APPLICABILITY OF THE BUS RAPID TRANSIT SYSTEM ALONG EPIFANIO DELOS SANTOS AVENUE

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Abstract

Epifanio delos Santos Avenue (EDSA), the 24-kilometer long prime artery of Metro Manila experiences heavy traffic daily. According to recent studies, 50% excess buses add drastically to the growing number of vehicles passing through EDSA. One way to decongest traffic is to cut through the volume of buses. A Bus Rapid Transit (BRT) system can be more effective in improving the service operation of buses rather than implementing more city bus operations. The study presents a proposed BRT system in EDSA. The study evaluates the transportation impact of the BRT system on commuter movement and urban travel, and assesses the environmental benefits of the proposed BRT system. Data used in this study were obtained through vehicle counting, onboard surveying of bus, cars, taxi and MRT and 1996 MMUTIS study. These were calibrated using the software EMME3 to build a traffic demand forecast model considering four scenarios: without BRT on the base year; without BRT on the design years; with BRT and with city buses traversing along EDSA; and with BRT but without the city buses traversing along EDSA on the design years 2016 and 2021. Based on the findings, implementation of the proposed BRT system in EDSA yields time savings, operating cost savings and environmental benefits such as lesser carbon dioxide emission.

Keywords: BRT, EDSA, EMME3

1. Introduction

1.1 Background of the Study

Despite the opening of the MRT in 1999, the implementation of the “yellow bus lane” in 2003, and the re-imposition of the number coding scheme recently, Epifanio delos Santos Avenue (EDSA), the 24-kilometer long prime artery of Metro Manila still experiences heavy traffic daily. The sheer size and volume of Public Utility Buses adds drastically to the growing number of vehicles passing through EDSA which causes traffic congestion. The EDSA Bus Route Revalidation Survey (2006) that was funded by Japan International Cooperation Agency (JICA) states that the carrying capacity of EDSA on a daily basis is 1600 buses, whereas, more than 3800 buses are plying EDSA daily. This study presents a proposed Bus Rapid Transit (BRT) system in EDSA. By doing so, the buses travelling along EDSA would be more systematic in their dedicated lanes and would contribute in decongesting EDSA.

1.2 Objectives of the Study

The main objective of this study is to assess the effectiveness of a Bus Rapid Transit system along Epifanio delos Santos Avenue. Specifically, the study aims to:

i. determine the transportation impact of the BRT system along EDSA on urban travel in the whole of Metro Manila, and
ii. assess the environmental benefits of the proposed BRT system in Metro Manila

2. Literature Review

The study of Fukuda, Fillone, Ishizaka and Ikeshita (2010) presented the positive impacts of BRT that can help in promoting the BRT system in Metro Manila. The BRT can produce high level of service at low cost, less boarding time, equal opportunity to access, reduction of traffic accidents, reduction in some pollutants, efficiency and customer satisfaction. The two pilot project routes are C5 (SLEX-Commonwealth Ave) and EDSA-Binangonan routes. Although the study focuses on the C5 route, it can help the study of BRT in EDSA since the methodology is adapted. The study presented the demand forecasting model based on MMUTIS and micro simulation model which was developed to estimate the impact of BRT introduction on Circumferential Road 5 (C-5) ring road in Metro Manila. Based on estimated demand, benefit from reduction of CO2, NOx, CO, PM were estimated as well as benefit from reduction of total travel time, total operating cost and damage cost by traffic accident. It presented the estimate total cost of P55 Billion. Overall, it demonstrated the applicability of the IGES Co-benefit guideline for a proposed transportation project in Manila.

3. Methodology

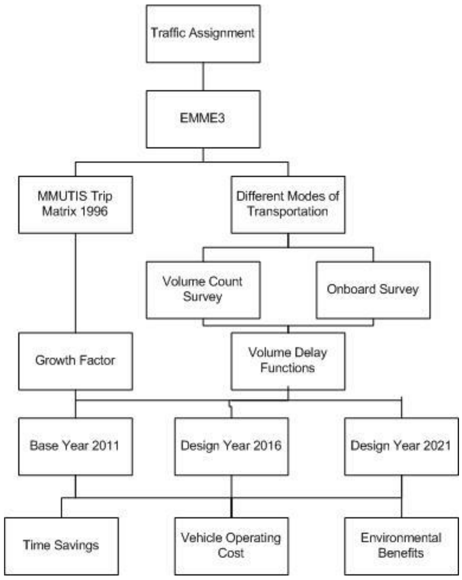

Fig. 1 – Summary of Procedures

Figure 1 shows the summary of procedures of the research. A person trip matrix was obtained from the 1996 MMUTIS. The next step was to identify the different modes of transportation that traverses EDSA. Then, a volume count survey was conducted in order to measure the number of vehicles that traverses EDSA segregated into vehicle types. An onboard survey was also conducted to assess the travel time, speed and number of passengers. Aside from that, volume delay functions were obtained using the BPR method. This would be important for the traffic assignment procedure. Using the software EMME3, the data obtained were calibrated using the developed equations.

Under the trip assignment modeling seven scenarios were developed such as: without BRT system in the present year, without BRT in the year 2016, with BRT and with city buses in the year 2016, with BRT but without city buses in the year 2016, without BRT in the year 2021, with BRT and with city buses in the year 2021 and with BRT but without city buses in the year 2021. The trip assignment also included the design of the whole BRT system along EDSA (eg. Lane of the BRT, bus stations, etc.). All seven scenario results were compared measuring its different characteristics such as travel time savings, vehicle operating cost and environmental benefits.

4. Results

In order to compare the present condition of EDSA with the future scenario considering the proposed BRT system, data were collected, calibrated to the present condition, projected to the design years and analyzed using the software EMME3.

The whole study area which is Metro Manila is divided into zones. Using the software EMME3, the transport network of Metro Manila were developed and is composed of 211 zones, 4044 nodes and 11162 links as shown in Figure 2.

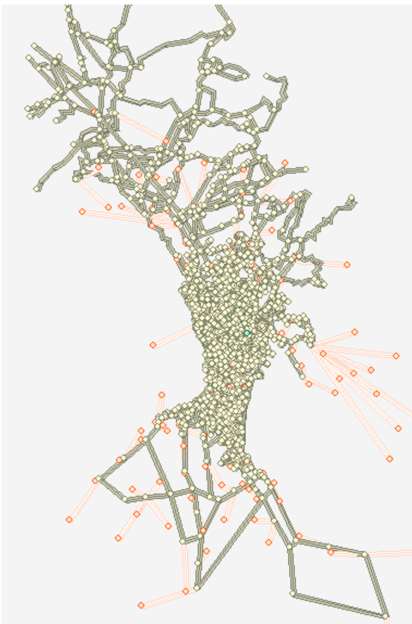

Fig. 2 – Metro Manila network

Table 1 shows the population of the whole Philippines. It also includes the population growth rate and the projected population in the design years. This trend shows the same with that of the whole of EDSA. The distribution of the population per barangay, segregated in zones, of EDSA can be seen in Appendix A which was obtained from the National Statistics Office.

Table 1 Population and Growth Rate of Philippines

Year	Population	Growth rate
1995	68,616,536	1.0
2000	76,506,928	1.92
2007	88,548,366	2.23
2010	94,013,200	2.31
2011	96,511,073	2.39
2016	107,478,819	2.57
2021	119,692,965	2.76

Volume Count Survey

A volume count survey at EDSA Orense was conducted using the video obtained from MMDA in order to obtain the percentage of each mode of transportation traversing along EDSA. The peak hour along the northbound side and southbound side occurred from 7:00 – 8:00 AM. Shown in Figure 3 and 4 are the actual values and percentage of the modes of transportation. It can be observed that the percentage of each mode of transportation is approximately the same for both directions. The private vehicles occupy the most space along EDSA during the peak hour with roughly 60% of all the vehicles traversing, whilst, the remaining 40% are public vehicles.

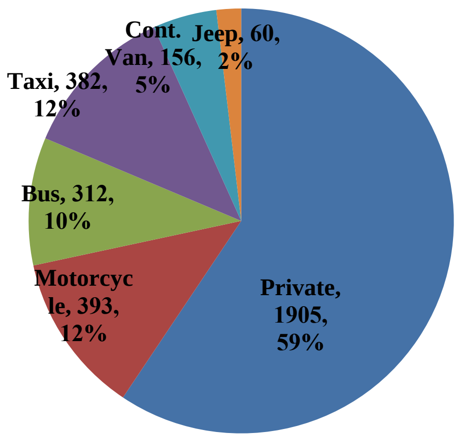

Fig. 3 – Percentage of the Peak Hour Volume Southbound

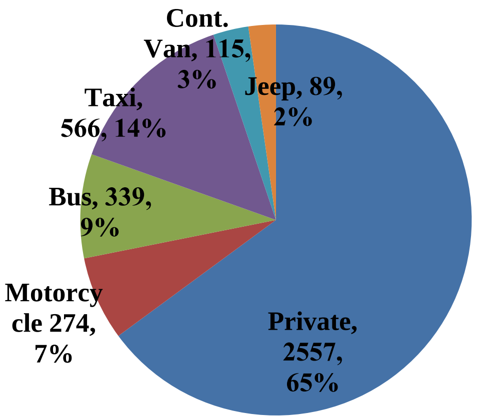

Fig. 4 – Percentage of Peak Hour Volume Northbound

Onboard Survey Analysis

Before conducting an onboard survey, the bus volume survey was first conducted to estimate the frequency of buses plying the routes. It was found out that for North bound buses, peak hour is during 8:30 – 9:30 AM. While, the peak hour of South bound buses is during 8:15 – 9:15 AM. From the bus volume survey, the total buses per route were proportioned in order to obtain the number of samples per bus route required for the actual onboard survey.

The researchers obtained onboard samples from the different modes of transportation traversing along EDSA in order to assess the service characteristics of each mode such as the passenger load, travel time and travel speed. These modes of transportation includes private vehicle, metered taxi, MRT and city buses both air-conditioned and non-air-conditioned. The sample sizes of each mode of transportation that were analyzed are: 4, 4, 21, 20 and 20 samples respectively.

Table 2 Proportion of Northbound buses

	Tungko		UE Letre		Malanday	
	AC	Non AC	AC	Non AC	AC	Non Ac
Total	123	108	36	21	40	10
	0.36	0.32	0.11	0.06	0.12	0.03
20 samples	7.28	6.39	2.13	1.24	2.37	0.59
	7	**7**	**2**	**1**	**2**	**1**

Table 3 Proportion of Southbound buses

	Baclaran		Ayala		Alabang		FTI
	AC	Non AC	AC	Non AC	AC	Non AC	
Total	125	101	31	5	45	87	13
	0.31	0.25	0.08	0.01	0.11	0.21	0.03
20 samples	6.14	4.96	1.52	0.25	2.21	4.28	0.64

Buses that travel from the north to the south end of EDSA or vice versa have the most number of buses. On the other hand, the buses that traverse only half of EDSA have less number of buses. It can be observed that an average of 460 buses traverse EDSA per hour per direction.

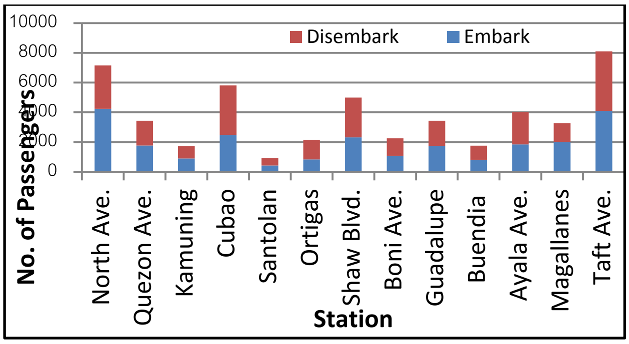

Fig 5 – Average Total Passengers Embarking and Disembarking Every Station in an Hour by MRT

In order to analyze the number of passengers that uses the MRT as their mode of transportation, the researchers obtained the MRT ridership count from the MRT Management Office for the month of September 2011. Figure 5 shows the average total passengers embarking and disembarking at every station per hour. It can be observed that most of the passengers embark and disembark at the end stations.

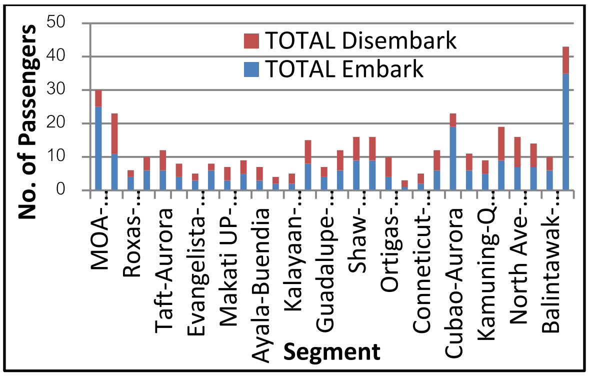

Fig 6 – Average Total Passengers Embarking and Disembarking Per Segment by City Buses

Figure 6 shows the average total number of passengers embarking and disembarking in each segment. Similar to the MRT ridership, most passengers embark and disembark at the end stations.

The MRT and bus ridership figures shown above were the basis to determine the stations of the proposed BRT system. The most number of passengers were the ones chosen since it caters the largest trips in the whole of EDSA.

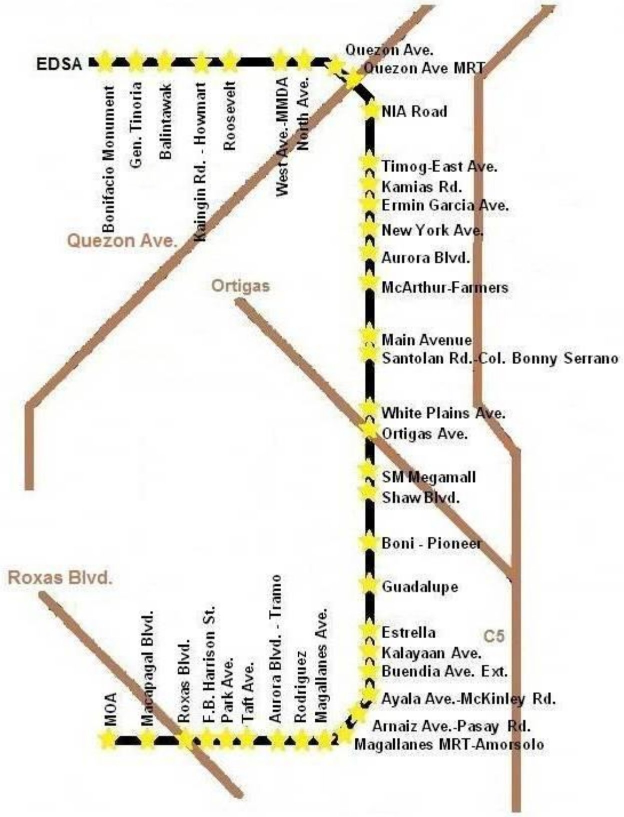

Fig 7 – Proposed BRT Stations

The proposed BRT will have 39 stations located at MOA Roundabout, Macapagal Blvd, Roxas Blvd., F.B. Harrison St., Park Avenue, Taft Avenue, Aurora Blvd.-Tramo, Rodriguez, Magallanes Ave, Magallanes MRT-Amorsolo, Arnaiz Ave.-Pasay Rd., Ayala Ave.-McKinley Rd., Buendia Ave. Ext., Kalayaan Ave., Estrella, Guadalupe, Boni-Pioneer, Shaw Blvd., SM Megamall, Ortigas Ave., White Plains Ave., Santolan Rd.-Col. Bonny Serrano, Main Avenue, McArthur-Farmers, Aurora Blvd., New York Ave., Ermin Garcia Ave., Kamias Rd., Timog-East Ave., NIA Road, Quezon Ave. MRT, Quezon Avenue, North Avenue, MMDA West Avenue, Roosevelt, Kaingin Rd.-Howmart, Balintawak, Gen. Tinoria and Bonifacio Monument. The stations were designed by considering the ridership of the city buses and MRT. The onboard survey also served as a guide. The number of stops during an onboard survey for city buses reaches more than 60 stops per whole trip. By implementing a fixed number of stations for the BRT system, the number of stops are reduced and controlled.

Table 4 Average Speed of the Different Modes of Transportation in EDSA

Type	Average Speed (km/h)	95% LOC	Lower Limit	Upper Limit
Airconditioned City Buses	14.41	1.47	12.94	15.88
Non-airconditioned City Buses	14.70	1.57	13.13	16.28
Taxi	21.81	9.26	12.55	31.07
Mass Rail Transit System (MRT)	27.43	1.65	25.79	29.08
Private Car	21.26	3.03	18.23	24.29

Table 4 presented the average speed of the different modes of transportation traversing along EDSA. City buses have the lowest average speed among all. The taxis and private vehicles have the same speed. Compared to the city buses, the MRT system is the most effective and fastest way to commute in EDSA.

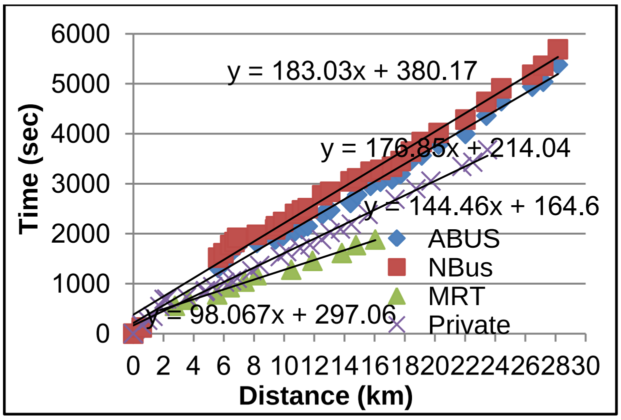

Fig 8 – Distance and Time Relationship of Transport Modes

The graph shown in Figure 8 is the relationship of distance and time of the different transport modes traversing EDSA. It is observed from the graph that the most effective way to commute along EDSA is through the MRT system. It requires less time compared to the city buses that are present in EDSA.

Table 5 Public and Private Daily Trips Percentage in Metro Manila, (MMUTIS, 1996)

	Year					
	1996	**2010**	**2011**	**2015**	**2016**	**2021**
Percent Public Trips	77.9	69.3	68.7	66.2	65.6	62.5
Percent Private trips	22.1	30.7	31.3	33.8	34.4	37.5
Total	100	100	100	100	100	100

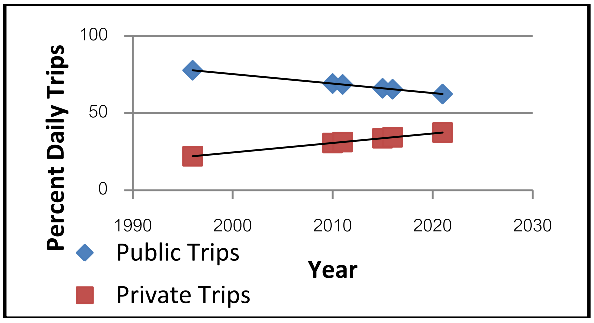

Fig 9 – Trends of the Private and Public Daily Trips

Table 5 shows the public and private daily trips percentage in Metro Manila for year 1996, 2010, 2011, 2015, 2016 and 2012, respectively. Percent public and private trips on year 1996 were obtained from MMUTIS data while percent public and private trips on year 2015 were obtained from the study Estimation of co-benefit from BRT introduction in Metro Manila using IGES' co-benefit guideline. Year 2010, 2011, 2016 and 2021 were assumed to be following a linear trend and thus they were interpolated. Figure 9 shows the trends of the public and private trips. The private trips show an increasing trend as opposed to the public trips which illustrate a decreasing trend.

Table 6 Percent Growth Estimates in Trip Generation for Metro Manila

	1996	2010	2011	2015	2016	2021
Percent Growth	1.00	1.62	1.66	1.84	1.88	2.11

Table 6 shows the trip generation percent growth estimates in Metro Manila for year 1996, 2010, 2011, 2015, 2016 and 2021, respectively. Percent growth on the year 1996 was obtained from the MMUTIS data while the 2015 percent growth was obtained from a study conducted by Fillone, et. al. Assuming that the percent growth in trip generation is following a linear trend, the percent growth for year 2010, 2011, 2016 and 2021 were interpolated respectively. These growth estimates were used to project the trip generation in the design years in EMME3.

Transport Co-Benefit Analysis

Transport Co-Benefit approach was used in order to calculate the time cost, operating cost and emissions per year respectively.

Table 6 Summary of savings from time cost, operating cost and emission (year 2016)

	Savings (BRT with city bus 2016)	Savings (BRT without city bus 2016)
Time cost (peso/year)	28,787,963,741	34,181,568,383
Operating cost (peso/year)	-68,249,844	18,830,666
CO (peso/year)	-2,344,316	-2,344,316
NOx (peso/year)	-339,979	-29,536
SPM (peso/year)	-7,390.82	32,336
CO_2 (peso/year)	-2,848,565	6,663,657

Table 7 Summary of savings from time cost, operating cost and emission (year 2021)

	Savings (BRT with city bus 2021)	Savings (BRT without city bus 2021)
Time cost (peso/year)	59,814,262,624	69,003,748,265
Operating cost (peso/year)	-29,537,704	57,563,866
CO (peso/year)	-1,114,457	-827,340
NOx (peso/year)	-206,153	117,227
SPM (peso/year)	-5,567	39,911
CO_2 (peso/year)	-2,295,148	8,020,602

Table 6 and Table 7 shows the summary of savings from time cost, operating cost and emission cost for year 2016 and 2021. From the results, it can be seen that there is a significant change if BRT is present in EDSA for year 2016 and 2021. It is also observed that the savings is much higher if there are no city buses present in EDSA compared to a situation wherein city buses are present in EDSA. As for the emissions, there is a significant savings in SPM and CO_2. Lastly, the data shows that there are no savings when it comes to carbon dioxide emissions if there are city buses and BRT present in EDSA. This is logical since more vehicles will be present in EDSA and therefore carbon dioxide emission will increase. Overall, the proposed BRT system is more efficient in terms of time savings, operating cost savings and emission savings if the city buses are removed and rerouted.

5. Conclusion

In the present situation, EDSA experiences heavy traffic daily. Without further actions to improve the flow of vehicular traffic, EDSA may experience unbearable situation in the near future. Based on the population data obtained from the National Statistics Office (NSO), it can be seen that the population is increasing every year. The increase in population coincides with the increase of automobile users as well as the daily commuter trips. With this, the researchers proposed a BRT system that would allow the automobile users and commuters to shift to a more efficient public transportation system.

Using the whole network of Metro Manila in the software EMME3, the researchers were able to generate the vehicular demand of EDSA. The impact of the BRT system during the base year (2011) and design years (2016 and 2021) were simulated using EMME3. The actual condition of EDSA was calibrated to match the designed network of the base year and was then projected to develop the network of the design years. There were three scenarios taken into account in the design years: (1) EDSA without the BRT system, (2) EDSA with the BRT system and city buses traversing along EDSA, and (3) EDSA with the BRT system but without the city buses traversing along EDSA.

The proposed BRT system along EDSA proved to have a great impact on the whole urban travel in Metro Manila. There is a decrease in time cost on the design years compared to the base year. The vehicle operating cost also has a significant change when the BRT system is present on the design years. Lastly, there has been a great environmental benefit if the BRT is implemented. All the parameters stated in the co-benefit guidelines proved to be effective if the condition with BRT system but without the city buses traversing along EDSA are applied. Overall, the Metro Manila network including EDSA obtained bigger savings in terms of time, operating cost and emissions by applying the IGES co-benefit estimation methodology.

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