The Impact of Organized Bus Route Scheme on City Bus Operation along Epifanio delos Santos (EDSA), Metro Manila

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Abstract: The purpose of the Urban Transport Scheme, specifically the Organized Bus Route (OBR) Project, is to improve public transport service and lessen the traffic congestion cause by city buses along EDSA. The main objective of this paper is to measure the impact of the OBR Scheme on bus service operating characteristics along EDSA. Specifically, to identify the distinct influential indicators of the OBR Scheme on bus service operating characteristics, to assess the previous schemes and analyze the present OBR scheme in terms of the identified influential indicators, and to compare both schemes in terms of the identified indicators. After several onboard bus surveys along EDSA under different bus routes, the average travel and running speeds, travel time and delay as well as the passenger demand in terms of passenger-kilometer were obtained. Hypothesis testing were conducted to determine if these important bus service operating characteristics improved compared to the data obtained during the previous schemes. Results showed that the OBR scheme being implemented was effective in terms of improved travel and running speeds along EDSA and more passengers were being carried by city buses along the studied section of EDSA. With the improved travel time less air pollution due to city buses would be experienced especially along EDSA.

Key words: Organized Bus Route (OBR) scheme, urban public transport, bus service operating characteristics, bus emissions

1. INTRODUCTION

Urban transport is a fundamental source of sustainability of a city. Traffic management is one of the major parts of urban planning. It does not only involve the design of roads but it also takes into account the congestion of vehicles in the city. The study focused on the city buses operation along EDSA and as well as the improvements made by the Metropolitan Manila Development Authority (MMDA) on bus operation along the said road.

The MMDA started to implement the OBR system in 2003. This was to address the problems of dispatching public city buses along EDSA. The objectives were: (i) reducing congestion along EDSA due to long bus queuing at major intersections and bus stops; (ii) remove illegal bus units from the circulation; (iii) eliminate illegal public bus transport drivers' practices of not completing trips and plying along non-authorized routes; (iv) optimizing vehicle operating performance and revenues for the bus companies; and (v) reducing vehicle emissions, particularly greenhouse gases contributing to climate change. The scheme was first tested before the ordinance was passed in 2003. The scheme was in an experimental state before the year 2003 as well as this was the time that the data for the study in 2002 was conducted. The OBR Scheme that was implemented in 2003 was run by a manual system.

The comparison was done based on the bus survey data from a study by Fillone (2002) where the OBR at that time was just being tested in terms of the governing policies as compared to the newly enhanced OBR Scheme that was mandated by year 2003. Provincial and private buses were disregarded from the study.

2. METHODOLOGY

EDSA is being managed by the MMDA using three notable schemes, the PUV Lane Scheme, The Organized Bus Route Project (OBR) and the Number Coding Scheme. These three were designed so that it would reduce the travel time of all public utility vehicles especially city buses, improve the operation of bus services along EDSA by controlling the headways between buses dispatched at the terminals and enforcing the rules on the use of loading and unloading areas. By abiding to these three schemes it could lessen the congestion and the traffic along EDSA. Data were gathered to assess the affectivity of these enforcements. These are the travel time and running time that would help in solving for the peak hour rate and headways. Once these data were obtained, we assessed the valuable information which was to get the travel speed of buses and passenger volume per bus.

Hypothesis testing of paired samples, that paired data before OBR scheme was executed along EDSA and those data of buses after the implementation of the said scheme, was the main method of determining whether changes in bus characteristics were statistically significant. Paired sample tests were done on such variables as average travel and running speeds, and average passenger-kilometer carried.

For paired sample test, the following issues were verified before using the test: (1) the relative frequency distribution of the population differences is approximately normal, and (2) the paired differences are randomly selected from the population of differences. For the first case, several methods were used to test the normality of data. Data normality was observed through a graphical presentation of data such as the use of a box plot that showed the range, median and upper and lower quartiles of data. Another one was the histogram, which showed the spread of data whether it followed a bell-shaped distribution. The normal probability plot was another reliable method where the residuals were plotted against its expected value when the distribution is normal. A good approximation of the expected value of the *i*th smallest observation in a random sample of *n* was computed as

$$z\left(\frac{i-0.375}{n+0.25}\right) \quad (1)$$

Where *z(A)* denotes the *(A)100* percentile of the standard normal distribution. This method is also known as the Ryan-Joiner Test for normality. The *r*, sample correlation coefficient calculated from the [z(A), observation] pairs will be compared to the critical *r* values developed by Looney, et al (1985).

Paired samples in hypothesis testing have the following null and alternative hypothesis

$$H_0: \mu_1 - \mu_2 = 0 \quad (2)$$

$$H_1: \mu_1 - \mu_2 \neq 0 \quad (3)$$

Where μ_1 = the mean of bus variable (travel speed, running speed, and passenger-kilometer carried) after the implementation of the enhanced OBR scheme, and μ_2 = the mean of the bus variable (travel speed, running speed, and passenger-kilometer carried) before the implementation of OBR scheme.

The test statistic was $|t| = \frac{\bar{d} - 0}{s_d - \sqrt{n}}$, where d is the sample mean of the paired difference of the samples, s_d the sample standard deviation of the paired differences, and n the number of samples. Using a two-tailed test, the rejection region was $|t| < t_{\alpha / 2}$ (critical). Also, when the confidence interval of the paired differences included the value zero, we had to accept the null hypothesis, H_0.

As mentioned earlier, before performing hypothesis testing for the paired samples, the data of paired differences came from a normal population. To test this assumption, several graphical and statistical tests were performed. The graphical presentations of data included the box plot and the normal histogram. The outliers shown in the box plot were identified and these were not included and removed in the succeeding statistical tests.

Average travel and running speeds could present some measures of bus performance along the route. The average travel speed, which is simply the distance travelled divided by the total time consumed, can provide insights into the overall movement of the bus as it encounters delay as well as its behavior when embarking or disembarking of passengers. The average running speed is simply the distance travelled divided by the running time of the bus. Consequently, stop times are not included in the computation of the average running speed.

The passenger-kilometer performance of the buses was obtained from the onboard bus survey by multiplying the number of passenger onboard the bus by the average running speed and running time along the segment. The difference of the before-and-after average passenger-kilometer performance of paired bus routes would be tested in the whole stretch of the bus routes. For this case, the study eliminated inter-route variation; paired samples were made by route. If there were several samples in a certain route, these were randomly paired.

The travel time of public utility vehicles is basically divided into three parts: running time, passenger related time, and traffic delay related time. Running time is the time consumed by buses while moving. Passenger related travel time is specifically the part consumed by embarking and disembarking passengers. Traffic delay related time is that time consumed due to traffic lights, obstruction of other vehicles and the like. The percentage composition of bus journey time showed the morning peak periods before-and-after the OBR scheme operation, such as percentage of time was spent on traffic delay related effects, running time, and lastly, for passenger related time.

3. BEFORE-AND-AFTER STUDIES OF BUS SERVICE OPERATION

This section discusses the changes in bus volume in the critical directions during the peak hour before-and-after the implementation of MMDA schemes along EDSA. The following paired data differences on bus service characteristics were then tested for changes using hypothesis testing: (a) before-and-after average travel and running speeds and (b) before-and-after average passenger-kilometer carried by buses. The changes in journey time composition as well as bottlenecks that developed using average bus time delay were also compared at important locations along EDSA.

3.1 Bus Volume Study

From what the group gathered during the surveys, the morning peak period occur from 6:00 AM to 9:00 AM. As expected, the morning peak hour volume of buses occurs around this peak period as shown in Table 1. The locations being chosen by the group were the spot where all the city buses pass. Some of the locations in EDSA have flyover or underpasses which are not an ideal in monitoring all the traversing buses.

Table 1. Comparison of Bus Volume Before-and-After the Traffic Schemes Implementation

Date	Location along EDSA	Peak hour Period (hrs)	Aircon No.(%)	Non-Aircon No.(%)	Total No.(%)
Southbound (before)					
Oct. 9, 2001	Magallanes	6:45-7:45	187(52.82)	167(47.18)	354(100)
Oct. 23, 2001	Guadalupe	6:00-7:00	159(36.72)	274(63.28)	433(100)
Mar. 12, 2002	Guadalupe	7:00-8:00	215(46.84)	244(53.16)	459(100)
Average (%)			**561(47.5)**	**685(52.5)**	1246(100)
Southbound (after)					
April 23,2009	Boni	7:30 - 8:30	216(44.54)	269(55.46)	485(100)
April 27,2009	Mantrade	8:00 - 9:00	232(47.25)	259(52.75)	491(100)
April 28,2009	Mantrade	8:00 - 9:00	226(48.39)	241(51.61)	467(100)
Average (%)			**674(46.73)**	**769(53.27)**	1443(100)
Northbound (before)					
Oct. 4, 2001	Magallanes	7:00-8:00	88(36.07)	156(63.93)	244(100)
Oct. 5, 2001	Guadalupe	7:00-8:00	148(44.18)	187(55.82)	335(100)
Mar. 12, 2002	Guadalupe	7:45-8:45	198(46.37)	229(53.63)	427(100)
Average (%)			**434(42.21)**	**572(57.79)**	1006(100)
Northbound (after)					
April 23,2009	Boni	8:00 - 9:00	201(43.04)	266(56.96)	467(100)
April 27,2009	Mantrade	7:00 - 8:00	227(43.40)	296(56.60)	523(100)
April 28,2009	Mantrade	8:00 - 9:00	200(40.24)	297(59.76)	497(100)
Average (%)			**628(42.23)**	**859(57.77)**	1487(100)

As can be seen in the Table 1 above, in the southbound direction, air conditioned buses decrease in percentage of 47.5% to 46.73% or 0.77% decrease, while the non-air conditioned buses, an average increase in percentage of 52.5% to 53.27% or 0.77% increase. Whereas in the northbound direction, air conditioned buses, increase in percentage of 42.21% to 42.23% or 0.02% increase on the average, while the non-air conditioned buses decrease in percentage of 57.79% to 57.77% or 0.02% decrease was observed.

Based on the observed data, less than percent increased or decreased in the previous bus volume data. This shows that the volume of buses along EDSA has not changed much. The scheme executed by the MMDA did not take affect the volume of buses traversing EDSA.

3.2 Average Travel and Running Speeds

Average travel and running speeds could provide some measure of bus service performance along the route. The average travel speed, which is simply the distance travelled divided by the total time consumed, could provide insights into the overall movement of the bus as it encounters delay as well as its behavior when dropping off or picking up passengers. The average running speed is simply the distance travelled divided by the running time of the bus. Hence, stop times were not included in the computation of the average running speed. This speed could provide some indication about the flow and density characteristics along the route, with lower running speeds indicating some congestion or much denser flow, while higher running speeds indicate less dense flow and more freedom for the bus to move forward.

As mentioned earlier, before performing hypothesis testing for the paired samples, the data of paired differences came from a normal population. To test this assumption, several graphical and statistical tests were performed. The graphical presentations of data included the box plot and the normal histogram. Figure 2 shows the box plot of differences of paired data of travel and running speeds for morning peak period. The outliers shown in the box plot were identified and these were removed in the succeeding statistical tests.

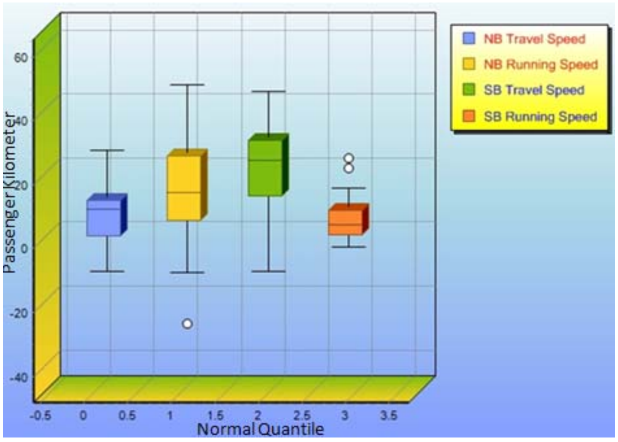

Figure 2. Boxplot of Paired Differences of Average Travel and Running Speeds of Buses In the Morning Peak Periods along Aurora Ave. to Ayala Ave. Segment of EDSA and v.v.

Figure 3 shows the histogram and the normal curve of the average running speed for the paired differences of the northbound and southbound directions. The histogram represents the graphical form of the frequency distribution of the average running speed. It also provides visual impression of the shape of the distribution of the measurements, as well as information about the scatter or dispersion of the data. The horizontal axis represents the measurement scale in terms of speed in kilometer per hour. The vertical axis represents the frequency scale or the count of speed within the range in the horizontal axis.

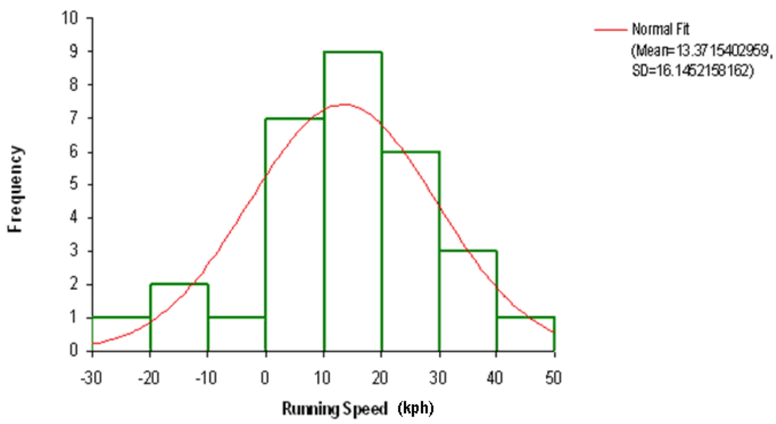

Figure 3. Histogram and Normal Curve of Paired Differences of the Running Speed of Buses for the Ayala Ave. to Aurora Ave. Segment of EDSA

As mentioned earlier, before performing hypothesis testing for the paired samples, the data of paired differences must come from a normal population. To test this assumption, several graphical and statistical tests were performed. One of these tests is the normal probability plot. The test of normality compares the r^2 of the normal probability plot of the differences of the paired average travel and running speeds for both morning and afternoon periods and the critical r. In Table 2., since the r^2 values of the differences of paired data are higher than the $r_{critical}$, these are proof of data abnormality. It also shows an increasing travel and running speed for both southbound and northbound route. These data assessed that travel and running speed for both directions were enhanced after the OBR scheme was being implemented.

A sample of the normal probability plot of the differences of the paired average running speed in the morning peak period is shown in Figure 4.

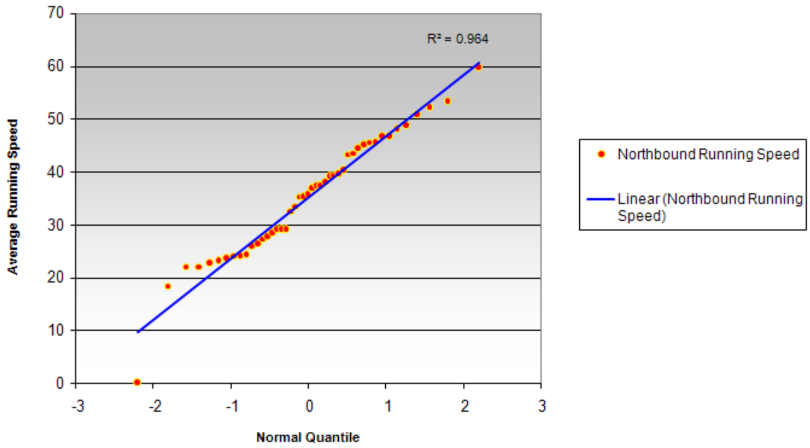

Figure 4. Normal Probability Plot of Observed Paired Differences of the Average Running Speeds of Buses for the Ayala Ave. to Aurora Ave. Segment of EDSA during the Morning Peak Period

Using statistical analysis, the group was able to get the t-stat and the $t_{critical}$ using one tailed t-test of paired samples of means. The $t_{critical}$ represents the critical values in order to know if the t –stat value is within the region of rejection or acceptance. The group used 5% level of significance. When t-stat value is within the positive and negative $t_{critical}$ value, then accept H_0 and reject H_1 as a decision. However, if t-stat value is out of range, H_1 will be accepted and H_0 will be rejected. Based in Table 2., the travel and running speed for both southbound and northbound direction accepted H_1 as a decision because the $t_{critical} < t_{stat}$. This means that the travel and running speeds for both directions improved after the execution of OBR scheme along EDSA. The H_1: U_{after} = U_{before} and H_0: $U_{after} > U_{before}$, where U_{after}= average travel and running speed of buses after the implementation of OBR and U_{before}= average travel and running speed of buses before the implementation of OBR. Since t_{stat} for northbound and southbound were greater than its $t_{critical}$, it could be concluded that the travel and running speeds improved.

Table 2. Hypothesis Test for the Paired Difference of the Average Travel and Running Speed

Paired differences		**No. of Samples**	**Southbound, AM Peak**	
(After – Before) (kph)			**t-stat : $t_{critical}$ α = 0.05**	**Decision**
Ave. travel speeds	**(16.43 – 11.67) 4.75**	45	8.629 : 1.684	Accept H_1 Reject H_0
Ave. running speeds	**(24.71 – 16.10) 8.60**	45	8.770 : 1.686	Accept H_1 Reject H_0
			Northbound, AM Peak	
Ave. travel speeds	**(23.03 – 18.09) 4.94**	45	2.740 : 1.699	Accept H_1 Reject H_0
Ave. running speeds	**(35.87 – 22.50) 13.37**	45	4.536 : 1.699	Accept H_1 Reject H_0

The average travel speeds before and after in the northbound direction during the morning peak period were 18.09kph and 23.03kph. While in the southbound direction, 11.67kph and 16.43kph were the obtained average travel speed for before and after, respectively. These would illustrate that the average travel speed along the northbound direction improved compared to the previous data gathered.

The average running speed before and after in the northbound direction during the morning period were 22.50kph and 35.87kph. While on the southbound direction, 16.10khp and 24.71kph were acquired before and after, respectively. These data indicate that the average running speed on both northbound and southbound directions improved showing that the scheme being implemented was a success.

3.3 Average Passenger-Kilometer Performance

This section discusses the number of passenger carried by the bus along the segment of Ayala to Aurora Blvd. and vice-versa. The difference of the before-and-after average passenger-kilometer performance of paired bus routes were tested along the significant segment of EDSA from the Ayala Avenue and EDSA intersection to Aurora Boulevard and EDSA intersection which are common for all bus routes passing EDSA.

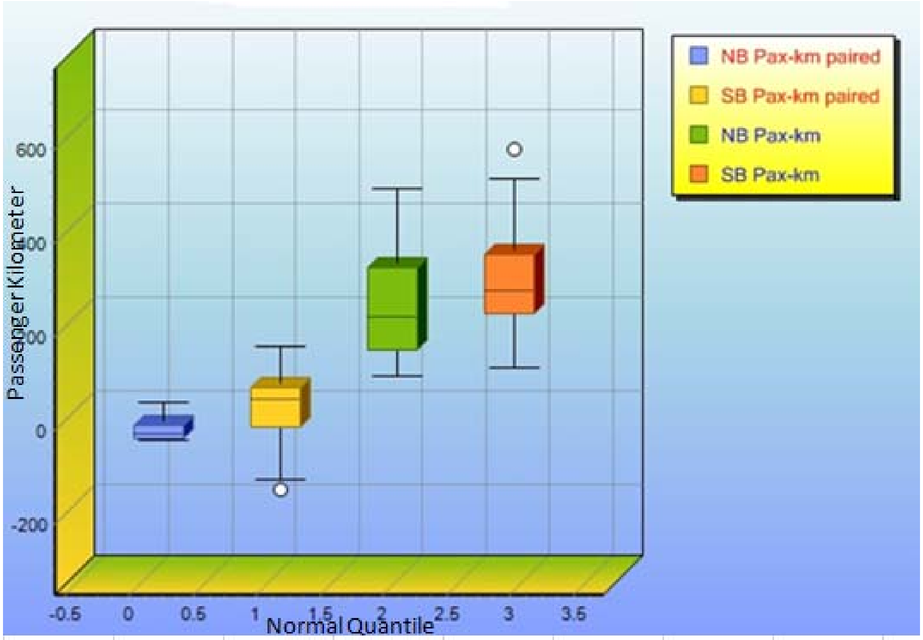

Figure 5. Boxplot of Recent and Paired Differences of Passenger-Kilometer of Buses in the Morning Peak Periods along Aurora Ave. to Ayala Ave. Segment of EDSA and v.v.

Figure 5 shows from left to right, the boxplots of the recent average passenger-kilometer in both directions, and before-and-after differences in the average passenger-kilometer in both directions of the morning peak along the Aurora Avenue to Ayala Avenue segment of EDSA. The second and last boxplots showed there are outliers, and hence the outliers were removed in the succeeding statistical tests.

The boxplot shows four data groups. These are the Northbound and Southbound Passenger-Kilometer for paired and unpaired. The paired Passenger-Kilometer, both for northbound and southbound directions represent negative skew, since it is not much spread out giving their mean lower than its median. However for the unpaired Passenger-Kilometer for Northbound and Southbound, it does give a higher value making it more spread out and giving a positive skew.

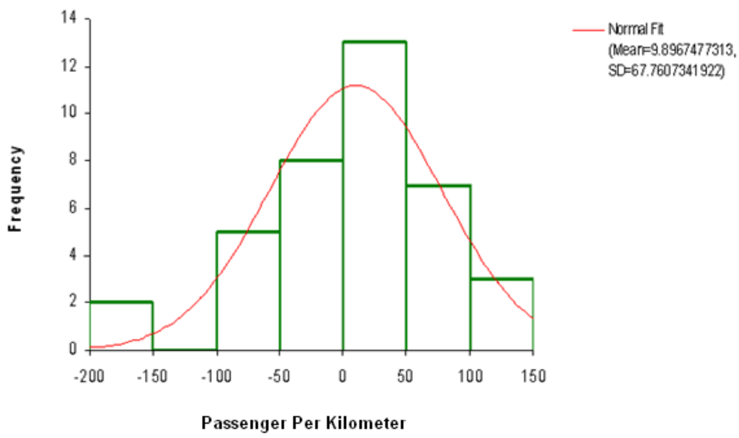

Figure 6. Histogram and Normal Curve of Paired Differences of Passenger- Kilometer of Buses for the Aurora Ave. to Ayala Ave. Segment of EDSA

The histogram (Figure 6) of the paired differences in average passenger-kilometer carried for the whole route in the morning peak shows normal spread of data.

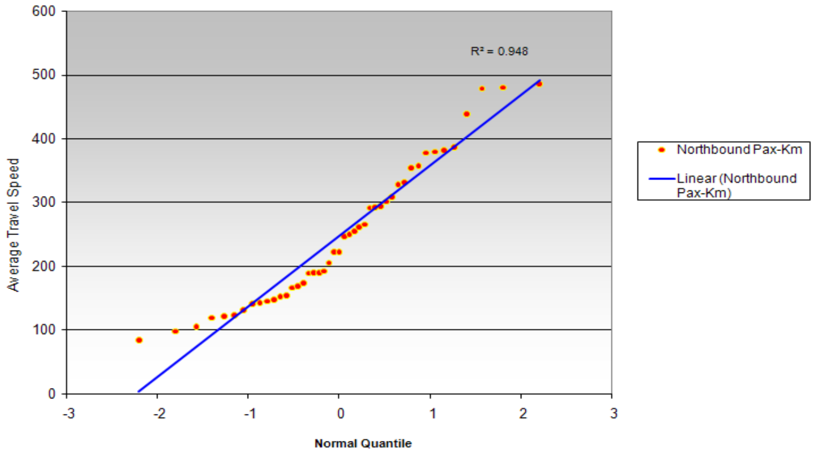

Figure 7. Normal Probability Plot of the Observed Paired Differences of the Average Pax-Km Carried by Buses for the Ayala Ave. to Aurora Ave. Segment of EDSA

The normal probability plot (in Figure 7) of the paired differences of the average passenger-kilometer carried in the morning peak period of northbound and southbound direction show some clustering along the straight line that is a good indication of normal data. The r^2 values are close to the $r_{critical}$ in Table 3, and therefore indicate normality. The explanation regarding the correlation of the linear trend line is similar to the analysis being examined by the group on the average travel and running speed. You will see that the plots adhere closely to the trend line proving that the trend lines for both southbound and northbound directions have a strong positive correlation.

Table 3. Hypothesis Test for the Paired Differences of the Average Pax-Km

Paired differences (After – Before)		**No. of Samples**	**t-stat:$t_{critical}$ α = 0.05**	**Decision**
			Ayala Ave. to Aurora Ave.	
Average Pax-Km	**(236.89 – 301.89) -65.00**	45	-23.804 : 1.682	Accept H_1 Reject H_0
			Aurora Ave. to Ayala Ave.	
Average Pax-Km	**(292.81 – 282.91) 9.90**	44	0.900 : 1.687	Accept H_0 Reject H_1

Using Statistical Analysis, the group was able to get the t-stat and the $t_{critical}$ using one tailed t-test of paired samples of means. The $t_{critical}$ represents the critical values in order to know if the t –stat value is within the region of rejection or acceptance. The group uses 5% level of significance. When t-stat value is within the positive and negative $t_{critical}$ value, then accept H_0 and reject H_1 as a decision. However, if t-stat value is out of range, H_1 will be accepted and H_0 will be rejected. Based on Table 3, the average passenger-kilometer for both southbound and northbound direction accepted H_1 as a decision because the tcritical < tstat. This only means that the average passenger-kilometer for both directions improved after the execution of OBR scheme along the road of EDSA. The H_1 was that Uafter = Ubefore and Ho was that Uafter > Ubefore. Where Uafter= average passenger kilometer of buses after the implementation of OBR and Ubefore= average passenger-kilometer of buses before the implementation of OBR. Since tstat for northbound and southbound were greater than its tcritical, it concludes average passenger-kilometer improved. The results showed improvement for the northbound direction whereas for the southbound direction, it did not improve.

3.4 Bus Journey Time Composition

The travel time of public utility vehicles is basically divided into three parts; running time, passenger related time, and traffic delay related time. Running time is the time consumed by buses while moving. Passenger related travel times are specifically that part consumed by embarking and disembarking passengers. Traffic delay related time is that time consumed due to traffic lights, obstruction of other vehicles and the like.

As the percentage composition of bus journey time would show in Table 4 below for both the south and northbound trips in the morning before and after the implementation of OBR MMDA scheme, the highest percentage of time was spent on moving time, then for traffic delay related effects, and lastly, for passenger related time. The actual average values of bus journey time composition is shown in the figure below. The figure below shows that in moving time, an increase in percentage took place for both northbound and southbound. However, for the time due to passenger and stop time/delay, it decreased. A good result was shown for the stop time/delay since it was lessen compared to the previous data. On the other hand, when it comes to the travel time due to passenger, the outcome showed that it is not very much useful for the passenger.

Comparing the actual average travel time of the before-and-after data, no improvement in journey time of buses was noted during the MMDA Scheme is already operational. In this case, there is a big improvement in terms of moving time and the time stop/delay. It is because most of the time of the buses was mostly spent on its travel. However on the time composition due to passenger, the buses spent less time. The reason may be due to the fact that buses in the morning peak period are concerned much on how to prevent heavy traffic flow.

Table 4. Bus Average Journey Time Composition (in %) during the Southbound and Northbound Peak Periods Before-and-after the MMDA Scheme Operation

Period	**Travel Time Composition In minutes (%)**			**Total min (%)**
	Moving min (%)	**Due to Passengers min (%)**	**Stop time/Delay min (%)**	
South_Before	81.91(67.97)	12.36(10.503)	28.13(21.530)	122.40(100)
South_After	69.79(85.42)	2.15(2.812)	9.91(11.771)	81.84(100)
North_Before	100.97(61.38)	13.35(8.308)	52.15(30.313)	166.47(100)
North_After	56.68(74.66)	3.03(3.994)	17.15(21.346)	76.86(100)

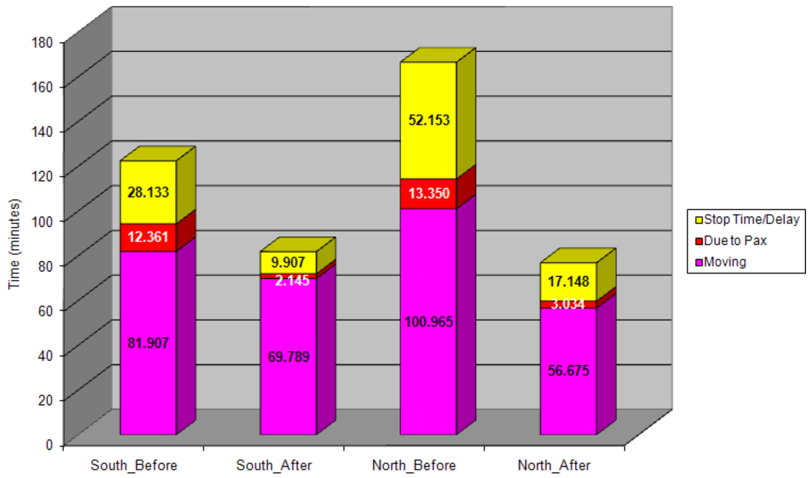

Figure 8. Bus Average Journey Time Composition (in percent) during the Southbound and Northbound Peak Periods Before-and-after the MMDA Scheme Operation

3.5 Bottlenecks along EDSA

There were some changes in the location of delays and dwell times of buses for the peak periods. It can be clearly shown here that after the MMDA has started its operation, there has been reduced delay in the said section. For the southbound morning peak period, before the MMDA Scheme operation, the major stop where bus dwell time was the longest is adjacent to the North Ave and EDSA intersection bus stop then followed by the Taft Ave. bus stop. However, when the MMDA Scheme was already in operation, bus dwell time was a bit longer near the Aurora intersections of EDSA, from 1.22 minutes before to 2.19 minutes after the MMDA Scheme operation. This may be due to the fact that the Aurora Blvd is the vantage point of all access routes going to QC to Manila and vice versa.

For the Northbound direction (Figure 10), bus dwell time and delay at the North Avenue, Taft Avenue, and Ortigas Ave Intersections of EDSA with average values of 8.52, 5.50, and 4.84 minutes respectively, were the highest three before the MMDA OBR scheme. As observed, the delay at both North Avenue and Taft Avenue intersections has something to do with the congested people that pile up since these points are recognized as terminal stations for provincial trips going to Cavite and Batangas for Taft Ave and going to Bulacan and Pangasinan for North Ave. Traditionally, the Shaw Boulevard bus stop is a major disembarking point for passengers coming from the Makati CBD area going to Pasig, Taguig, and Pateros areas but then was changed to Ortigas Ave. due to the fact that there more public buses going to those areas.

Comparing the travel time delay of both the northbound and southbound peak periods, more delay is experienced in the southbound morning peak period compared to the northbound morning peak period, whether this is before or after the MMDA Scheme operation.

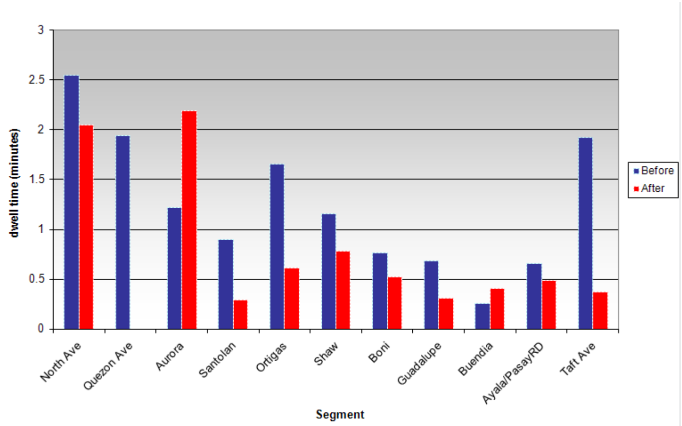

Figure 9. Time Delay at Major Intersections and Bus Stops along EDSA during the Southbound Morning Peak Period Before-and-after the MMDA Scheme

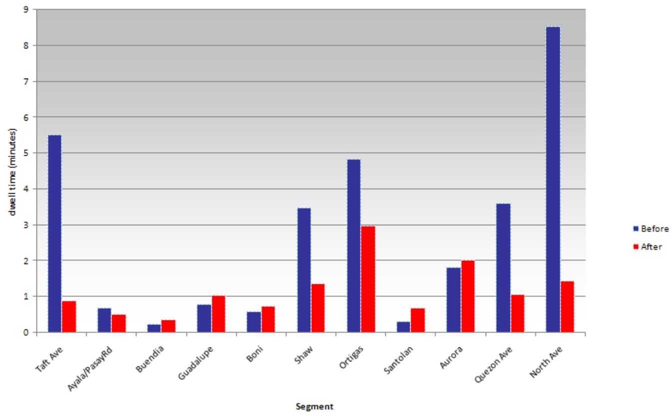

Figure 10. Time Delay at Major Intersections and Bus Stops along EDSA during Northbound Morning Peak Period Before-and-after the MMDA Scheme

3.6 Time – Distance Relationship

Time–distance analysis presents the relationship of time with respect to the distance being traversed. Time is in terms of minutes while distance is in terms of kilometers.

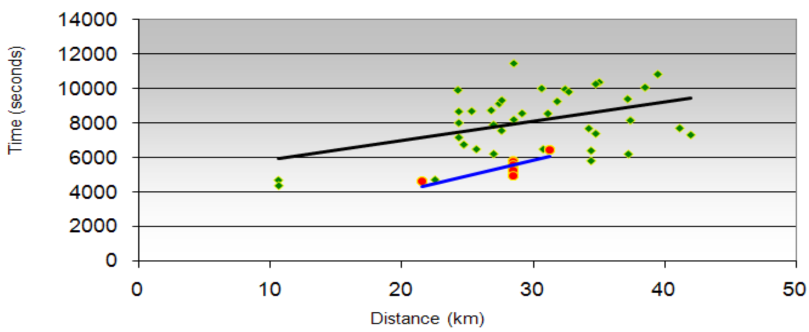

Figure 11. Before-and-After Time – Distance Chart of Aircon Bus on the Southbound direction

Figure 11 shows the relationship of distance and time of non-air conditioned and air conditioned buses on northbound and southbound directions and how the trend line of the current data is similar to the previous one. It describes that the shorter distance travelled, the shorter time it spent and the longer distance travelled, the longer time it spent denoting that the graphs are directly proportional with each other.

3.7 Bus Emission Estimates

Using the bus emission standards of Bangkok obtained from the Clean Development Mechanism (CDM) Project, 2003 for CO and NOx as shown in Figure 12 and 13, respectively. While also in this study, the estimated particulate matter (PM) from buses, regardless of speed is 0.135 g/km/ton. Hence, using the before and after results of the study, the estimated CO, NOx, and PM are provided in Table 5.

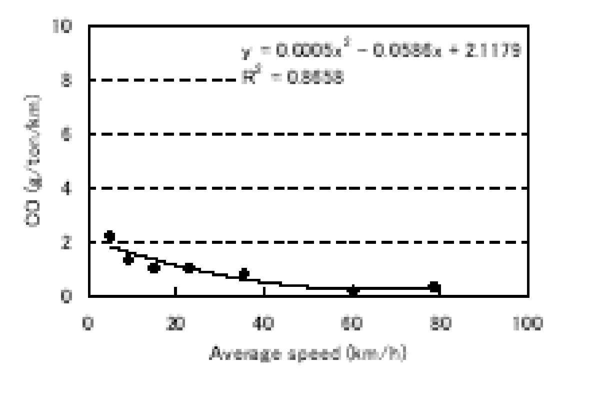

Figure 12. CO bus emission model

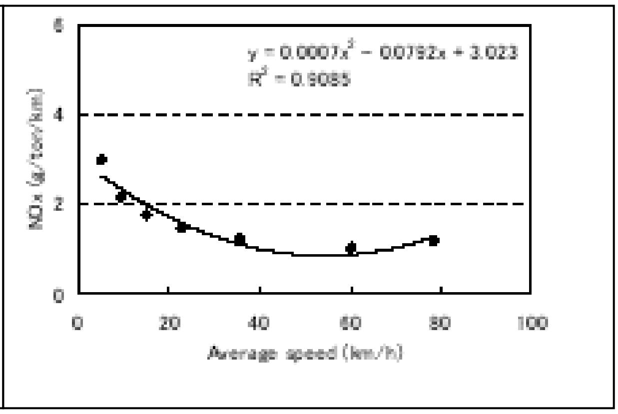

Figure 13. NOx bus emission model

Table 5. CO, NOx, and PM Emission Estimates Before and After OBR

	Northbound						
	Morning Peak-Hr Bus Volume (Ayala-Aurora EDSA Segment)	CO per bus (g)	Total CO (kg)	NOx per bus (g)	Total NOx (kg)	PM per bus (g)	Total PM (kg)
Before OBR	335	254.09	85.13	378.11	126.67	0.135	9.26
After OBR	496	215.99	107.13	327.64	162.51	0.135	13.71
	Southbound						
Before OBR	415	308.68	128.10	450.80	188.30	0.135	13.30
After OBR	481	264.33	127.14	391.47	187.08	0.135	11.47

The CO and NOx emission per bus during the morning peak hour are all high before the OBR project because of the lower average speed values of buses. Because of the increase in bus volume after the OBR study, the total CO and NOx emissions are higher in the northbound direction during the morning peak hour period while in the south bound direction these values are almost the same before and after OBR. The total PM of buses is quite low compared to the CO and NOx emissions in both directions before and after the OBR.

4. CONCLUSION

The Urban Transport Scheme, specifically termed as the Organize Bus Route Scheme, was initiated to lessen the traffic congestion along EDSA since it is the major commuting highway of Metro Manila. More cars and buses had made its way through EDSA making the traffic condition worst for the past decade.

To explain further, the MMDA Organized Bus Route Project Scheme has brought changes in bus service operations such as:

1. The average travel and running speed of city buses increased. The buses are now more efficient because they cannot drop off or pick up passengers when not on designated stops. Passengers can now rely on using buses for commuting because some of the factors that support this result are segregation of buses (Bus A, Bus B and Provincial Bus) and PUV Lane that is considered exclusive for Public Utility Buses.
2. Passenger-Kilometer has also decreased due to the fact that the dwell time and the travel time delay decreased after the new OBR Scheme was implemented.
3. The Buses' dwell time to pick up and drop off at major intersections for both northbound and southbound gradually decreased after Organized Bus Route Scheme was fully implemented. This is due to proper embarking and disembarking of passengers at designated bus stops and because of the limited time allowed to pick up and drop off passengers.

The study also estimated the morning peak hour CO, NOx, and PM emissions of buses along the Ayala Avenue to Aurora Boulevard segment of EDSA in both directions. These emissions per bus are generally higher before the OBR compared to the levels with the OBR in place because of the improved bus average travel speeds with the OBR in place.

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