EFFECT OF MRT 3 OPERATION ON BUS SERVICE ALONG EPIFANIO DE LOS SANTOS AVENUE (EDSA), METRO MANILA

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Abstract: Buses plying the EDSA route were tested for changes in their service operating characteristics after the introduction of the mass rail transit (MRT 3) system. Using paired samples and applying hypothesis testing, there are some indications that the average passenger-kilometer carried by buses has changed during the afternoon peak period while this is not true for the morning peak period. The average travel and running speeds of buses also improved during the morning peak period in the southbound direction. Buses were able to withstand the competition through the introduction of more non-airconditioned buses and by improving service through reduced number and time duration of stops.

Key Words: Bus transit, Mass rail transit, Public transport system, Hypothesis test, Paired samples test

1. INTRODUCTION

Before MRT 3 introduced its service along EDSA, city buses were the dominant provider of public transport along this major highway. Predictions and opinions abound regarding buses not being able to withstand the competition brought about by MRT 3 in providing service to commuters along EDSA. However, after almost two years since the MRT 3 came into full service beginning July 17, 2000, buses are still fully present along EDSA. This study compared some of the important operating and service characteristics of buses such as its average travel and running speeds, average passenger-kilometer carried, bus journey time composition, and bus delay along important locations along EDSA. Volume of buses during both the morning and afternoon peak periods were also noted.

Bus service operations that traverse EDSA were surveyed using the conventional method of onboard bus passenger survey before-and-after the MRT 3 introduced its service. Data on buses before the MRT 3 operation were gathered from the period January 1998 to June 2000 while data on buses after MRT 3 introduced its service were gathered immediately after the opening of the whole stretch of the latter from July 17, 2000 to February 2002. Relevant data gathered include the number of alighting and boarding passengers, moving and stop times and causes of delays. Data were then processed to obtain average travel and running speeds, bus journey time composition due to traffic delays, passenger stops, and moving time as well as average passenger-kilometer performance of buses.

Paired samples of bus variables were used and hypothesis testing was the primary method used to determine whether changes in the service performance and operation of buses have changed after the introduction of MRT 3 along EDSA. Paired sample test was used to eliminate bus enter-route variations.

2. METHODOLOGY

The critical direction of travel along EDSA in the morning is going towards South and for the afternoon is towards North. Critical in the sense that majority of commuters are coming from the North towards South in the morning and from the CBD areas in the reverse direction in the afternoon. Hence, bus and MRT 3 movement on these two directions were the primary focus of the study.

By doing an onboard bus survey from the origin of the bus service line up to its end, several important variables regarding bus service and operational characteristics were obtained, such as the average travel and running speeds, dwell time at stops and intersections, average passenger-kilometer performance and journey time composition. Paired samples of these important variables were compared before-and-after the MRT 3 became operational since the MRT 3 is perceived to have greatly affected the service operation of buses along EDSA in terms of reduced passengers carried by the latter, meaning there is a significant mode shift by commuters from the bus to MRT 3.

Volume studies were also conducted at important locations along EDSA to determine if there were changes in bus volumes operating especially during the peak hour period.

Hypothesis testing of paired samples, i.e. those data before the MRT introduced its service along EDSA, and those data of buses with the presence of MRT service, was the main method of determining whether changes in bus service characteristics are statistically significant. Paired sample tests were done on such variables as average travel and running speeds, and average passenger-kilometers carried. The samples were paired in terms of route being serviced in order to remove the inter-route variations of bus variables. For bus routes with several samples, random pairing was done. Please see Tables A.1 to A.20 in the Appendix for the data.

For paired sample test, the following issues have to be 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 can be observed through a graphical presentation of data such as the use of a boxplot that show the range, median and upper and lower quartiles of data. Another one is the histogram, which show the spread of data whether it follows a bell-shaped distribution. The normal probability plot is another reliable method where the residuals are 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* is computed as

$$z\left(\frac{i-.375}{n+0.25}\right) \qquad \text{Eq. 1}$$

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 was compared to the critical *r* values developed by Looney, et al (1985).

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

$$H_0: \mu_1 - \mu_2 = 0 \quad \text{Eq. 2}$$

$$H_1: \mu_1 - \mu_2 \neq 0 \quad \text{Eq. 3}$$

where μ_1 = the mean of bus variable (travel speed, running speed, and passenger-kilometer carried) after the MRT 3 operation, and
μ_2 = the mean of the bus variable (travel speed, running speed, and passenger-kilometer carried) before the MRT 3 operation.

The test statistic is $|t| = \dfrac{\bar{d} - 0}{s_d - \sqrt{n}}$, where $\bar{d}$ 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 is $|t| < t_{a/2}$ (critical). Also, when the confidence interval of the paired differences includes the value zero, we have to accept the null hypothesis, H_0.

3. PUBLIC TRANSPORT ALONG EDSA

EDSA is the main thoroughfare that spans the North to South direction of Metro Manila. It has 5-lane roads in each direction. Before MRT 3 came into service along EDSA, city buses dominated this important highway. Jeepneys operate only in some segments or just traverse the avenue. Newly introduced vehicles for hire that operate like a paratransit, such as the megataxis, provide service intermittently and are usually present during the peak periods. Figure 1 shows that several bus service lines operating in Metro Manila converge along EDSA. The newly operational MRT 3 line, whose 13 stations are encircled red in Figure 1, is now sharing with the buses the provision of mass transport service along this stretch of EDSA.

MRT 3 poses as a major threat to the viability of operating city buses along EDSA especially with its reduced fare that is currently in effect. The MRT 3 fare starts from P9.50 pesos and increases by 50 centavos for every station thereafter with the end station costing 15 pesos (Table 2). For the airconditioned buses, the current fare is nine (9) pesos for the first 5 kilometers and increases by one peso for every kilometer thereafter. On the other hand, the fare of the non-airconditioned buses starts at four (4) pesos for the first five kilometers and increases by 0.50 centavos for every kilometer thereafter.

After around one and a half years with MRT 3 in operation, buses providing service along EDSA seemed to hold on to their own share of passengers. This study investigates this perception further.

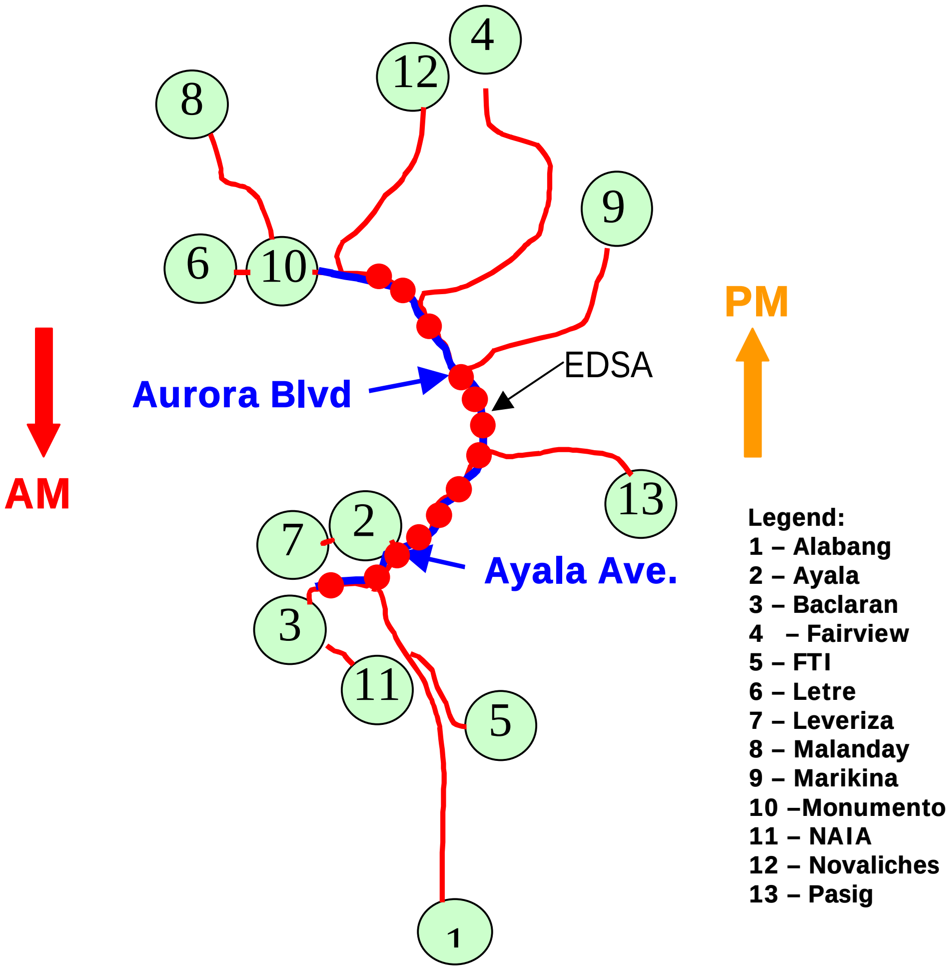


Figure 1. MRT and Bus Service Routes Traversing EDSA

4. 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 MRT 3 operation 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.

4.1 Bus Volume Study

From the Metro Manila Urban Transport Integration Study (MMUTIS, 1998), the morning peak period occur from 6:00 AM to 9:00 AM while the afternoon peak period occur from 4:00 PM to 7:00 PM. As expected, the peak hour volume of buses for both morning and afternoon occur around these peak periods as shown in Table 1.

As can be seen in Table 1, there was a somewhat significant increase in the percentage of non-airconditioned buses operating during the peak hour after the MRT 3 implementation for both directions and peak periods. In the southbound direction during the morning peak hour, the average increase in the percentage of non-airconditioned buses was from 41.51 % to 52.50 % or a 10.99% increase while in the northbound direction during the afternoon peak hour, it was from 36.86% to 53.55% or a 16.69% increase. For some commuters, for as long as travel time is tolerable, even though the degree of comfort offered by non-airconditioned buses is less compared to airconditioned buses or the MRT 3, the non-airconditioned buses is the mode of choice.

Table 1. Comparison of Bus Volume Before-and-after the MRT 3 Operation

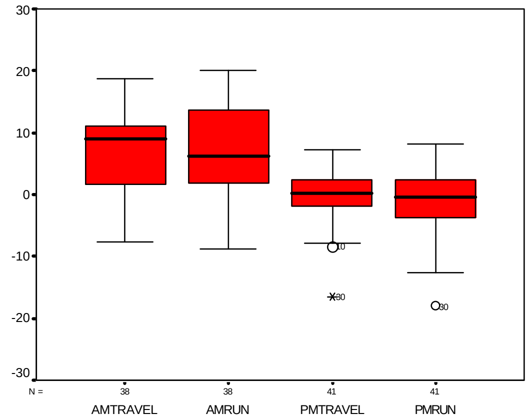
Date	Location Along EDSA	Peak Hour Period (hrs)	Before		
			Aircon No. (%)	Non-aircon No. (%)	Total No. (%)
Southbound (Before)					
Nov. 12, 1998	Boni Ave.	8:00-9:00	318 (71.14)	129(28.86)	447(100.00)
Feb. 18, 1999	North Ave.	6:30-7:30	204(60.90)	131(39.10)	335(100.00)
Mar. 2, 1999	Malibay	7:00-8:00	94(63.51)	54(36.49)	148(100.00)
Nov. 12, 1999	Boni Ave.	6:30-7:30	226(50.33)	223(49.67)	449(100.00)
Jan. 14, 2000	Guadalupe	6:30-7:30	217(46.57)	249(53.43)	466(100.00)
Average (%)			58.49	41.51	100.00
Northbound (Before)					
Nov. 13, 1998	Boni Ave.	17:30-18:30	255(69.29)	113(30.71)	368(100.00)
Feb. 16, 1999	Malibay	17:00-18:00	79(59.85)	53(40.15)	132(100.00)
Feb. 18, 1999	North Ave.	16:45-17:45	165(63.46)	95(36.54)	260(100.00)
Nov. 12, 1999	Boni Ave.	16:30-17:30	247(62.22)	150(37.78)	397(100.00)
Jan. 14, 2000	Guadalupe	16:45-17:45	218(60.89)	140(39.11)	358(100.00)
Average (%)			63.14	36.86	100.00
Southbound (After)					
Aug. 11, 2000	North Ave.	6:30-7:30	149(53.60)	129(46.40)	278(100.00)
Oct. 9, 2001	Magallanes	6:45-7:45	187(52.82)	167(47.18)	354(100.00)
Oct. 23, 2001	Guadalupe	6:00-7:00	159 (36.72)	274 (63.28)	433 (100.00)
Mar. 12, 2002	Guadalupe	7:00-8:00	215(46.84)	244(53.16)	459(100.00)
Average (%)			47.50	52.50	100.00
Northbound (After)					
Aug. 11, 2000	North Ave.	17:30-18:30	129 (52.87)	115 (47.13)	244 (100.00)
Mar. 20, 2001	Malibay	17:15-18:15	77(50.99)	74(49.01)	151(100.00)
Mar. 22, 2001	Boni Ave.	16:45-17:45	211(49.41)	216(50.59)	427(100.00)
Mar. 27, 2001	North Ave.	17:45-18:45	119(45.25)	144(54.75)	263(100.00)
Oct. 4, 2001	Magallanes	17:00-18:00	88(36.07)	156(63.93)	244(100.00)
Oct. 5, 2001	Guadalupe	17:00-18:00	148(44.18)	187(55.82)	335(100.00)
Mar. 12, 2002	Guadalupe	17:45-18:45	198(46.37)	229(53.63)	427(100.00)
Average (%)			46.45	53.55	100.00

4.2 Average Travel and Running Speeds

Average travel and running speeds can provide some measure of bus service performance along the route. The average travel speed, which is simply the distance traveled 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 dropping off or picking up passengers.

The average running speed is simply the distance travel divided by the running time of the bus. Hence, stop times are not included in the computation of the average running speed. This speed can provided 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 must come from a normal population. To test this assumption, several graphical and statistical tests were performed. The graphical presentations of data include the boxplot and the normal histogram. Figure 2 shows the boxplot of differences of paired data for average travel and running speeds for both morning and afternoon peak periods. As the boxplot would show, outliers were identified in both the afternoon average travel and running speeds. These outliers were removed and not included in the succeeding statistical tests.



Legend:
AMTRAVEL – Morning peak paired differences of average travel speed (Ayala Ave. to Aurora Ave.)
AMRUN – Morning peak paired differences of average running speed (Ayala Ave. to Aurora Ave.)
PMTRAVEL – Afternoon peak paired differences of average travel speed (Aurora Ave. to Ayala Ave.)
PMRUN – Afternoon peak paired differences of average running speed (Aurora Ave. to Ayala Ave.)

Figure 2. Boxplot of Average Travel and Running Speeds of Buses in the Morning and Afternoon Peak Periods Along the Aurora Ave. to Ayala Ave. Segment of EDSA

A sample of the normal histogram of the differences of the paired data for the average running speed of the afternoon peak period is shown in Figure 3. The obtained histogram of the differences of the paired average travel speeds for both morning and afternoon periods are basically flatter than normal, while that of the average running speeds in both periods are near normal.

Another test of normality is the normal probability plot. The test of normality compares the *r** 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* as introduced by Looney et al (1985). In Table 2, since the *r** values of the differences of paired data are higher than the $r_{critical}$, these are proof of data normality.

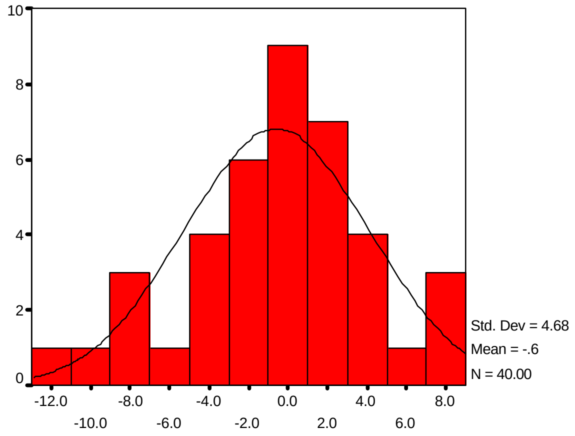


Figure 3. Histogram and Estimated Normal Curve of Paired Differences of the Average Running Speed of Buses for the Aurora Ave to Ayala Ave. Segment of EDSA during the Afternoon Peak Period

Table 2. Correlation Coefficient, *r*, Test for Normality of Data

Paired differences (After – Before)	No. of Samples	Southbound, AM Peak	
		r^*	$r_{critical}$
1. Average travel speeds	38	0.9770	0.970
2. Average running speeds	38	0.9703	0.970
		Northbound, PM Peak	
1. Average travel speeds	39	0.9740	0.971
2. Average running speeds	40	0.9794	0.972

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

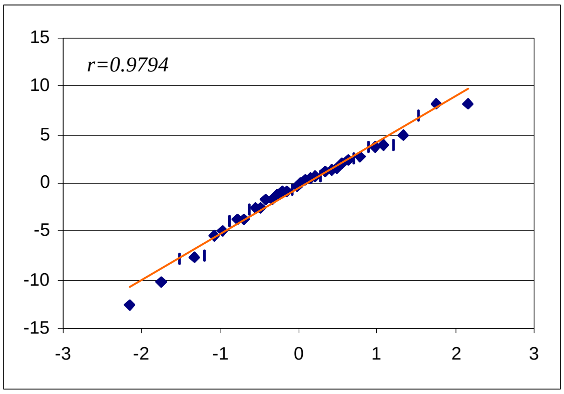


Figure 4. Normal Probability Plot of Observed Paired Differences of the Average Running Speeds of Buses for the Ayala Ave. to Aurora Ave. Segment of EDSA during the Afternoon Peak Period

Applying now the hypothesis test on the before-and-after paired differences of the average travel and running speeds for both the morning and afternoon peak periods along the common segment from Aurora Ave. to Ayala Ave. for morning peak and the reverse direction of Ayala Ave. to Aurora Ave. segment of EDSA for the afternoon peak, the results (with 95% level of confidence) are given in Table 3. We can therefore state that

1. For the morning peak period, there is enough evidence to prove that both the average travel and running speeds of southbound morning peak period have changed since the confidence interval does not include the zero value and the *t*-values are higher than the $t_{critical}$ values. The average travel and running speeds improved by around 7.186 kph and 7.218 kph, respectively, after the introduction of MRT 3 service during the morning peak period.
2. However, for the northbound afternoon peak period, there is not enough evidence to prove that both the average travel and running speeds of buses have changed. This is so since the confidence interval includes the value zero and the t-values are lower than the $t_{critical}$ values.

Table 3. t-Test Results of the Paired Differences of the Average Travel and Running Speeds Before-and-after the MRT 3 Operation

Paired Differences (After – Before)	No. of Samples	Mean	95% Confidence interval		t-value:$t_{critical}$ $\alpha = .05$
			Lower	Upper	
AM Peak					
Ave. travel speed	38	7.186	4.970	9.403	6.569 : 2.025
Ave. running speed	38	7.218	4.728	9.709	5.873 : 2.025
PM Peak					
Ave. travel speed	39	0.465	-.724	1.655	0.792 : 2.023
Ave. running speed	40	-0.587	-2.085	0.911	-0.793 : -2.021

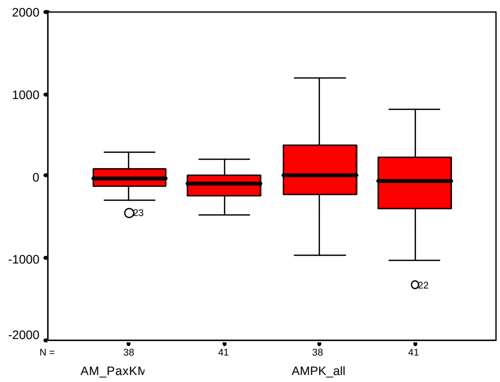
4.3 Average Passenger-Kilometer Performance

The passenger-kilometer performance of the buses was obtained from an 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 were tested in two parts: (1) 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 (points A and B, respectively, in Figure 1), and (2) along the whole stretch of the bus routes. For the second case, to eliminate inter-route variation, paired samples were made by route. If there were several samples in a certain route, these were randomly paired.

Figure 5 shows, from left to right, the boxplots of the before-and-after differences in the average passenger-kilometer of the morning peak along the Aurora Avenue to Ayala Avenue segment of EDSA, then that of the afternoon peak in the reverse direction. Next is the before-and-after paired difference of the average passenger-kilometer of the morning peak for the whole route and lastly, that for the afternoon peak for the whole route. The first and last boxplots showed an outlier, and hence the outliers were removed in the succeeding statistical tests.

As an example, the histogram (Figure 6) of the paired differences in average passenger-kilometer carried for the whole route in the afternoon peak shows normal spread of data.

A sample of the normal probability plot (Figure 7) of the paired differences of the average passenger-kilometer carried in the afternoon peak period shows some clustering along the straight line that is a good indication of normal data. The r^* are all higher than the $r_{critical}$ in Table 4, and therefore indicates normality.



Legend:
AM_PaxKm – Morning peak paired differences of average passenger-kilometer carried (Ayala Ave. to Aurora Ave.)
PM_PaxKm – Afternoon peak paired differences of average passenger-kilometer carried (Aurora Ave. to Ayala Ave.)
AMPK_all – Morning peak paired differences of average passenger-kilometer carried (for whole route)
PMPK_all – Afternoon peak paired differences of average passenger-kilometer carried (for whole route)

Figure 5. Boxplot of AM and PM Average Pax-Km Paired Differences

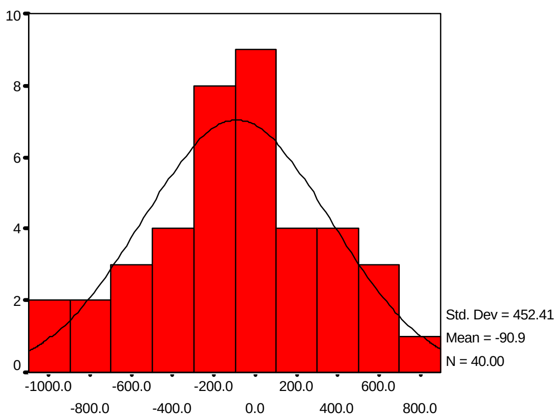


Figure 6. Histogram of Paired Differences of Average Passenger-Kilometer for the Whole Bus Route during the Afternoon Peak Period

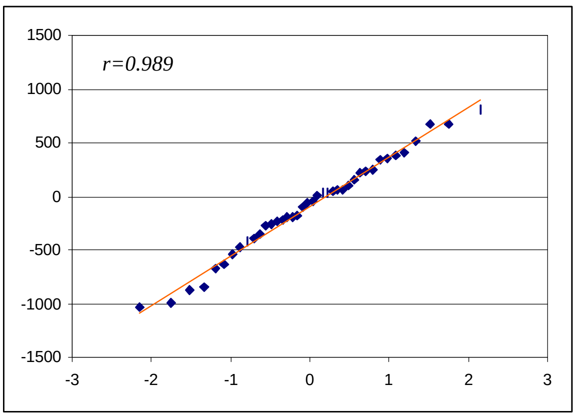


Figure 7. Normal Probability Plot of the observed paired differences of the Average Pax-km Carried by Buses for the Whole Route (PM Peak)

Table 4. Correlation Coefficient, *r*, Test for Normality of Data

Paired differences (After – Before)	No. of Samples	*r**	$r_{critical}$
		Ayala Ave. to Aurora Ave. (v.v.)	
1. Average Pax-Km (AM)	37	0.9867	0.970
2. Average Pax-Km (PM)	41	0.9784	0.973
		Whole Route	
1. Average Pax-Km (AM)	38	0.9828	0.970
2. Average Pax-Km (PM)	40	0.9890	0.972

Table 5. t-Test Results of Paired Differences of Average Passenger-Kilometer Performance of Buses Along the Common Segment of EDSA

Peak Period	No. of Samples	Paired Differences of Pax-Km (After - Before)			t-value: $t_{critical}$ Decision! (α = .05)
		Mean	95% Confidence interval		
			Lower	Upper	
Morning	37	-10.008	-60.578	40.562	-0.401 : - 2.027 Accept H_0!
Afternoon	41	-108.437	-163.736	-53.138	-3.963 : - 2.020 Reject H_0!

Table 6. t-Test Results of Paired Differences of Average Passenger-Kilometer Performance of Buses for the Whole Route

Peak Period	No. of Samples	Paired Differences of Pax-Km (After - Before)			t-value: $t_{critical}$ Decision! (α = .05)
		Mean	95% Confidence interval of the difference		
			Lower	Upper	
Morning	38	53.706	-96.370	203.783	0.725 : 2.025 Accept H_0!
Afternoon	40	-90.916	-235.602	53.771	-1.271 : - 2.021 Accept H_0!

As the two-tailed hypothesis test (applying Eqs. 2 and 3) would show in Tables 5 and 6, the following findings can be deduced

1. There is some evidence to suggest that the average passenger-kilometer carried by buses have changed along the Ayala Avenue to Aurora Avenue segment of EDSA during the afternoon peak period since the confidence interval of the paired differences does not include the zero value. This can also be proven by the fact that the two-tailed $|t|$-value = |-3.963| (absolute) is greater than the $|t|_{critical}$ = |-2.020|. The negative mean value of 108.437 pax-km meant a reduction in the mean number of pax-km carried by buses after the MRT 3 service. Knowing the length of the Ayala Ave. to Aurora Ave. segment of EDSA to be around 8.56 km means that on the average, a reduction of 12.67 passengers per bus occurred.
2. However, for the morning peak period along the segment of Aurora Avenue to Ayala Avenue of EDSA and for the whole route in both the morning and

afternoon peak periods, there is not enough evidence to suggest that the average passenger-kilometer carried by buses have not changed since the confidence interval includes the value zero. The $|t|$-values are also lower than the $|t|_{critical}$ values.

It should be noted that the negative signs of the t- or $t_{critical}$ values simply refer to the left side of the curve for the two-tailed t-test.

4.4 Bus Journey Time Composition

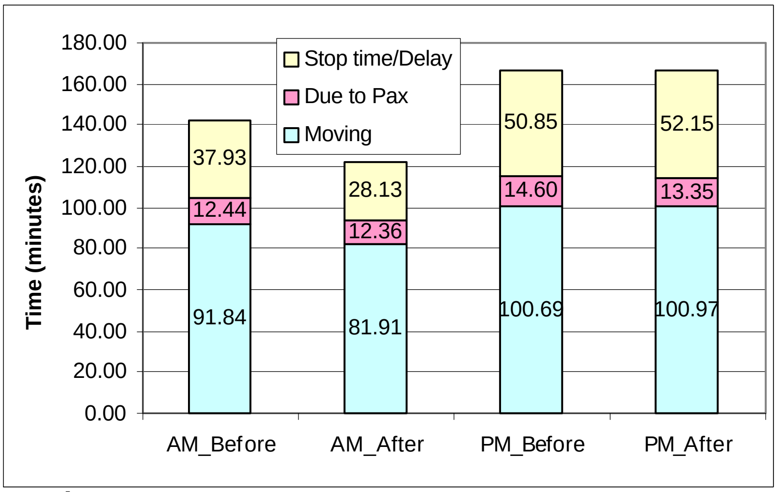
The travel time of public utility vehicles is basically divided into three parts; running time, passenger related time, and traffic delay related time. Running time is the time consumed by buses while moving. Passenger related travel times are specifically that part consumed by embarking and disembarking 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 7 for both the morning and afternoon peak periods before-and-after the MRT 3 operation, the highest percentage of time was spent on traffic delay related effects, then for running time, and lastly, for passenger related time. The actual average values of bus journey time composition is shown in Figure 8. Figure 8 would also show that the morning peak period of travel along this stretch of EDSA is on the average lower than the afternoon peak period of travel.

Comparing the actual average travel time of the before-and-after data, improvement in journey time of buses was noted only during the morning peak period when the MRT is already operational. No discernible improvement occurred during the afternoon peak period. The reason may be due to the fact that in the morning peak period, buses coming from the peripheries are already full of passengers going directly to the CBD areas and they need not stop for so long to wait for and pick up passengers but only to occasionally drop-off passengers. In the afternoon peak period, due to the fact that there are a lot of big shopping malls along this stretch of EDSA, commuters tend to pass by these malls before going home. Since the end destinations of most commuters are way beyond the end station of the MRT 3 but are usually serviced by buses, most commuters choose the bus when going home instead of using the MRT 3 first then changing to bus or jeepney mode at the end station. Although considerable time can be saved when using the MRT 3, there are other factors, which favor the bus mode in this case. One is the considerable effort needed to change modes because of the long flights of stairs and long walks to the waiting line of buses and jeepneys. Another factor is the need to compete with other passengers for jeepney or bus space, usually filled up at these locations and times.

Table 7. Bus Average Journey Time Composition (in percent) during the Morning and Afternoon Peak Periods Before-and-after the MRT 3 Operation

Period	Travel Time Composition (%)			Total
	Moving	Due to Passengers	Stop time/Delay	
AM_Before	64.93	8.99	26.09	100.00
AM_After	67.97	10.50	21.53	100.00
PM_Before	60.83	9.00	30.17	100.00
PM_After	61.38	8.31	30.31	100.00



Legend:
AM_Before – morning peak before MRT 3 **PM_Before** – afternoon peak before MRT 3
AM_After – morning peak after MRT 3 **PM_After** – afternoon peak after MRT 3

Figure 8. Bus Average Journey Time Composition during Morning and Afternoon Peak Periods Before-and-after the MRT 3 Operation

4.5 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 MRT 3 has started its operation, there has been reduced delay in the said section. For the southbound morning peak period, before the MRT 3 operation, the major stops where bus dwell time was the longest is adjacent to the Shaw Boulevard and EDSA intersection bus stop (Figure 9), then followed by the Aurora Blvd. bus stop. However, when the MRT 3 was already in operation, bus dwell time was a bit longer near the North Avenue intersections of EDSA, from 1.93 minutes before to 2.43 minutes after the MRT 3 operation. This may be due to commuting passengers changing modes from buses to MRT 3. On the average, total bus delay on these important intersections/bus stops reduced by around 6.25 minutes, from 17.15 minutes before to 10.90 minutes, after the MRT 3 operation.

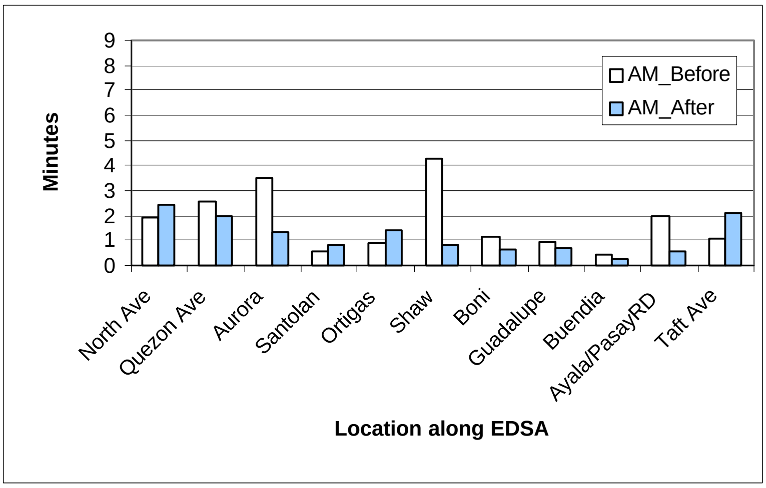


Figure 9. Time Delay at Major Intersections and Bus Stops Along EDSA during the Southbound Morning Peak Period Before-and-after the MRT 3

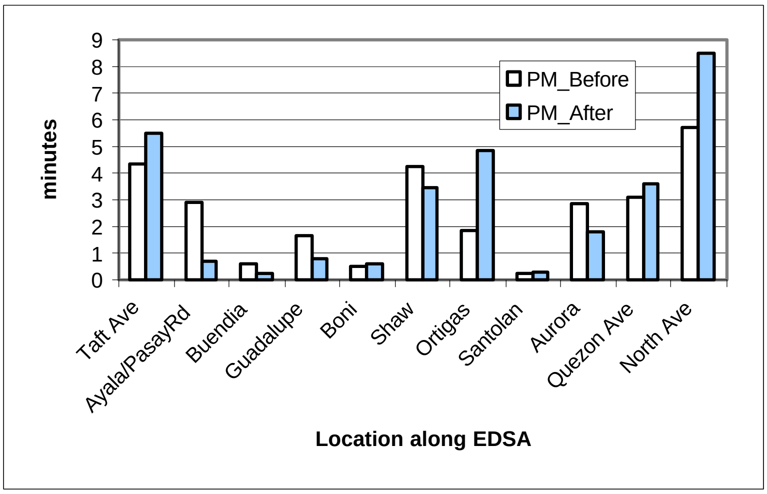


Figure 10. Time Delay at Major Intersections and Bus Stops Along EDSA during the Northbound Afternoon Peak Period Before-and-after the MRT 3

For the Northbound direction (Figure 10), bus dwell time and delay at the North Avenue, Taft Avenue, and Shaw Boulevard Intersections of EDSA with average values of 5.96, 4.33, and 4.23 minutes respectively, were the highest three before the MRT operation. As observed, the delay at both North Avenue and Taft Avenue intersections has something to do with the ongoing construction of the MRT 3 structures then, and also of passenger embarking and disembarking at the SM Megamall North EDSA for the former. 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.

Comparing the travel time delay of both the morning and afternoon peak periods, more delay is experienced in the afternoon peak period compared to the morning peak period, whether this is before or after the MRT 3 operation.

5. CONCLUSION

The operation of the MRT 3 system along EDSA has brought some changes in the bus public transportation system of Metro Manila especially along EDSA. These are

1. Public utility buses seemed to be able to hold their ground in terms of the volume of passengers being carried especially along the whole route in both the morning and afternoon peak periods. However, along the Ayala Ave. to Aurora Ave. segment of EDSA, there is some evidence of reduction in the average passenger-kilometer being carried during the afternoon peak period.
2. The competition with MRT 3 has brought some changes in bus service operations such as
    - buses are now reducing the number of stops that they make along EDSA, thereby significant reduction in delay is realized and as proof are the improved average travel and running speeds especially during the morning peak period, and
    - the increase in the number of non-airconditioned buses to reduce fare to make it more cheaper and affordable compared to MRT 3 and on the part of the operators, would also mean reduced operating costs.

3. Choke points along EDSA have shifted to locations such as the Taft Avenue-EDSA and North Ave.-EDSA intersections that are mainly due to mode changing by commuters so that public transports such as buses and jeepneys converge near the MRT 3 terminal to cater to these commuters.

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