EMPIRICAL ANALYSIS OF ROUTE OPERATING CHARACTERISTICS, LEVEL OF SERVICE AND PROFITABILITY: THE CASE OF JEEPNEYS IN THE CITY OF MANILA

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Abstract: This research investigated the empirical relationships between route operating characteristics, profitability, and level of service for the case of jeepneys in the City of Manila. An understanding of these factors and their inter-relationships is a prerequisite to proper planning, management, and regulation of jeepney operations. From the survey data collected, empirical models were established to determine the appropriate (or "optimal") route operating characteristics that would maximize jeepney profitability for the benefit of the drivers/operators, and at the same time maximize level of service for the benefit of the passengers.

1. INTRODUCTION

Jeepneys, undoubtedly, have contributed in transporting the Filipino masses to and from any point of the metropolis. However, the present jeepney route system and the location of jeepney terminals are believed to be contributory to traffic congestion and inefficiency. Unless, these issues are carefully studied, the problem will continue to stretch to the future of Manila residents, those who work in the City and even those from other areas who simply pass through the City.

It is noted that nearly two-thirds of all trips of public transport in Metro Manila is by road and that jeepneys carry more passengers in total than the buses. Despite urban pressures brought about by the jeepneys, the passengers, comprised mainly of the common masses, remain faithful in taking the "king of the roads" as their carrier wherever they are in the metropolis. Movement in the City of Manila, characterized by a narrow road network, will not be at its utmost without the jeepneys providing the cheapest and door-to-door service.

As in the past, the putting up off Light Rail Transit has scared the jeepney drivers of being eliminated along major thoroughfares. With some sectors clamouring for the gradual phase-out or relegating the jeepneys to secondary or tertiary roads, it is untenable for any transport planner or policymaker to come up with an overture that would greatly affect the enormous passengers being transported by the so-called "king of the roads."

The nature and dynamics of jeepney route operations has become a challenging task for any transport planner. The uniqueness of jeepney as a transport mode put forward enormous issues and concerns which need to be studied to achieve desired transport plans. As such the researcher hopes to answer the following questions: (1) What is the

desirable route length, jeepney capacity and fleet size of the jeepneys operating in the City of Manila? and (2) How does route length affect the level of service and profitability of jeepneys?

1.1 Objectives of the Study

The study specifically aims to: (1) Determine the nature and characteristics of jeepneys plying through the main and minor road networks of Manila; (2) Describe the empirical relationships between length of routes, capacity, fleet size, operating hours per day, number of round trips per day, travel time per round trip, waiting time at terminal areas, average load factor, average occupancy and revenue; (3) Derive empirical models for establishing appropriate route length and fleet size that would allow profitable operations at the same time provide adequate level of service; and (4) Develop policy guidelines for planning and managing jeepney route operations in the City of Manila.

1.2 Conceptual Framework

Of the insurmountable urban transportation problems in the Philippines, the author decided to zero in on studying the jeepney for its being an important transport mode in the country. The jeepney was born out of the American throwaway jeep and Filipino ingenuity after the Liberation of Manila. This has been a predominant mode of public transport in Metropolitan Manila, accounting for 55 percent daily trips, followed by buses at only 15 percent (Ebata, *et al*, 1996:1). Based on the Databook on Philippine Transportation prepared by the National Center for Transportation Studies, the highest mode share of total person trips per day belongs to jeepneys, estimated at 46.10 percent in 1974, 58.50 percent in 1980, 56.50 in 1985 and 49.40 in 1989. In 1994, the jeepney industry shared 40 percent of the total vehicles registered in the National Capital Region (NCR) and there were about 350,000 units plying the major and minor routes in the metropolis (Sevilla, 1994).

The popularity and unprecedented growth of jeepneys are attributed to the following: 1) **local availability** - manufacturing technology is locally available and parts such as second-hand engines and imported chassis are readily available; 2) **intermediate size or capacity** - compatible to most Metro Manila road network and configuration, enabling it to easily move, stop, load and unload passengers as well as penetrate even the smallest interior areas as well; and 3) **accessibility** - providing a door-to-door service at practically any time and place (Bayan, 1995: 29 and Ebata, *et al*, 1996: 2). Other attributes that make jeepneys popular are its ability to provide relatively efficient and high level of services, being able to cultivate stable riding habits due to their extensive network and route choice, high frequency, seat availability, among others (Iwata, 1995).

Beside its distinction are some disreputable concerns brought about by jeepney operations, namely: 1) presence of *colorum* or unauthorized public utility jeepneys that compete with legally registered units in terms of revenues and limited space; 2) high level of air polluting emissions; 3) increasing number of backyard manufacturers whose products are quite unsafe due to the government's incapability to control or monitor such activities; and 4) inconsistent enforcement of traffic rules and regulations which further

aggravate the problem on driver's behavior such as improper loading and unloading as well as imprudent driving (Bayan, 1995: 29).

The jeepney route operating characteristics include route length, jeepney capacity, length of operating hours per day, and fleet size. Profitability is a function of gross revenue and operating costs while level of service considered travel time, travel speed, travel delay and waiting time. Figure 1 shows the interrelationship between the key operating characteristics, level of service and profitability and how it is operationalized in terms of passengers and operators' concerns. It is clear in the figure that there arise a trade-off when level of service meets profitability. This trade-off represents the benefit loss if one party prefers to have one in lieu of another. Conversely, the meeting of the level of service and profitable represents the desirable state of operating characteristics which is the essence of this study. From the primary and secondary data, the desirable route length, capacity and operating hours.

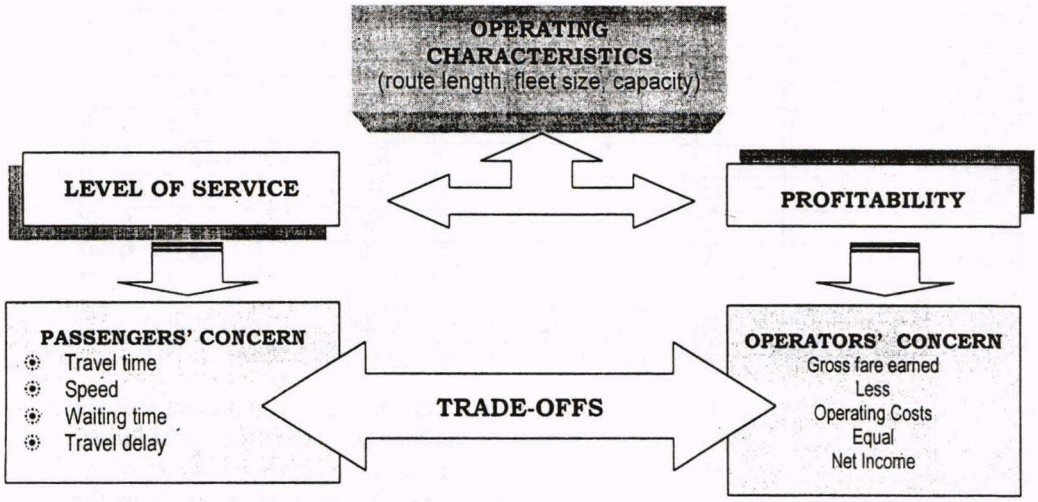

Figure 1. Conceptual Framework

1.3 Research Methodology

Field surveys undertaken were driver interview survey, passenger interview survey, boarding and alighting survey, and jeepney terminal survey.

There were 34,052 jeeps that ply through Metro Manila, of which 11,017 or 32% ply through the City of Manila (LTFRB, 1996). A target terminal area was selected among the 51 terminals found in the City of Manila. The enormity in the number of jeepneys that operate in the City of Manila led the researcher to decide on a sample size representative of the target area. Divisoria terminal hosts some 34 or 19% of 182 routes in the City of Manila with 1,697 or 20% of 8,502 jeepneys serving the commuters. There are 14 intracity routes (44% of 34 routes in Divisoria) while 20 intercity (59%). The mean route length of jeepneys in Divisoria is 7.27 km. Thus, the researcher selected Divisoria as the target terminal for having the most number of routes and most number of jeepneys that commence and end their trips in the said terminal. Divisoria terminal which

serves 35 routes or 1,772 jeepneys, has a varied and wide spread of route length ranging from a minimum of 2 kilometers to a maximum of 15.5 kilometers.

The average route length of jeepneys destined at T.M. Kalaw is the longest at 12.08 due to a big number of intercity routes (14 longer route length ranging from 7.0 to 15.5 km) and only one short route length (Divisoria-T.M.Kalaw, an intracity route at 4.0 km). In terms of the number of routes, Arroceros, Blumentritt, Divisoria and Pier South are the major jeepney terminals in Manila. On the other hand, Divisoria (1,697 units or 19.96%), Quiapo (1,158 units or 13.62%), L. Guinto (961 units or 11.30%) and Blumentrittt (855 units or 10.06%) rank as the major jeepney terminals in terms of the number of jeepneys. Table 1 shows the major jeepney terminals in Manila.

Table 1. Jeepney Statistics by Terminal and by Type of Route

Terminals	Number of Routes				Frequency of Jeepneys				Average Route Length
	Intracity	Intercity	Through	Total	Intracity	Intercity	Through	Total	
Arroceros	-	17	-	17	-	835	-	835	10.29
Blumentritt	11	18	-	29	150	705		855	7.06
Divisoria	14	20	-	34	489	1,208	-	1,697	6.88
L. Guinto	3	3	2	8	529	375	57	961	7.50
Pier South	4	18	-	22	162	617	-	779	10.38
Quiapo	5	10	2	17	309	820	29	1,158	6.51
Recto	2	15	-	17	65	611	-	676	10.56
Sta. Cruz	3	7	3	13	57	263	5	325	9.80
Stop & Shop	1	9	-	10	28	459	-	487	9.03
T.M. Kalaw	1	14	-	15	-	729	-	729	12.08
Total	44	131	7	182	1,789	6,622	91	8,502	9.01

Note: This does not include *colorum* jeepneys and terminals which have less than 5 routes.

Of the 35 routes in Divisoria terminal, seven routes were selected to represent varying route lengths (Table 2). The Divisoria-Gastambide via Morayta and Divisoria-Moriones via Dagupan routes represent the 2,281 or 20.71% of the total jeepneys that are in the intracity routes. In particular, the Divisoria-Moriones via Dagupan route represents the illegal route that exists in the City which needs to be legalized, if proven to be of service to the people and profitable for the drivers. The rest of the selected routes represent the intercity routes of varying route length.

The target sample size is aimed at covering at least 10% of the total jeepneys that ply through the six selected routes and two passengers for all the jeepneys being surveyed. Adjustments on the target sample size were made in order to stratify samples into four time interval per direction. As a result, the sample size for jeepney drivers became 77 and the passengers turned 154.

2. PROFILE OF SURVEY RESPONDENTS

2.1 Jeepney Drivers

This starts with the profile of the jeepney drivers and passengers who were interviewed. The jeepney drivers' profile include age, number of years in jeepney driving occupation,

ownership and number of drivers per unit, capacity of the jeepneys driven, number of operating hours per day, number of operating days per week, gross fare earned, income per day and operating costs per day.

Table 2. Profile of the Selected Jeepney Routes and its Sample Size

Terminals	Route Number	Type of Route	No. of Units
Divisoria - Gastambide via Morayta	1751	Intracity	75
Divisoria - Moriones via Dagupan	0000	Intracity	110
Divisoria-T.M. Kalaw	1760	Intracity	95
Divisoria - Sangandaan via Maypajo	1620	Intercity	188
Divisoria-San Juan	1730	Intercity	131
Baclaran - Divisoria via Mabini	0510B	Intercity	168
Divisoria – Malanday via J.A. Santos	1600	Intercity	79
Average/Total		**37% intracity**	**715**

Of the 90 jeepney drivers who were interviewed, the average age was 39. As reflected in Figure 3, the age bracket of the jeepney driver respondents were as follows: 20-29 (20 or 22%); 30-39 (32 or 36%); 40-49 (32 or 36%); 50-59 (5 or 5%) and 60-above (1%). Data show that the jeepney drivers interviewed belong to the senior population. More than 70% of the respondents were between 30 to 40 years old. The oldest respondent is already 64 years old while the youngest is 21.

The average number of years in jeepney driving occupation was 13. As shown in Figure 4, majority of (48%) of the drivers have been driving for less than 10 years, followed by those driving for 10 to 20 years (36%). The oldest driver has been driving a jeepney since 1953 and the youngest in terms of jeepney occupation has only driven since 1998.

2.2 Jeepney Passengers

Of the 180 respondents, 71 or 39% were males and 109 or 61% females (Figure 3); 113 or 63% were singles, 63 or 35% were married and 4 or 2% were widow or widower (Figure 4). The average age of the jeepney passenger respondents is 27. As shown in Figure 5, the respondents were almost equally distributed among below 20 years old (48 or 31.17%), 21-30 years old (46 or 29.87 percent), 31-40 (31 or 20%).

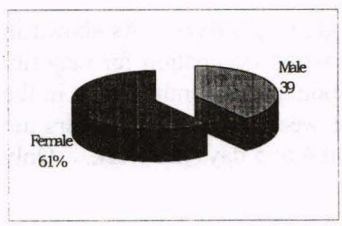

Figure 3. Gender

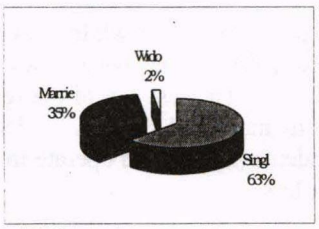

Figure 4. Civil Status

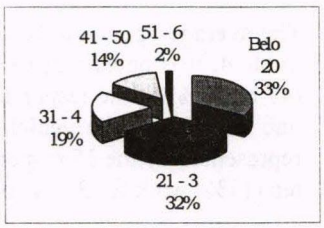

Figure 5. Age of Jeepney Passengers

Majority of the passenger respondents interviewed were either students (61 or 34%) or non-working housewives (33 or 18%), followed by professional (22 or 12%), and the rest were laborers, clerical workers, plant workers, traders, technicians and service workers.

The average monthly income is P2,785. Since majority of the respondents turned out to have no income being students, housewives and unemployed.

4. CHARACTERISTICS OF CURRENT OPERATIONS

4.1 Route Profile

4.1.1 Round Trips

Table 3 shows the route length and number of round trips per day of the seven selected routes. Divisoria-Moriones route which is the shortest route has the highest frequency in terms of round trips at 17, followed by Divisoria-T.M. Kalaw and Divisoria-Morayta via Gastambide routes at 11 and 10, respectively. Divisoria - Sangandaan via Maypajo has an average of 8 trips per day while Divisoria-San Juan and Baclaran - Divisoria via Mabini, 6 trips per day. Divisoria - Malanday via J.A. Santos has the smallest number of trips at 4 per day. Figure 6 shows that the number of round trip decreases as route length increases.

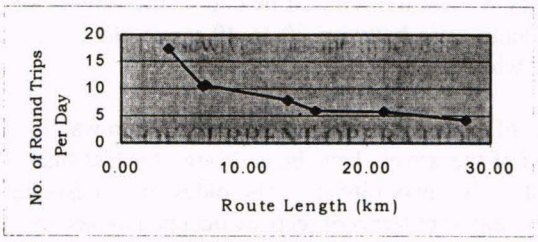

Figure 6. Round Trips per Day vs Route Length

4.1.2 Ownership & Number of Drivers per Jeepney

It was also noted that 33 or 37% of the jeepney drivers who were interviewed owned the jeepneys they drove and 57 or 63% were rented out. Of the 90 respondents, 50% had one driver per unit and another 50% had two drivers per unit .

4.1.3 Schedule of Operations

The average operating days per week was 5 while the mode was 6 days. As shown in Table 4, it is noted that jeepney driving has become a non-stop occupation for majority (47 or 52%) of the respondents. The rest day of the respondents is limited only in the one day ban of the vehicle as mandated by law. The weekday jeepney drivers are represented by the 15 respondents (37%) who operate from 4 to 5 days per week. Only ten (11%) work for 3 days or less.

On the average, the 90 jeepney driver respondents had some 10.73 working hours per day. Majority (46 or 51%) had 10 to 14 working hours per day, followed by 24 or 27% who had 5 to 9 working hours per day, 13 or 14% with less than 5 working hours per day and 7 or 8 %with 15 or more working hours per day.

4.2 Fleet Characteristics and Utilization

4.2.1 Type of Engine and Fleet Size

It is interesting to note that all of the jeepneys surveyed use "surplus" engines from Japan. The engines are generally of Isuzu brand. Majority (36 or 40%) of the jeepneys drivers by the respondents were using C240 type of engine, followed by 4BA1 (16 or 18%) and C221 (10 or 11%). There were only few Mitsubishi (6 units) and Fuso (1 unit) engines.

As previously mentioned, the seven selected routes belong to Manila's top 12 routes in terms of fleet size. As per LTFRB records, Divisoria-Sangandaan via Maypajo route has the biggest fleet size at 188, followed by Baclaran-Divisoria via Mabini at 168 and Divisoria-San Juan at 131. Table 4 indicates the fleet size per route.

4.2.2 Capacity

The mean and mode passenger capacity was 18. Ranging from 14 to 20, the passenger capacity (Figure 9) of the jeepneys surveyed were as follows: 18 (43 or 48%); 20 (21 or 23%); 16 (17 or 19%); 22 (5 or 6%) and 14 (4 or 4%).

4.2.3 Occupancy

In the seven routes surveyed, the average occupancy during a.m. peak was higher than in the p.m. peak. Interestingly, the shortest route (1.8 km) had a higher average occupancy in comparison with other route lengths. Figure 10 demonstrate that there exists no relationship pattern between the average occupancy at any time of the day and the route length.

4.2.4 Average Load Factor

As shown in Table 3, there exists a low positive correlation between load factor and route length.

Table 3. Fleet Characteristics and Utilization

Routes	Route No.	Round Trip Length	Fleet Size	Capacity Mean	Capacity Mode	Load Factor	Average Pax-km
Divisoria - Gastambide via Morayta	1	3.89	110	17	18	0.55	36
Divisoria - Moriones via Dagupan	2	6.65	74	17	16	0.62	69
Divisoria-T.M. Kalaw	3	6.90	95	19	18	0.61	78
Divisoria - Sangandaan via Maypajo	4	13.55	188	17	16	0.64	145
Divisoria-San Juan	5	15.80	131	17	18	0.65	123
Baclaran - Divisoria via Mabini	6	21.35	168	19	18	0.64	254
Divisoria - Malanday via J.A. Santos	7	28.00	79	19	18	0.68	357

Note: Pax – Abbreviation for passenger(s).

5. PROFITABILITY

Profitability was measured in terms of net income which is simply the difference between revenue and operating cost. These are described in details in the following sections by

deducting all costs from gross fare earned. Bayan's study (1995) indicated that operating costs share a very high percentage of 91.2 %while maintenance and operating costs only have a minimal share of 7.0 % and 1.8 % in the total operating cost of jeepney operations.

5.1 Operating Costs

Drivers typically pay a fixed amount called "boundary" to the jeepney owner in exchange for operating the jeepney over a one day period. The mean boundary was P383.72 per day and it ranges from P100 to P540 depending on the passenger capacity and number of operating hours per day. The survey revealed that 25 respondent drivers or 28% pay between P400-499 for boundary; 26 or 29% pay between P300-399; 12 or 13%, between P200-299; and the rest pay between the ranges P100-199 and P500-600.

The mean fuel cost was P169.62 per day. Fuel cost ranged from P50 to 100 depending on the route length, base terminal of the jeepney, operating hours per day and number of round trips per day. The average maintenance and repair cost per month was P1,530. On the other hand, the average oil and lub consumption per week was 1.58 liters. This ranged from less than a liter to seven liters per week depending on the condition of the engine. The average cost of oil is P60.00 per liter. Jeepney drivers also pay for dispatchers at an average of P20.00 per day.

5.2 Gross Revenue

As expected, the average gross fare ended at P954.22 during weekdays was bigger than that of weekends. On the average, the gross fare earned on weekdays and weekends were P1,168.98 and P1,019.33, respectively. Likewise, the net income on weekdays was bigger than that of weekends recorded at P481.11 and P331.28, respectively. Majority of the respondents had a gross fare earning between P600 to P1,200 on weekdays, and P400 to P1,000 on weekends.

Most drivers noted that gross earnings on Saturdays were lower due to traffic delays which may be attributed to the absence of regulation on traffic volume. Weekday gross fare earned obviously is bigger than what can be earned during Saturday and Sunday. Interestingly, gross fare earned during Saturdays is more than what can be earned during Sundays. Gross fare earned during Sundays only become higher than Saturday for Divisoria-Sangandaan route.

5.3 Net Income

As shown in Table 4, majority (47 or 52%) of the drivers have a weekday net income ranging from P201 to P 400; followed by 27 or 30%, having net income ranging from P401 to P600; 11 or 18%, more than P600; .and the rest 5 or 6%, below P200. Likewise, majority of the respondents earned a net income between P200 to P400. However, a significant number (18 or 20%) mentioned that their net income only reached P200 and sometimes below due to heavy traffic congestion during weekends. Figure 8 show that net income is always higher during weekdays compared with weekends.

Table 4. Net Income (pesos)

Net Income Per Day	Weekdays		Weekends	
	Frequency	Percentage	Frequency	Percentage
200 Below	5	5.56	18	20.00
201 – 400	47	52.22	40	44.44
401 – 600	27	30.00	17	18.89
601 – 800	4	4.44	3	3.33
801 –1000	3	3.33	5	5.56
1001 – 1200	3	3.33	-	-
1201 – 1400	1	1.11	-	-
None	-	-	7	7.78
Total	90	100.00	90	100.00

Figures 7 and 8 compare the average gross fare earned and net income during weekdays. It is noticed the average gross fare earned and net income of Route ID Number 1 (Divisoria-Sangandaan via Maypajo) tops other routes. The apex of both gross fare earned and net income is at Route Number 4 which is Divisoria-Sangandaan via Maypajo running at some 7 kilometer length. A similar trend is observed for the average gross fare earned and net income per day during weekends. The difference between the gross fare earned and net income curves account for the expenses shouldered by the jeepney drivers such boundary fee, fuel cost, oil, cleaning, dispatcher's fee or *kotong*, fines and fees for traffic violations, among others.

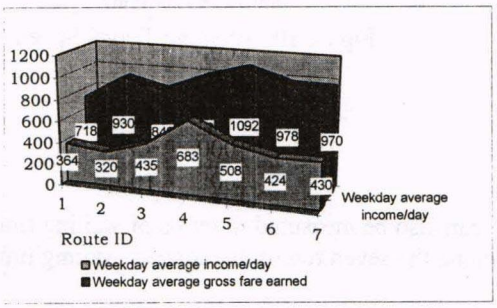

Figure 7. Weekday Average Gross Fare Earned and Net Income per Day

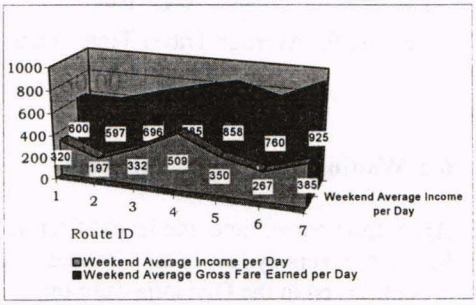

Figure 8. Weekend Average Gross Fare Earned and Net Income per Day

6. LEVEL OF SERVICE

6.1 Travel Time and Speed

Based on the boarding and alighting survey, the average travel time per route is shown in Table 5 and Figure 9. As expected, the route travel time is directly proportional with route length. As per computation, the results show that the shortest route is not the lowest in terms of speed and the longest route has the highest speed. However, other route lengths have varied speed which do not indicate any significant relation with route length. For instance, the Divisoria-T.M. Kalaw route which is the second shortest route among the seven surveyed routes appear to have the highest average travel speed in comparison with the other six routes. Likewise, Baclaran-Divisoria via Mabini route which is the second longest route appears to have the lowest average travel speed

compared to the six routes. From the data, it can be gleaned that speed does not vary significantly with increasing route length (Figure 10).

Table 5. Average Travel Time and Speed versus Route Length

Route	Route Length	Average Travel Time		Average Travel Speed
		(min)	(hr)	km/hr
Divisoria - Moriones via Dagupan	1.95	25	0.42	6.33
Divisoria - T.M. Kalaw	3.33	35	0.58	5.70
Divisoria - Gastambide via Morayta	3.45	43	0.72	4.81
Divisoria - Sangandaan via Maypajo	6.78	88	1.47	4.62
Divisoria - San Juan	7.90	116	1.93	4.09
Baclaran - Divisoria via Mabini	10.68	159	2.65	4.03
Divisoria - Malanday via J.A. Santos	14.00	164	2.73	5.12

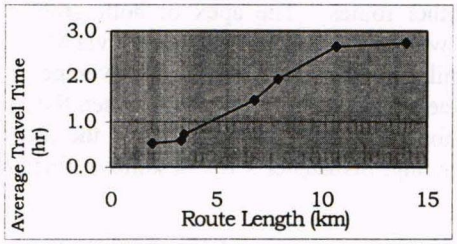

Figure 9. Average Travel Time versus Route Length

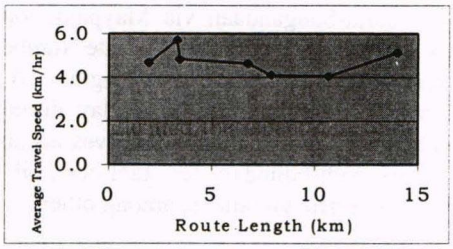

Figure 10. Average Travel Speed versus Route Length

6.2 Waiting Time at the Terminal

Apart from travel time, the level of service can also be measured in terms of waiting time before the jeepney leaves the terminal. Among the seven routes, the longest waiting time was observed in the Divisoria Terminals.

It can also be observed that Divisoria-Moriones and Divisoria-T.M. Kalaw routes have the longest waiting time despite its relatively short route length. This is attributed to many factors such as the characteristics of the terminal area, number of fleet size/volume of jeepneys sharing in the same terminal area and number of passengers to be served in a particular route.

Table 6. Average Waiting Time at the Terminal Areas (min)

Route	Route ID	Route Length	Divisoria	Turn Around Point
Divisoria - Moriones via Dagupan	1	1.95	3	2
Divisoria-T.M. Kalaw	2	3.33	13	2
Divisoria - Gastambide via Morayta	3	3.45	2	4
Divisoria - Sangandaan via Maypajo	4	6.78	8	5
Divisoria-San Juan	5	7.90	6	4
Baclaran - Divisoria via Mabini	6	10.68	6	6
Divisoria - Malanday via J.A. Santos	7	14.00	8	1

The terminal areas of the Divisoria-Moriones and Divisoria-T.M. Kalaw routes along Dagupan and Juan Luna Streets, respectively, are notorious for congestion due to utilization of lanes by street vendors and presence of commercial vehicles (trucks and all utility vehicles) occupying the road shoulder. Although Baclaran-Divisoria route shares the same terminal area with Divisoria-T.M. Kalaw route, majority of the jeepneys plying.

6.3 Travel Delay

Travel delays consist of stops due to boarding and alighting of passengers, fixed delay (intersection delay), operational delay or combination of several causes. Table 7 presents the proportion of travel delay to total travel time. For all routes being studied, a combination of travel delay such as boarding and alighting, intersection delay and operational delay comprises the biggest portion of the total travel time.

For Divisoria-Moriones via Dagupan route, operational delay (19%) ranked second to a combination of travel delays, followed by alighting at 5%. Apart from a combination of travel delays, boarding (16%) and alighting (11%) are the major components of travel delay for Divisoria-T.M. Kalaw route. For Divisoria-Gastambide via Morayta, running time has the biggest share in the total travel time while the major travel delay is a combination of many causes. Travel delays for Divisoria-Sangandaan, Divisoria-San Juan, Baclaran-Divisoria via Mabini and Divisoria-Malanday via J.A.Santos were generally brought about by a combination of causes.

Table 7. Proportion of Travel Delay to Total Travel Time (percent)

Route ID	Running Time	Total Delay	Boarding	Alighting	Boarding & Alighting	Intersection Delay	Operational Delay	Combination
1	22	79	13	5	2	3	19	27
2	14	85	16	11	1	3	2	22
3	33	66	2	1	0	0	2	16
4	27	73	7	6	2	4	3	36
5	47	53	3	3	3	10	3	22
6	46	67	2	1	1	2	0	10
7	46	53	4	7	4	5	10	20

Figure 18 shows that the proportion of travel delay to total travel time is inversely proportional to route length. This means that the percentage of travel delay to total travel time increases as the route decreases.

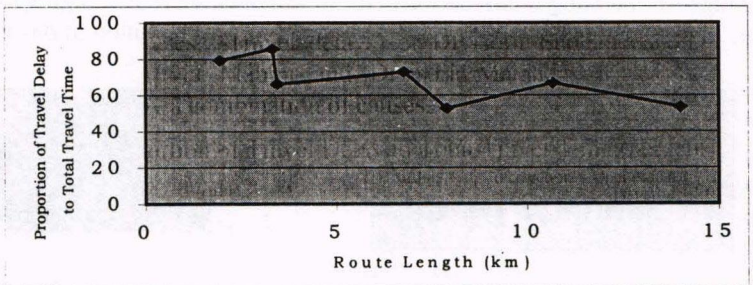

Figure 18. Proportion of Travel Delay to Total Travel Time versus Route Length

7. ANALYSIS OF EMPIRICAL RELATIONSHIPS

This section presents the results of the empirical analysis of profitability (in terms of net income) and level of service (in terms of travel delay) both as a function of jeepney operating characteristics (i.e., route length, capacity, operating hours, fleet size and number of round trips).

7.1 Profitability versus Operating Characteristics

7.1.1 Profitability versus Route Length

Figure 11 indicates that average net income is highest at a route length of approximately seven kilometers. Figure 12 which shows the scatter plot of net income with route length indicates that there is a wide range of variability in net income across all route lengths.

This result suggests that there are many other factors affecting net income beside route length. This may include factors such as traffic congestion, actual operating hours, among others.

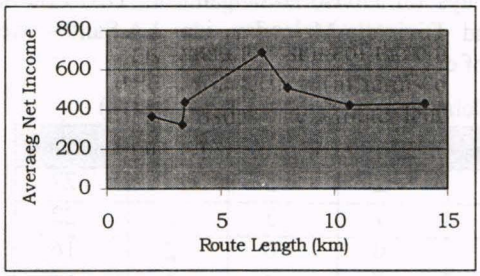

Figure 11. Average Net Income vs Route Length

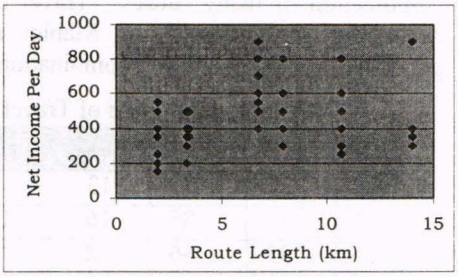

Figure 12. Net Income vs Route Length

7.1.2 Profitability versus Capacity and Operating Hours

Figure 13 clearly indicates a positive relationship between income and vehicle capacity. It is quite obvious that larger jeepneys would provide gross revenue potential and potential and thus would be more profitable. On the other hand, Figure 14 indicates that there is a positive correlation between net income and operating hours per day. However, at the range of operating hours between 10 to 15 hours, there is a high variability in net income. This may have something to do with the actual distribution of passenger trips.

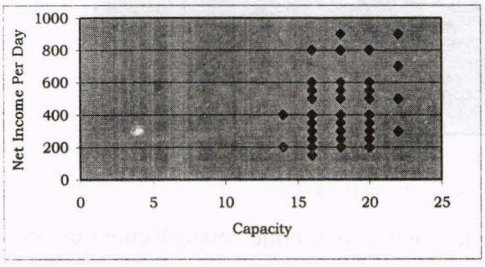

Figure 13. Average Net Income versus Capacity

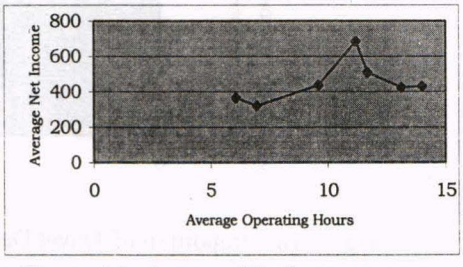

Figure 14. Average Net Income versus Average Operating Hours Per Day

7.1.4 Profitability versus Fleet Size

Figure 15 suggests that net income varies with fleet size either in a linear or parabolic fashion. Given the data collected, there is not enough evidence to determine the appropriate relationship.

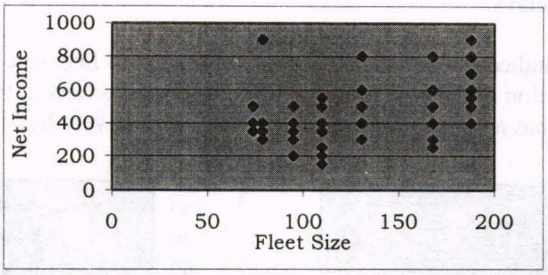

Figure 15. Net Income versus Fleet Size

7.2 Level of Service versus Operating Characteristics

7.2.1 Level of Service versus Route Length and Capacity

Figure 16 shows that travel delay inversely related to route length. Furthermore, there appears to be a higher variability in travel delay for routes with shorter length. and the number of round trip. This means that the proportion of travel delay decreases as the number of round trips increases.

Figure 17 indicates that travel delay is inversely related to capacity. This may be due to the fact that larger jeepneys would need longer time to wait at the terminal to be filled-up, and also would require more boundary and alighting activities.

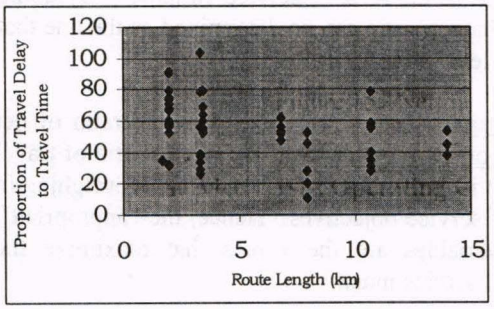

Figure 16. Proportion of Travel Delay to Total Travel Time versus Route Length

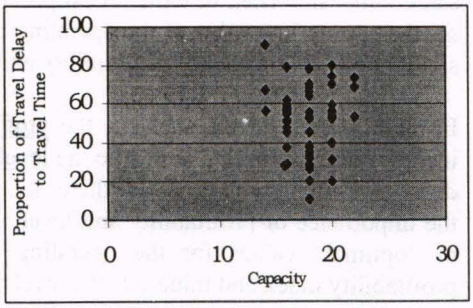

Figure 17. Proportion of Travel Delay to Total Travel Time versus Capacity

7.2.2 Level of Service versus Operating Hours and Fleet Size

Figure 18 shows that travel delay is inversely prproportional to operating hours. This result suggests that jeepneys that operate on longer hours cover both peak and off-peak periods and therefore the overall delay would be lower because the off-peak periods would have lower delays.

Figure 19 likewise indicates that travel delay is not related to fleet size. This is expected since a large proportion of delay is running delay, as opposed to wait time at the terminal. Fleet size typically has an impact on wait time which is relatively less than actual delay.

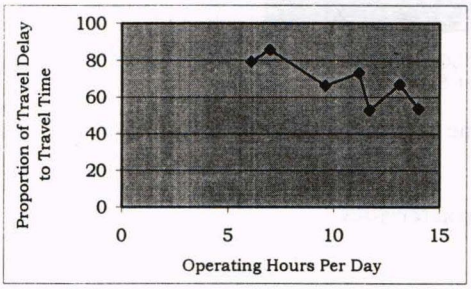

Figure 18. Proportion of Travel Delay to Total Travel Time vs Operating Hours Per Day

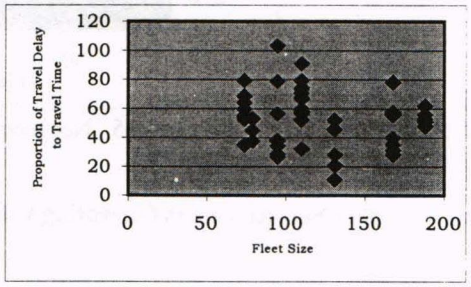

Figure 19. Proportion of Travel Delay to Total Travel Time versus Fleet Size

7.3 Appropriate Jeepney Operating Characteristics

By consolidating findings from the two preceding sections, conclusions can be derived regarding the appropriate operating characteristics of jeepneys from the perspective of increasing profitability and enhancing level of service. To enable superimposition of the empirical graphs of profitability and level of service versus the operating variables, the profitability variable (net income) was divided by gross income so that it would have the same dimension (i.e., in terms of proportion) as the level of service variable. By doing so, the appropriate value of the operating characteristic can be determined as the one that simultaneously maximizes profitability and level of service.

In other words, in this analysis, the profitability index was defined as the ratio of net income over gross revenue, while the level of service index was defined as ratio of travel delay over total travel time. Furthermore, it is assumed that there is an equal weighing in the importance of profitability and level of service objectives. Hence, the "appropriate" or "optimal" values for the operating variables are the values that maximize the profitability index and minimize the level of service index.

7.3.1 Route Length and Capacity

Figure 20 shows that profitability is maximum at a route length of seven kilometers. On the other hand, level of service expressed in terms of travel delay decreases as route length increases, as can be gleaned from Figure 18. Hence, delay can be minimized by increasing route length up to a point where profitability is maximized which in this case is **seven (7) kilometers**. Beyond seven kilometers, profitability begins to decline even though level of service. Figure 20 graphically illustrates the results of this discussion.

Figure 21 shows that profitability increases as jeepney capacity increases. On the other hand, level of service is maximum at a capacity of 18 passengers per vehicle. Hence, profitability and level of service are optimized at a jeepney capacity of **eighteen (18).**

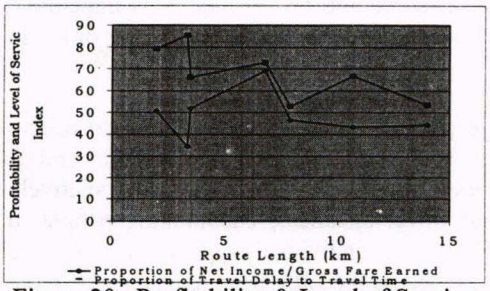

Figure 20. Profitability & Level of Service versus Route Length

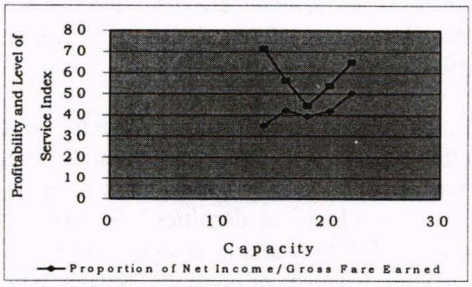

Figure 21. Profitability & Level of Service versus Jeepney Capacity

7.3.2 Operating Hours and Fleet Size

Figure 22 shows profitability reaches a maximum at a length of operating hours approximately equal to twelve. On the other hand, level of service decreases as length of operating hours increases. Hence, profitability and level of service are optimized when operating hours is **twelve (12) hours per day**. Meanwhile, Figures 19 and 23 do not suggest any conclusive result. Net income is expected to decrease as fleet size increases, but this was not revealed by the data. This may be attributed to the inaccurate fleet size data due to prevalence of "colorum" operations. As shown in Figure 31, the analysis for optimal fleet size yielded **inconclusive** results.

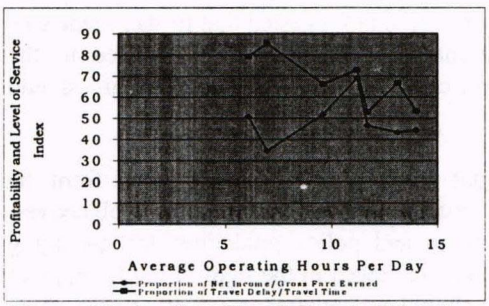

Figure 22. Profitability & Level of Service versus Operating Hours Per Day

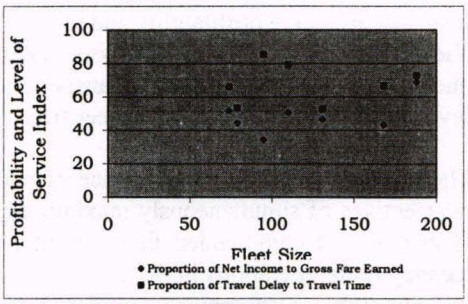

Figure 23. Profitability &Level of Service versus Fleet Size

8. CONCLUSIONS AND RECOMMENDATIONS

Among the major conclusions of this research were that: (a) the optimal route operating characteristics are route length of seven kilometers, jeepney capacity of eighteen passengers, and operating hours of twelve hours per day; (b) fleet size has no clear relationship with profitability and level of service; (c) profitability varies with route length in a parabolic fashion indicating the existence of a route length that maximizes profitability; and, (d) travel delay is inversely related to route length; (d) profitability is maximum at route length of approximately seven kilometers while capacity at optimum level of service and profitability appears to be between 18 to 22; and (e) the jeepneys drivers would have an optimum level of profitability when length of operating hours is twelve hours per day.

Most jeepneys use diesel-fed engines which are particularly polluting. In this research, it was found out that travel delays are higher for shorter route lengths. This means that passengers of jeepneys on routes with shorter route lengths are more vulnerable to air pollution. It should also be noted that emission rates of air pollutants are generally more severe when vehicles are operating under congested conditions. Hence, it is imperative that the causes of travel delays in jeepney route operations be addressed in order to minimize air pollution.

In the context of metropolitan development, jeepneys are expected play a support role to other high-capacity mass transit modes such as Light Rail Transit (LRT) systems, and as main travel mode for commuters in areas where roads are narrow and with relatively lower development densities. For very short travel distances, encouraging people to access LRT by walking is a good policy, However, individuals typically can tolerate walking distances of up to 250 meters only. To access the LRT from a distance of more than 250 meters, other modes such as jeepneys would be necessary. As a feeder mode, jeepney's intermediate size and capacity give it a comparative advantage against other modes as it can easily access narrow roads and provide door-to-door service at a travel cost which is relatively lower than that of the Tamaraw FX or bus.

With the conclusions above-mentioned, the local government may use this information in its effort to improve jeepney operations within its jurisdiction. This finding may be used to reassess the justification for the prevailing belief that fifteen kilometers should be the standard jeepney route length. Since route length is significantly related to travel delay, transport planners and regulator must look into coming up with regulatory measures to regulate route length with a view towards improving the level of service.

Regarding the inconclusive results obtained in the analysis of the relationship between fleet size and route profitability and level of service, it is suggested that further studies be undertaken to investigate this issue before making recommendations related to the question of whether the Land Transportation Franchising and Regulatory Board should revise its policies in regulating fleet size.

The research revealed the existence of optimal route operating characteristics from the perspectives of simultaneously maximizing profitability and level of service objectives. Hence, it is recommended that current planning and policy guidelines for managing jeepney route operations in the City of Manila be reviewed in the light of the findings of this research. Furthermore, similar studies should be undertaken for other case study areas in order to establish the stability of the empirical relationships derived from this research.

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