffic as well as commuter traffic. The other finding form the data analysis is that the annual average vehicle kilometers travelled for the each corridor also do vary. Figure 2 below represent the annual average vehicle kilometers travelled at the first y-axis and the length of all the corridors at the second one.

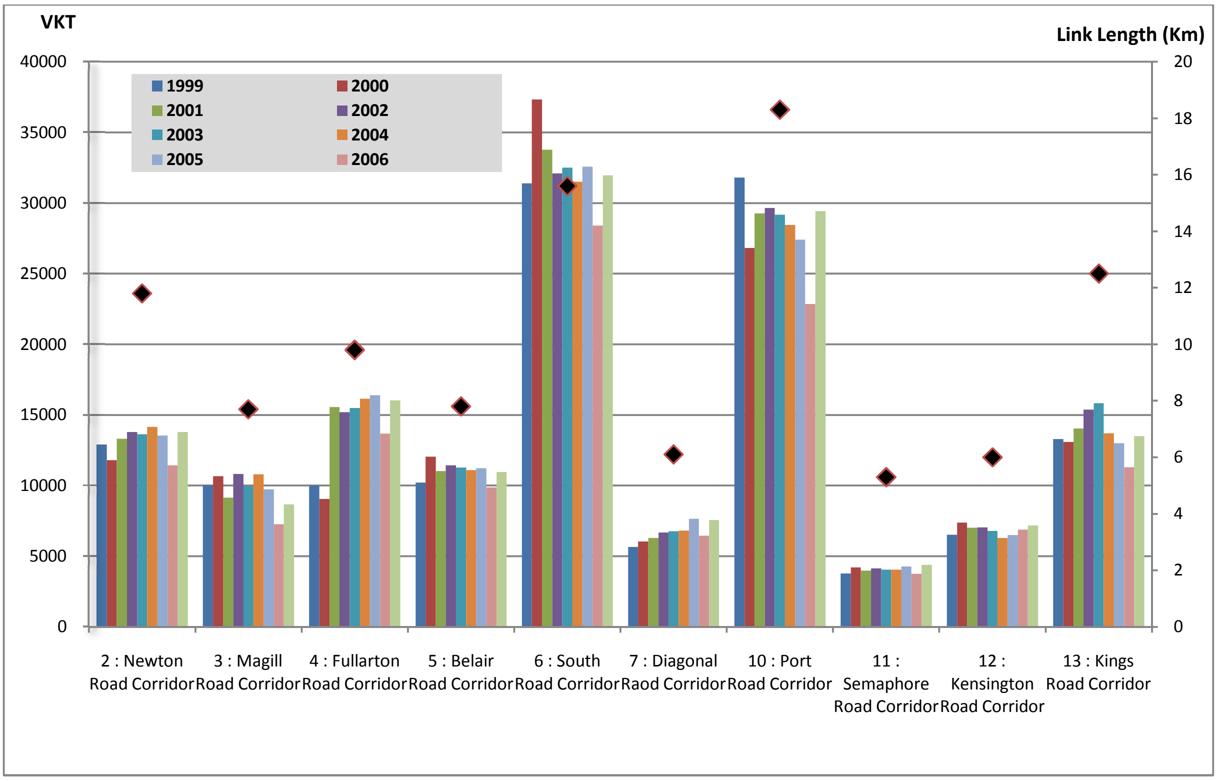

Figure 2 The Average vehicle kilometres travelled and the average travel time

3.2 The travel time reliability measurement

Three previous studies have used the concept of the travel time reliability as the performance measure which came up with the similar suggestion that there is an opportunity to use the travel time reliability as traffic performance measure in terms of relatively easy to interpret to the road users (Chen *et al*., 2003, Lyman and Bertini, 2007, and Rakhal *et al*., 2006). As has been discussed in Chen *et al* (2003) paper, the concept of the level of service is more useful for use by traffic engineers rather than by road users. For Instance, the information of the 20 minute travel time and a five minute extra travel time is more easy to understand than the A or D level of services.

Lyman and Bertini (2007) used the travel time index, planning time index and the buffer time index in their study. Even though the three indices gave the similar results, these study suggested that the planning time index seemed to overestimate the extra travel time so that it might underestimated the travel time reliability. Further, they used the buffer time index and the travel time index in their analysis. Chen et al (2003) used the 90th percentile travel as the travel time reliability measurement and found that providing the average and the 90th percentile travel time will give the better information to road users.

In line with the previous research, this paper investigated the use of the Buffer Time index as well as the Planning index as the traffic performance measure in the Adelaide road networks based on the eight years consecutive travel time data. Due to the lack of data availability, we did not differentiate the Planning index and buffer index either by time of day or during weekend, thus the planning index and buffer index were calculated for all periods. By using the Equation 4, the Planning Index was calculated and figure 3 below illustrates the variations of the Planning index and annual average travel time for all the selected corridors. The first y-axis represents the Planning index and the second y-axis represents the average travel time. Both of Planning index and average travel time are measured in minutes. From figure 3, it can be seen that there are not much variations in the annual average travel time over the eight years data. Indeed, for the Magill Road and the Kensington Road corridor, the annual average travel times are fluctuating.

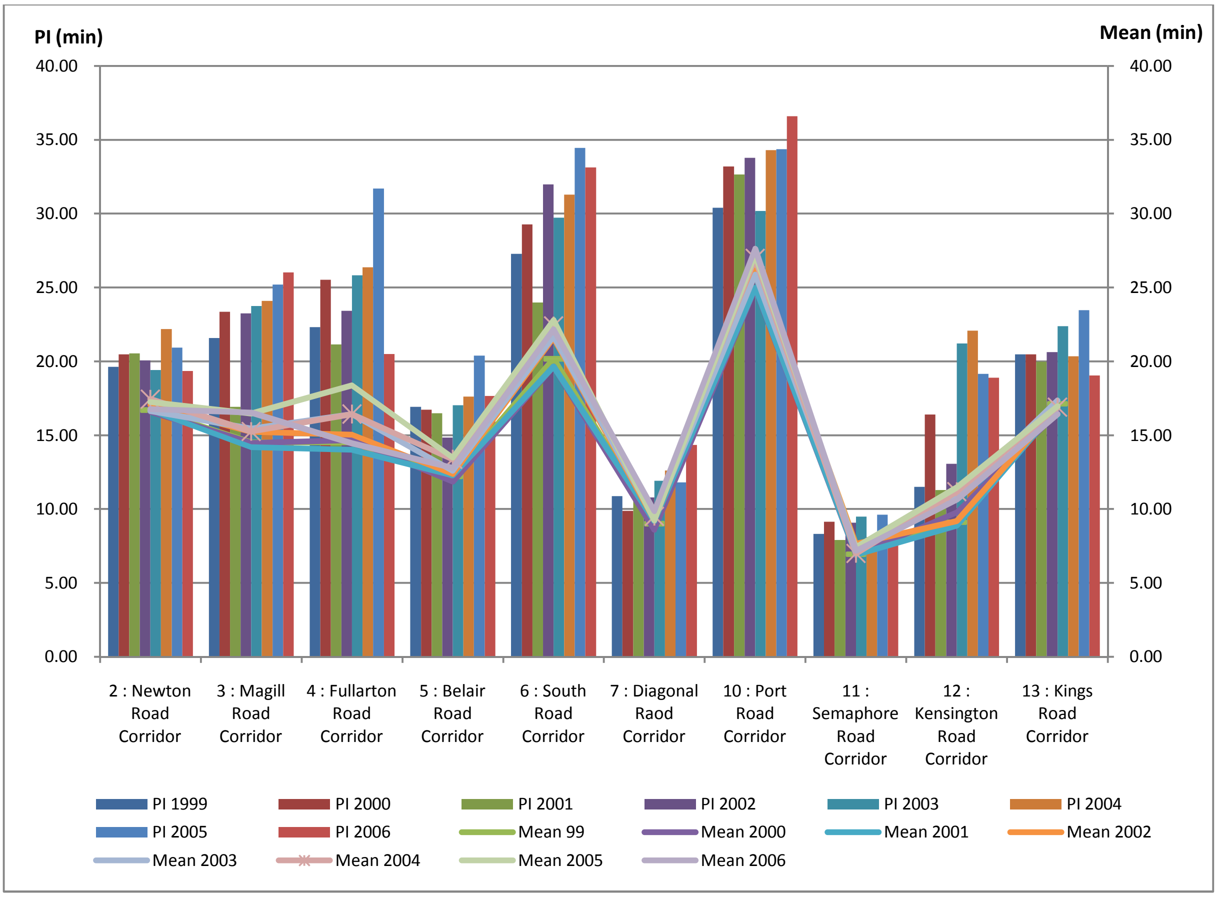

Figure 3 The Planning Index and the annual average travel time

On the other hand, the Planning index of the data vary significantly over eight years, the planning index for the Magill Road, South Road and Port Road corridors are steadily increasing, however for the Newton Road, Cross Road, and Semaphore Road corridor, the planning indexes seem to be constant. Those patterns might be affected by the function of the corridors, since the first three corridors served the traffic which are going and leaving Adelaide CBD but the second three serve the diagonal trips.

Figure 4 shows the buffer time index for the selected corridor. It can be seen that, there are significant fluctuations in the buffer time indices over eight years; for instance, the Kensington Road corridor buffer time index in 2003 and 2004 are much higher than the others. It reached the peak at almost 100 per cent, which means that the road user need to have almost double of their average travel time to make sure that they will not be late for the important appointment. Planning index for Newton Road and Semaphore Road gave the similar pattern to buffer time indexes which are not exceed the 30 percent. The other interesting findings are, although the Port Road corridor has been identified as the busiest corridor, its average buffer time index is about 20 percent. This anomaly could be described by looking into the distribution of its travel time.

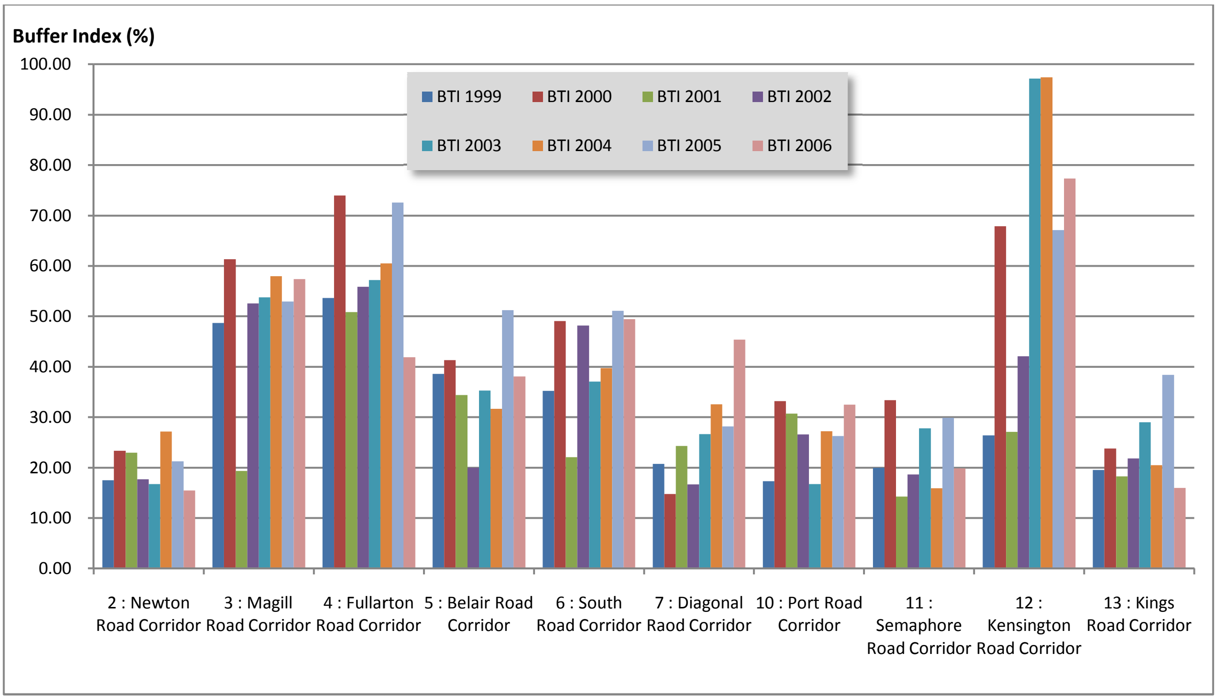

Figure 4 The buffer time index

Since buffer time index as well as the planning index seems to underestimate the travel time reliability due to the significant differences between the mean travel time and the 95th percentile, further statistical analysis are required to understand the travel time distribution over the years. Then, next section will extensively examine the travel time distribution and its parameter.

4. TRAVEL TIME VARIABILITY

This section analyses and discusses in dept the travel time distribution and its variability for further assessment of the travel time reliability. Since the data is an eight years of data collection, whereas there are about 30 runs for each year for each corridor then for over eight years there are about 255 of runs of travel time data were ready to analyse.

Table 1. below statistically summaries the travel time distribution for all corridors. The table shows the basic parameter of data description such as the mean, variance, standard deviation and the skewness as well as the kurtosis. From the table, it can be seen that the range of the standard deviation of that data which vary from 0.8 to 4.8. The highest one belongs to South Road corridor whereas the lowest one for the Semaphore Road corridor. To get more detail about the travel time distribution, the graphs for all actual and transformed travel time are provided in the Appendix.

Table 1 Summary of the travel time data for all corridors

		Newton Road	Magill Road	Fullarton Road	Belair Road	South Road	Diagonal Road	Port Road	Semaphore Road	Kensington Road	Kings Road
Mean		16.9195	15.3720	15.7286	12.7169	21.4869	9.3475	26.4622	7.1837	10.3448	16.9239
Median		16.6500	14.0667	13.7000	12.3750	19.2700	9.1417	25.6833	7.1167	9.1333	16.7000
Std. Deviation		1.7732	3.7821	4.3748	2.0614	4.8503	1.3302	3.8251	0.8221	3.3035	1.8661
Variance		3.1443	14.3041	19.1391	4.2493	23.5256	1.7694	14.6315	0.6758	10.9131	3.4823
Skewness		0.6302	1.2315	1.4339	1.3540	1.2468	1.0851	1.0227	0.8419	2.0541	1.2384
Kurtosis		0.1479	0.7122	1.3712	2.7231	0.6700	1.9670	1.0380	1.3030	4.0609	4.3861
Minimum		13.7333	9.7167	10.8000	9.2333	15.7167	6.7833	20.2000	5.6667	6.7167	13.1000
Maximum		23.0000	27.3833	32.2333	22.8333	38.6500	15.2500	43.3167	10.9167	23.9000	27.9667
Percentiles	10	14.7667	11.6700	12.0867	10.5333	17.2267	7.9017	22.3400	6.2590	7.7667	14.7600
	90	19.4933	21.5300	23.1733	15.5750	29.4167	10.9650	32.5800	8.3450	15.3667	19.1167
	95	20.3967	24.0700	25.0870	17.1417	31.4050	11.9100	34.2133	8.5667	18.3883	20.2942

In line with the previous studies which suggested that the travel time distribution might follow the log normal distribution, the test of normality was also conducted. Table 2. presents the p value of the Kolmogorov-Smirnov test and or the 95% confidence level table 3 summaries the Chi Square goodness of fit test for actual and transformed travel time data for the 0.05 and 0.01 significance level.

Table 2 The result of the Normality test for actual and transformed travel time data

Corridors	Kolmogorov-Smirnov for actual travel time			Kolmogorov-Smirnov for transformed travel time		
	Statistic	df	Sig.	Statistic	df	Sig.
Newton Road	.072	255	.003	.052	255	.093
Magill Road	.169	255	.000	.128	255	.000
Fullarton Road	.206	255	.000	.173	255	.000
Belair Road	.094	255	.000	.062	255	.020
South Road	.197	255	.000	.174	255	.000
Diagonal Road	.089	255	.000	.061	255	.024
Port Road	.095	255	.000	.076	255	.001
Semaphore Road	.070	255	.004	.055	255	.060
Kensington Road	.216	255	.000	.162	255	.000
Kings Road	.079	255	.001	.057	255	.042

Table 2. and table 3 give the similar results. As the p values of the Kolmogorov-Smirnov are less than 0.05 as well as the value of the Chi Square test is much far from the critical value for the 0.05 and 0.01 significance levels, these tests show that the travel time distributions do not

follow the normal distribution.

These findings are similar to the Richardson and Taylor (1978) data analysis, which found the travel time data may not be normally distributed; consequently the data were transformed into the log normal distribution. The new groups of data were then tested for their goodness of fit to the log-normal distribution.

The Kolmogorov-Smirnov test for the transformed data give the values of p which are slightly different with the previous test, as it can be seen from the table, the p value of Newton Road and Semaphore Road corridor are higher than 0.05 which means that travel time distribution of these corridors follow the log normal distribution. However, the rest of the corridors gave a similar p value as in the previous table so that the log normal distribution are not significantly well fit with the travel time distribution.

Table 3 The Chi Square test for the actual and transformed travel time data

Corridors	Chi Square values for actual data	Chi Square values for transformed data	Significance level	
			0.05	0.01
Newton Road	21.967	16.05327	14.07	18.48
Magill Road	110.8241	76.30191	14.07	18.48
Fullarton Road	257.0221	142.8079	14.07	18.48
Belair Road	55.85174	30.82866	14.07	18.48
South Road	193.2862	127.8148	14.07	18.48
Diagonal Road	33.77504	13.36236	14.07	18.48
Port Road	65.5547	34.21664	14.07	18.48
Semaphore Road	22.69488	12.34016	14.07	18.48
Kensington Road	199.6741	119.4365	14.07	18.48
Kings Road	20.30734	9.981465	14.07	18.48

In line with the Kolmogorov test, the Chi square test also give the same result, from table 3, it is clearly seen that only Newton Road and Semaphore Road corridor give the value below the critical value for the 0.05 and 0.01 significance levels, thus it can be concluded that only these corridors fit with the log normal distribution.

Two tables above clearly suggest that the travel time distribution do not fit with the normal distribution. And the suggestion of previous studies that the travel time distribution might follow the log normal distribution only applied for some corridors, for the remaining corridors, the log normal distribution did not fit the observed travel time distributions. Thus require further research to examine if other theoretical distributions may provide satisfactory fit for the observed data.

5. CONCLUSION

The travel time reliability study has become an interesting area for research. Extensive studies have been conducted in order to improve the travel time reliability measurement. The buffer time index as one of the travel time metric has been used in some studies to assess the traffic performance of the specific corridor. By adopting the similar technique, this study examines the ten selected corridors of the Adelaide Road networks by using the eight consecutive years of travel time data. From the data analysis, it is found that there were many differences in buffer time index results among the corridors and for some the differences are much larger than others. In addition, the buffer time index might be not be enough to represent the travel time reliability due to the significant variability of the travel time. To support the hypotheses that the travel time distribution might follow the log-normal distribution, the Kolmogorov-Smirnov and Chi Square test of goodness-of-fit was also conducted. After testing the distribution of the travel time, this study found that the travel time distribution for some cases might follow the log normal distribution and for others did not fit with the log normal distribution, therefore the further goodness of fit test were done. The result is the travel time distribution fit with log normal distribution.

By assessing the travel time reliability measurement, this study also proposes to refine the current metrics. The further analysis of the log-normal distribution of route travel times as well as link level travel times, as well as other possible distributions, is recommended for further research.

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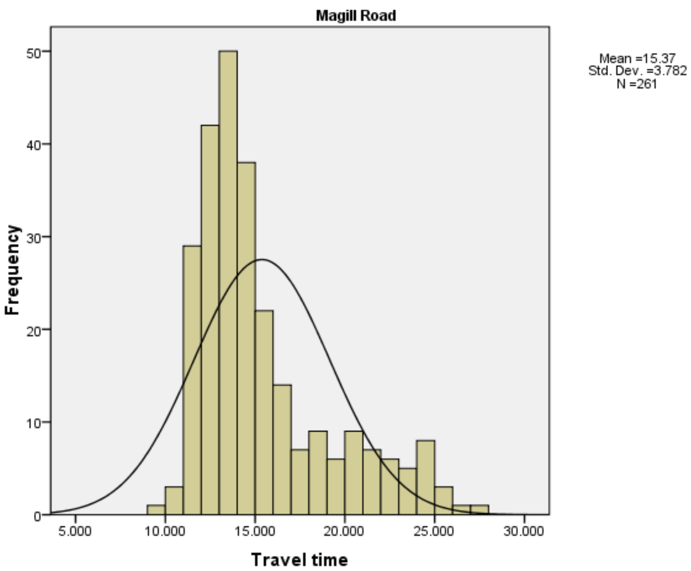
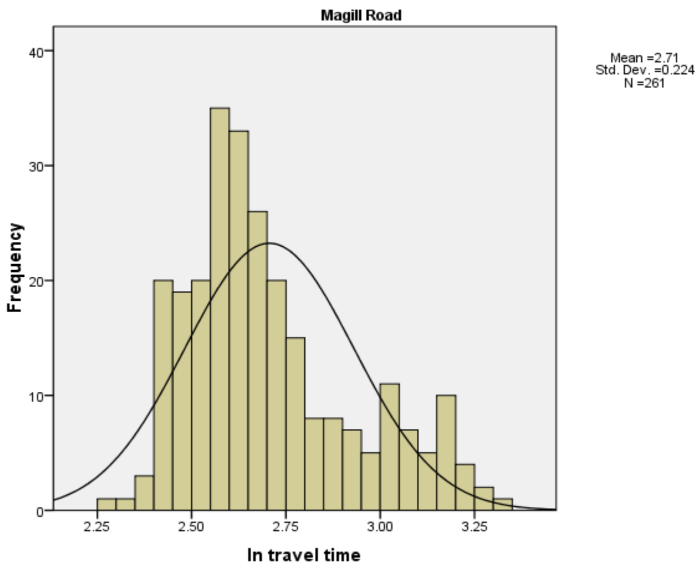
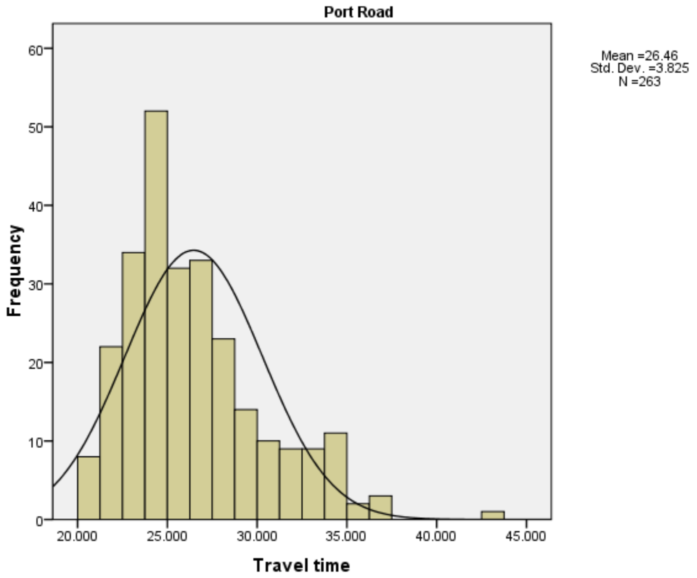
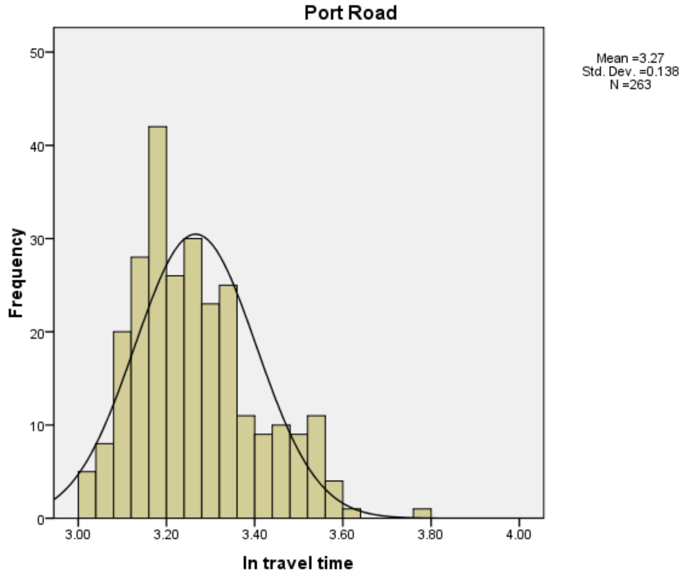
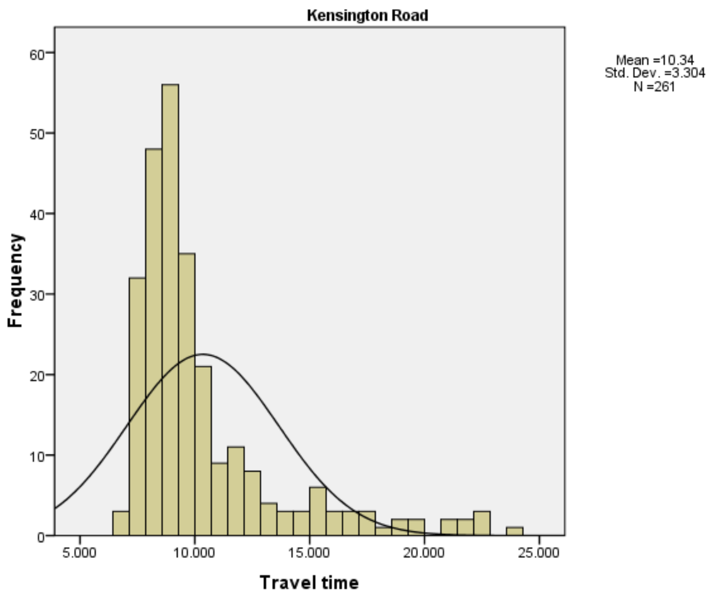
APPENDIX

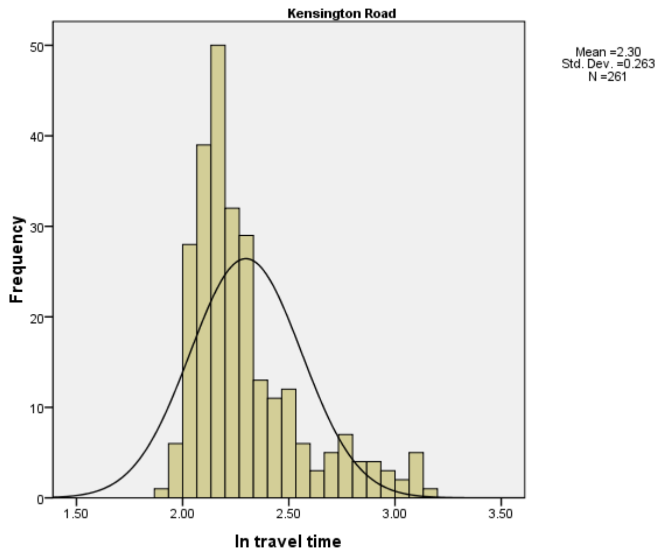


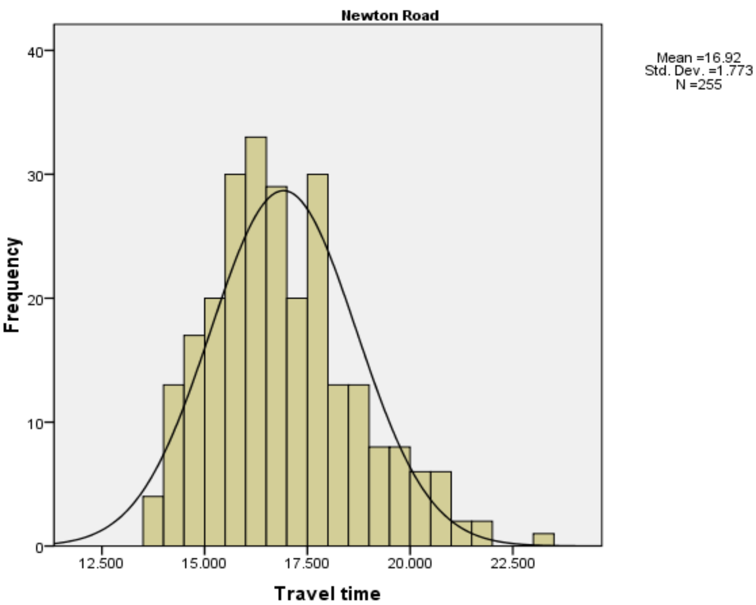


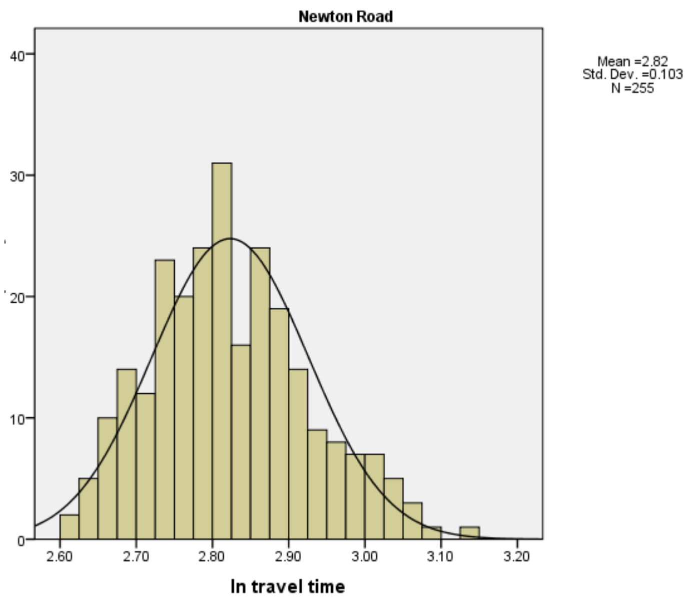

Port Road
Mean =26.46
Std. Dev. =3.825
N =263
Frequency
Travel time

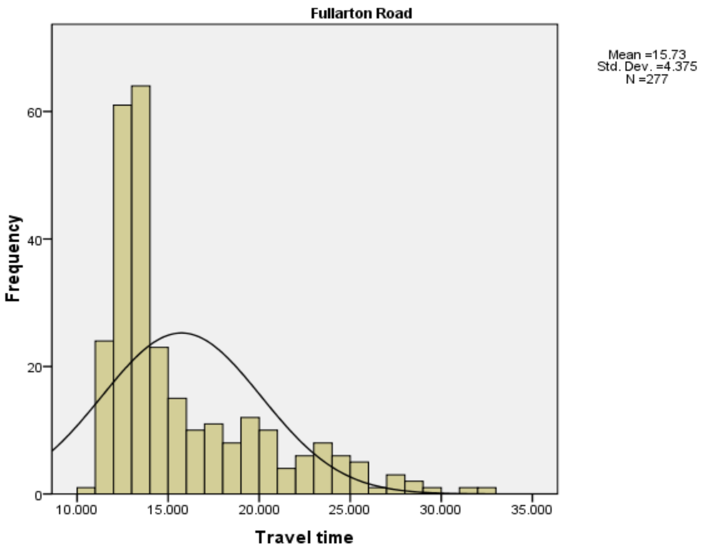

Port Road
Mean =3.27
Std. Dev. =0.138
N =263
Frequency
ln travel time

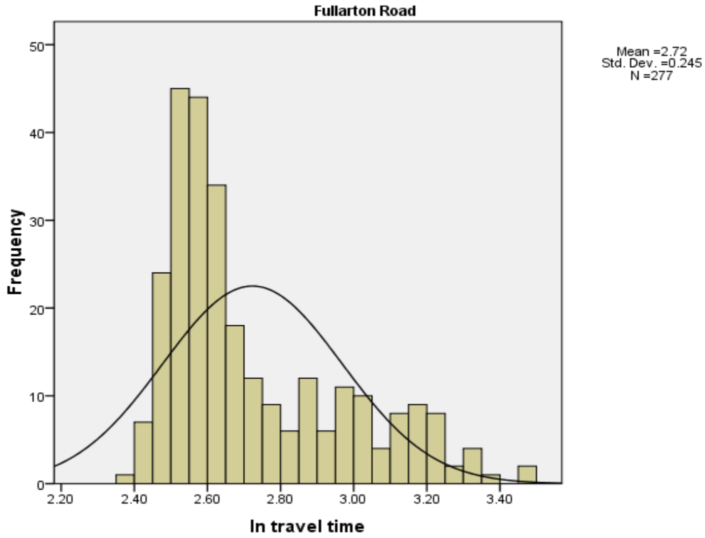

Kensington Road
Mean =10.34
Std. Dev. =3.304
N =261
Frequency
Travel time

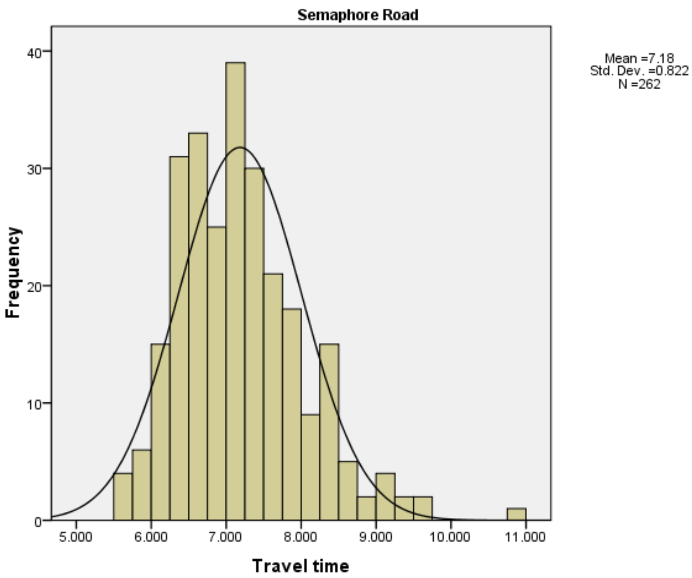

Kensington Road
Mean =2.30
Std. Dev. =0.263
N =261
Frequency
ln travel time

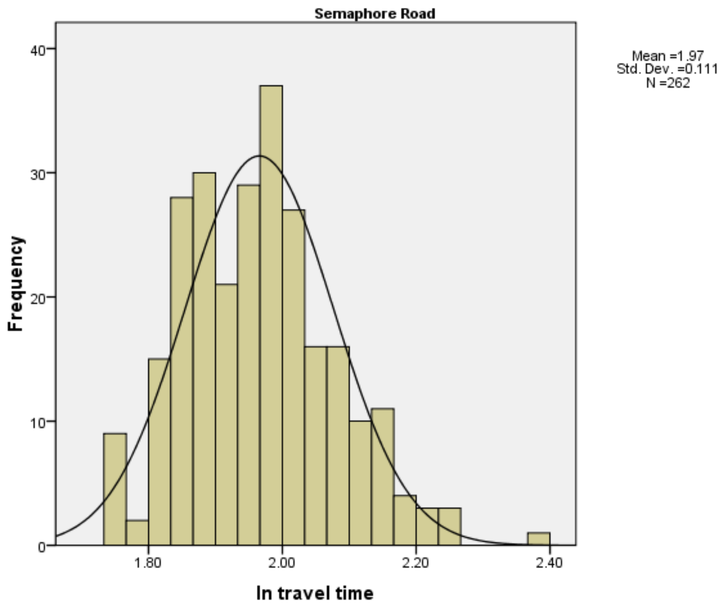

Newton Road
Mean =16.92
Std. Dev. =1.773
N =255
Frequency
Travel time

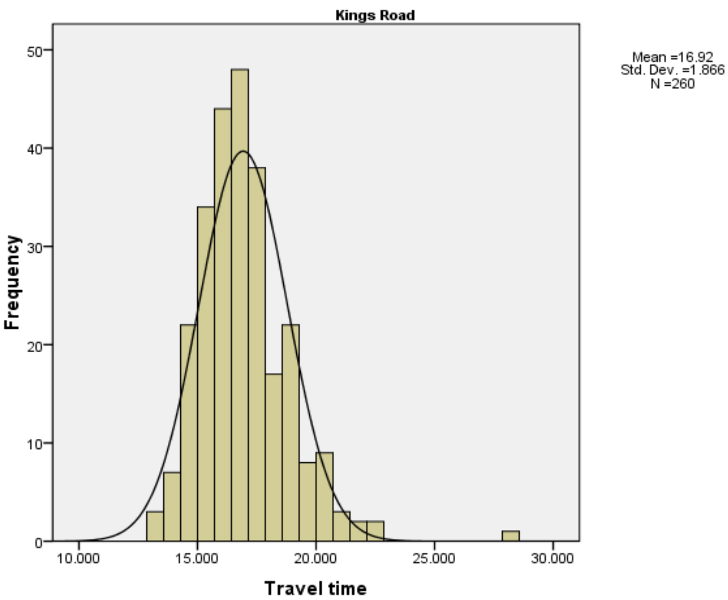

Newton Road
Mean =2.82
Std. Dev. =0.103
N =255
ln travel time

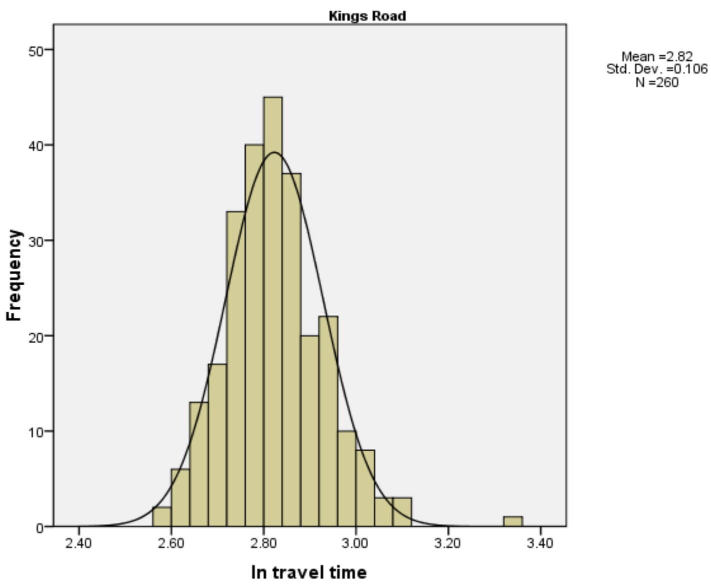

Fullarton Road
Mean =15.73
Std. Dev. =4.375
N =277
Frequency
Travel time

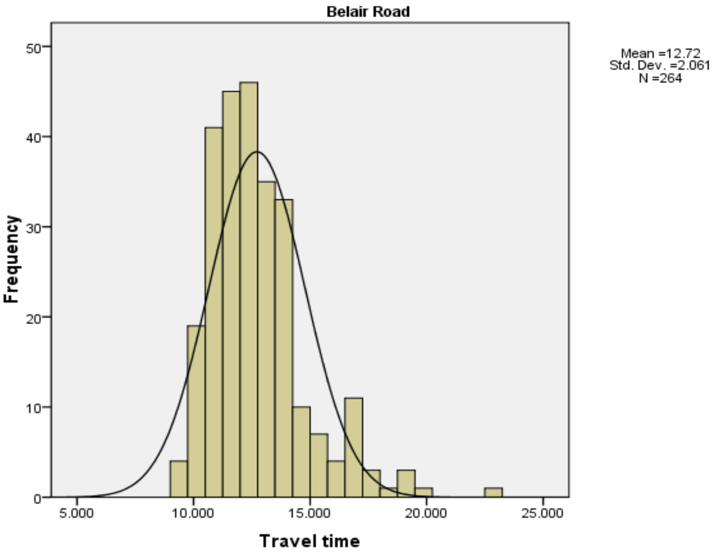

Fullarton Road
Mean =2.72
Std. Dev. =0.245
N =277
Frequency
In travel time

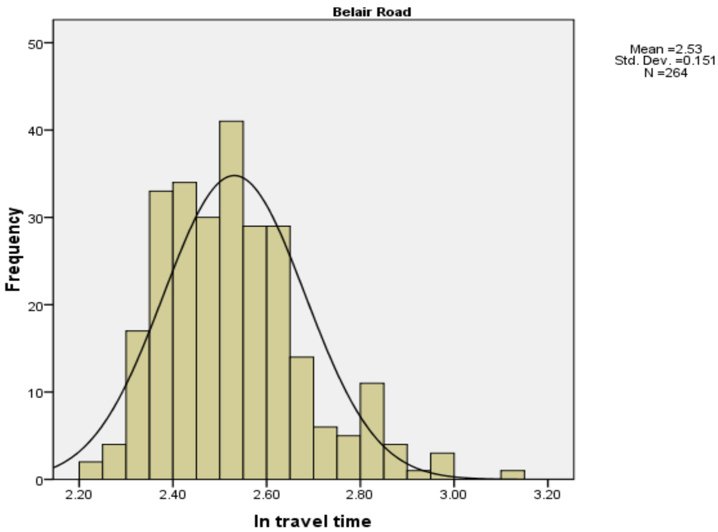

Semaphore Road
Mean =7.18
Std. Dev. =0.822
N =262
Frequency
Travel time

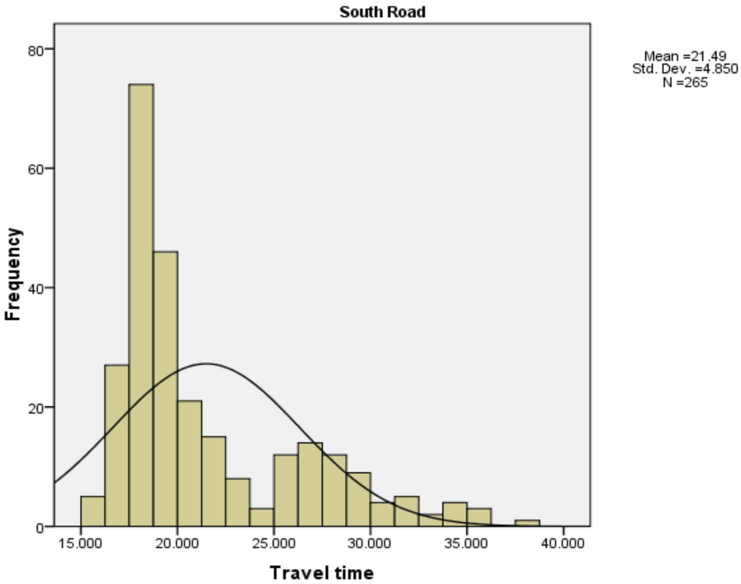

Semaphore Road
Mean =1.97
Std. Dev. =0.111
N =262
Frequency
In travel time

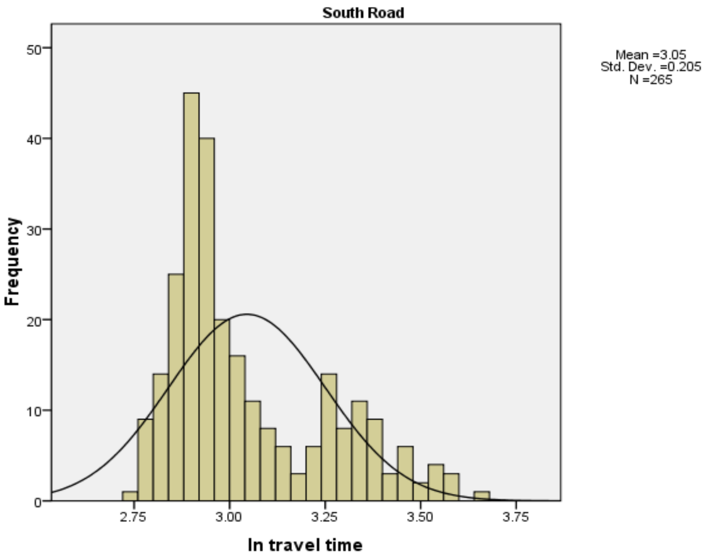

Kings Road
Mean =16.92
Std. Dev. =1.866
N =260
Frequency
Travel time

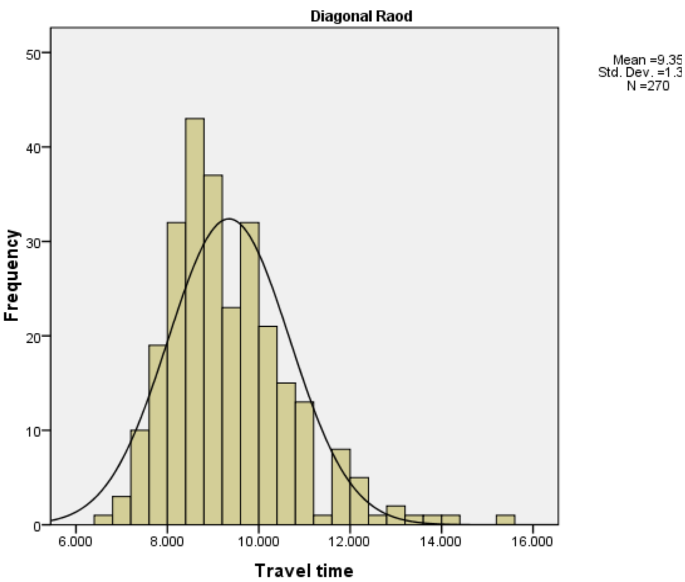

Kings Road
Mean =2.82
Std. Dev. =0.106
N =260
Frequency
In travel time

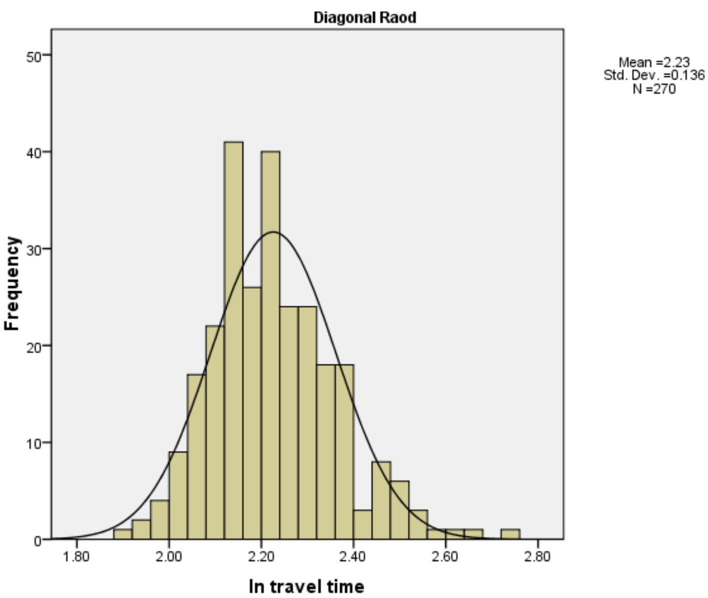

Belair Road
Frequency
Travel time
Mean =12.72
Std. Dev. =2.061
N =264


Belair Road
Frequency
ln travel time
Mean =2.53
Std. Dev. =0.151
N =264


South Road
Frequency
Travel time
Mean =21.49
Std. Dev. =4.850
N =265


South Road
Frequency
ln travel time
Mean =3.05
Std. Dev. =0.205
N =265


Diagonal Raod
Frequency
Travel time
Mean =9.3
Std. Dev. =1.3
N =270


Diagonal Raod
Frequency
ln travel time
Mean =2.23
Std. Dev. =0.136
N =270

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