A Proposed Non-Deterministic Mathematical Model to Develop a Standard Jeepney Fare in Metro Manila Using a Cost-Benefit Approach

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Abstract: The objective of this research is to propose a non-deterministic mathematical model to develop a standard jeepney fare basis in Metro Manila using a cost−benefit approach. The factors that were taken into consideration in the mathematical modelling process were diesel price, spare parts price, fixed costs, operator's profit, and accidental costs. Experimental research method and quantified data questionnaires were used as tool in data gathering. The total cost breakdown was done in order to plot total cost versus total benefit from which the regression curve will be formed. In addition, the MATLAB software was used in order to determine the regression curve that models the data plotted. This curve was known as the Benefit Estimation Curve (B.E.E). From the benefit prediction provided by the B.E.E, the researchers were able to formulate a non-deterministic formula as a standard jeepney fare basis in Metro Manila.

Keywords: Transport Policy, Fare Basis, Jeepney

1. INTRODUCTION

Jeepney has become the preeminent mode of transportation in the Philippines especially in Metro Manila. But even though jeepneys comprise the majority of the transport sector, more often than not, jeepney operators and drivers are claiming that it is a futile venture that comes with huge losses. Furthermore, jeepney fares and hikes are being regulated by the government and have always been the center of query amongst commuters, drivers, and operators whether it is reasonable or not.

For the longest time, the process of fare hike conceptualization and implementation has been an opinionated debate between the operators/ drivers and the government. Additionally, the impact of the final decision made directly affects and acclimatizes the quality and the corresponding price of services granted to the transport users as well as the profit earned by the investors. However, up until today, hardly any study was conducted in order come up with a scientific tool as a basis for fare hikes and rollbacks. In lieu of this, the researchers have decided to conduct this study.

The main objective of this study is to develop a proposed mathematical equation as a basis for a standard jeepney fare evaluation in Metro Manila. The specific objective includes the collection of all the data and variables necessary in order to formulate the proposed equation and to recommend a fare evaluation methodology basis using the proposed equation.

The findings of this study will serve as a basis in formulating decisions on transport policies with regards to Fare Evaluation Methodology. This research can give the Public Utility Jeepney (PUJ) fare evaluators an alternative methodology to determine by how much increase or decrease in the fare prices should be implemented.

The focus of this research is on the minimum fare price of jeepneys plying in Metro Manila thoroughfares only. The research only focused on the factors mentioned above along with its financial impacts. It does not include location variables such as route distances, traffic conditions, modal alternatives, population, and other transport facilities. Furthermore, the computation for additional fare for every additional of 4 km is not included in this study together with discounted and special fares.

2. JEEPNEY STRUCTURE AND OPERATIONS

2.1 Structure

Jeepney transport has been the leading mode of transportation althroughout Metro Manila, Philippines for the past few decades. It has been present for quite some time, yet, its fare methodology seems stagnant and has failed to evolve and further develop to cater to the needs of not only the populace, but also, and most importantly for the transport investors themselves. Sadly, up to the present date, a scientific way to evaluate jeepney fare is yet to be established, thus the creation and conceptualization of this study.

This research was conducted to develop a standard jeepney fare basis in Metro Manila (NCR) using cost benefit approach. The researchers opted to utilize the cost-benefit approach to perceive and limit the profitability of jeepney transport business, notwithstanding the welfare of both the public, and the transport investors.

2.2 Public Transportation

Transportation is the motion or movement of a person from one place to another. There are different modes of transportation in the air, water, rails and roads. Roads, railways, airways, are some of transport infrastructures, which are fixed installations.

Public transportation provides people with mobility and access to employment, community resources, medical care, and recreational opportunities, especially among those who have no other choice. Among the different means of public transport available in Metro Manila such as a buses, taxis, tricycles or pedicabs, light rail transit and commuter train system, jeepneys are the most effective and efficient means of public transportation in the city because of its cheap and there are routes going to nearly all the nooks and crannies of the sprawling metropolis.

2.3 Jeepney as a Public Transport

Jeepneys are popular for the commuters because of its: (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; (3) accessibility – providing door-to-door service at practically any time and place (Bayan, 1995 : 29 and Ebata, et al., 1996:2).

In this era where most of the people need a mode of transportation for them to travel from one place to another, there are several vehicles to choose from. There are some who use to have private cars while taking the path to their own destination and there are some who have no choice but to commute, which sometimes require more than one trip to be able to go to their own destinations.

One of the modes of transportation, which the middle class societies use to ride, is jeepney. There are lots of jeepney that are scattered all over the nation. Most of the places that you want to go have a corresponding jeepney trip or route that you can ride on. This mode of transportation is very favorable to those people who want to spend less on commuting, especially to those who don't have enough budgets to ride on much expensive public utility vehicles like buses, vans and taxis. This is one of the cheapest ways of getting to your destinations.

2.4 Jeepney Operations

The jeepney had been the predominant mode of public transport in Metropolitan Manila, accounting for 55% of the daily person trips, followed by buses at 15% (Ebata, et al, 1996:1). Based on the Data book on Philippine Transportation prepared by the University of the Philippines, National Center for Transportation Studies, the highest mode share of total person trips per day belongs to jeepneys, estimated at 46% in 1974, 59% in 1980, 56% in 1985; and 50% in 1989. However, the trend is decreasing due to the introduction of the other modes. In 1994, the jeepney industry accounted for 40 % 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).

In 1997, A Bus and Jeepney Operators Interview Surveys were undertaken as part of the Metro Manila Urban Transportation Integration Study (MMUTIS). One of its main objectives was to establish an updated transportation database system similar to the one built in JUMSUT which is intended to contribute to transportation planning, research and education in the Philippines. A total of 49 jeepney operations and 18 jeepney cooperatives participated in the survey. Included in the survey are jeepney operators with a minimum fleet size of 5 units. For public transport modes, the jeepney has a significant share of total demand. This mode comprised 51% of the total demand or 77% of public transport demand alone. However, a distinct 40% of "business" trips were notably made by cars (JUMSUT I). Jeepney is dominating the trips in Metro Manila accounting for 39% of the trips. The work trip commuting demand was significant enough to encourage jeepney services to serve the affluent commuter moving from the suburb to the urban or vice versa. Jeepneys are used not only by the very poor but by middle and upper income groups. Jeepneys are privately owned and operated, with the fleet mostly owned by individual operators who lease them to drivers. In addition, the vehicles are assembled locally. The dominance of jeepneys have resulted from generally dispersed travel demand pattern in Metro Manila. According to JICA (1995), other factors leading to dominance of jeepneys include: Abundant low-cost labor that contributes to low operating costs, the self-management system of the industry including the support of jeepney association, the availability of local technology for vehicle supply, fare levels about equal to those for buses whose service level is generally lower than that provided by jeepney (Proceedings of the 17th Annual Conference of the Transportation Science Society of the Philippines (2009)).

2.5 Fare Regulation System

The Land Transportation Franchising and Regulatory Board (LTFRB) is responsible for the regulation and issuance of franchise to public utility vehicles. A Certificate of Public Convenience (CPC), an authorization issued by the LTFRB for the operation of land-based public transportation utilities must first be obtained before an operator can provide transport

services. This certificate could be issued only upon submission of the requirements as provided in the Public Service Act 146, and approved by the Board. The whole process normally takes sixty (60) days.

With regards to fare regulation, the Department of Transportation and Communications (DOTC) on March 30, 1992 issued Department Order No. 92-587 defining the policies governing transport services which includes liberalization and deregulation. This policy is aimed at enhancing competition in order to improve the quality of public transport service.

The implementing guidelines of the said order were issued by LTFRB through Memorandum Circular Number 92-009. This circular defined the policy framework for the regulation of transportation services and one of the subjects was fare setting. It was provided in the memorandum that control in pricing of transport services shall be liberalized and that no fare adjustments shall be made unless authorized or approved through public hearings conducted by the Board. The widening of the fare range within an indicative or reference rate for bus and jeepney operations was also provided as well as the fare system for air-conditioned buses (Journal of the Eastern Asia Society for Transportation Studies, Vol. 1, No.2, Autumn, 1995).

2.6 Fare Structures

A fare structure is a system set up to determine how much is to be paid by various passengers using a transit vehicle at any given period.[7] It is based on different categories which influence the access rights regulating the use of the public transport system by the passenger, and the price a passenger has to pay for a specific trip. The most common of which are the following: first, is the flat fare (same fare irrespective of distance travelled on a particular route); graduated fare (fare increases with distance travelled on a particular route); and lastly is the zone fare (fare increases with journey distance according to fare bands and is usually independent of number of bus routes used i.e. free transfers, and also usually independent of mode of travel selected if bus and rail are both available). It includes whether or not concession fares are offered for particular groups of passengers, typically, children, students and the elderly. Whether or not passes of various types (e.g., weekly, monthly, and tourist) are offered in addition to single journey tickets is also part of fare structure. (Transportation Research Board of the National Academies, 2003).

In addition to the distinction of the different types of fare structures, the researchers further discussed the following types. First in the line is the flat rate, it is where the fare is the same no matter how far a person travels.[8] This can be based on the duration of the ticket a person buys in a single boarding. This is only applicable to cities covering a small area which is a reasonable option. It has a low-cost recovery ratio and requires substantial operating subsidy.

The second one is the graduated fares. It is stated that as the passengers travel further the amount of fare that they are going to pay is also increasing. The amount of money is directly proportional to the distance travelled. In this fare structure, the benefit of this approach is close enough to match between the service that the transit provided and the fare paid.

Another one is the Zonal fares. Under this fare structure, the city is divided into zones in which the passengers are paying the amount of fare depending on the number of zones that they travel. This is similar to the graduated fares, but the difference is the dependency to the route structure. It has different charge for the different modes that a passenger uses.

Last but not the least is the concession fares. This concession fare is what a student like us is actually paying. Others from students are seniors and disabled persons. This is the

agreement between the government and the operator of the public transport. Also, the government is actually the one who informs on whom this fare is going to acquire.

Aside from the fare structure, fare level is the other issue with setting fare. Fare level refers to the average fare paid per passenger (or per passenger-kilometer) for the whole system. Raising or lowering this average level obviously changes the total income of the bus system. If the fare structure talks about the different classes of passengers, the fare level is dependent on the amount of revenue that an operator could generate or expected to obtain.

According to Public-Private Infrastructure Advisory Facility, the structure of fare income can be thought of as a set of variations to the standard adult single journey fare for different groups (e.g. 20% discount for students, 30% discount for monthly passes). The fare level is how the family of fares moves up or down and is determined by the target cost recovery ratio for the system. If the fare income is expected to drop to 80% of total costs in the coming year due to general inflation, and the target is 100% cost recovery, the fare level will have to rise by about 25% (assuming no lose in passengers as a result of the higher fares) to achieve this. How is done must be in line with the social objectives of the fares policy and the agreed fares structure.

2.7 Related Problems

Tricycle passengers in Tagbiliran City are disappointed against some city officials who seemed dependent on the decision of tricycle operators and drivers as to the full implementation of fare rollback. The tricycle operators as well as the drivers are not abiding the mandated rollback tricycle fare passed by the city council instead they still ask the passengers with P8-peso minimum fare despite the resolution.[11] Thus, these tricycle operators issued statements that they will not follow the fare rollback unless the city government will not give them the fare matrix. In addition, another reason of them not to abide the government's resolution is that the expensiveness of lubricants for machines and tires.

LTFRB is planning to reduce the fare for taxis, buses, and commuter vans this January 2015. According to Winston M. Ginez, the LTFRB chairman, before a decision is issued they will conduct simultaneous hearings not only in Metro Manila, but nationwide. The idea behind the decision of reducing the fare was the hearing conducted after the former LTFRB Board Member and Negros Oriental Representative Manuel M. Iway filed a petition in November to reduce fares of buses, taxis, and commuter vans. His petition was called for a reduced flag-down rate that was based on the continuous decline of diesel price three years ago. However, Bong Suntay, president of the Philippine National Taxi Operator Association, called the reduced flag-down rate during the hearing "unfair," saying that "lower fuel prices are not the sole factor in coming up with a fare increase or decrease, they should also consider the expensive spare parts and our lower wages.

According to Transportation Research Board Executive Committee (TRBC) of Washington DC, the nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. In their book "Traveler Response to Transportation System Changes" Chapter 12: Transit Pricing and Fare Changes, transit systems differentiate fares among riders on the basis of the two types of travel characteristics:

1) Rider characteristics which includes demographic and socioeconomic aspects, affiliation and mobile impairment, and;

2) Trip characteristics which includes trip distance, trip duration, quality service and time period.

Based from TRBC, the impacts of changes in general fare level have primarily been studied using aggregate measures of fare elasticity. These measures reflect system wide

ridership response to fare changes and are thus averages of the responses across transit modes, purchase types, rider types, and trip characteristics. Transit ridership response thus measured has been found to vary considerably among different fare change situations, but with a strong consistency on average. Furthermore, when aggregate ridership responses are examined by mode of transit, size of service area, time-of-day, and other important factors, useful patterns and findings emerge that suggest explanations for some of the variations found among individual cities or market segments (Mayworm, Lago and McEnroe, 1980).

Throughout the United States and Europe, the most commonly observed range of aggregate fare elasticity values is from −0.1 to −0.6 (Webster and Bly, 1980). The aggregate fare elasticity average for U.S. cities, excluding those with HRT/Metro, is about −0.4 when calculated using log or midpoint arc elasticity. When cities with HRT/Metro are included, the average is less. A common fare-change rule used by many transit systems for aggregate ridership response to bus fare changes is loosely based on the Simpson & Curtin formula. The formula itself was derived from a regression analysis of before-and-after results of 77 surface transit (bus and streetcar) fare changes.

The changes in fare structure basis of TRBC states that in the past 20 years, there have been very few documented studies of transit systems changing the basis on which fares are calculated. When transit systems were privately owned, distance-based or zonal fares were relatively common. After public takeover, however, most transit systems—particularly small and medium-sized operations—opted for simple, flat fare systems. Distance based or zonal fares were retained primarily in instances where trip distances were long, with commuter rail as the extreme example, or sometimes when routes crossed political boundaries of local governments. Studies of the earlier fare structure base changes in the United States were generally inconclusive with respect to effects on transit ridership, aside from the obvious observation that flat fare systems favor long trips by giving them the least cost per mile (Pratt, Pedersen and Mather, 1977).

In the book Public Transport Pricing Policy – Empirical Evidence from a Fare-Free Scheme in Tallin, Estonia by Oded Cats Triin Reimal and Yusak Susilothe, the Transportation Research Board has recently introduced a free-fare public transport (FFPT) in an effort to improve accessibility and mobility for its residents. This paper presents a macro- level empirical evaluation of FFPT impacts on service performance, passenger demand and accessibility for various travelers groups. In contrast to previous studies, the influence of FFPT on passenger demand was estimated while controlling for supply changes. The results indicate that the FFPT measure accounts for an increase of 1.2% in passenger demand with the remaining increase attributed to extensions made in the network of public transport priority lanes and increased service frequency. The relatively small effect could be attributed to the previous price level and public transport share as well as the short-term impact. The evidence-based policy evaluation is instrumental in supporting policy makers and facilitating the design of public transport pricing strategies.

According to Abdullah Fawzy, the head of Egyptian Metro Company (EMC), the company raised the ticket price of the rail-based systems in Cairo to cope with the high prices of spare parts and workers' wages. This is because their company does not receive any financial support from the state thus; the Ministry of Education owes over 400 million EGP to the EMC. In addition, the EMC incurred losses of 50 million EG during the curfew period which was imposed amid security unrest in August. However, these loses do not affect the companies' benefits.

3. METHOD AND RESULTS

This study is conducted in order to develop a proposed mathematical model as a basis for a standard minimum jeepney fare evaluation methodology in Metro Manila (NCR). For accuracy of variable identification and data collection, the researchers utilized the experimental research method using a cost-benefit approach. Among other types of research methods, the experimental method offers more freedom for the researchers to manipulate variables to understand causal processes as compared to other methods.

3.1 Conceptual Framework

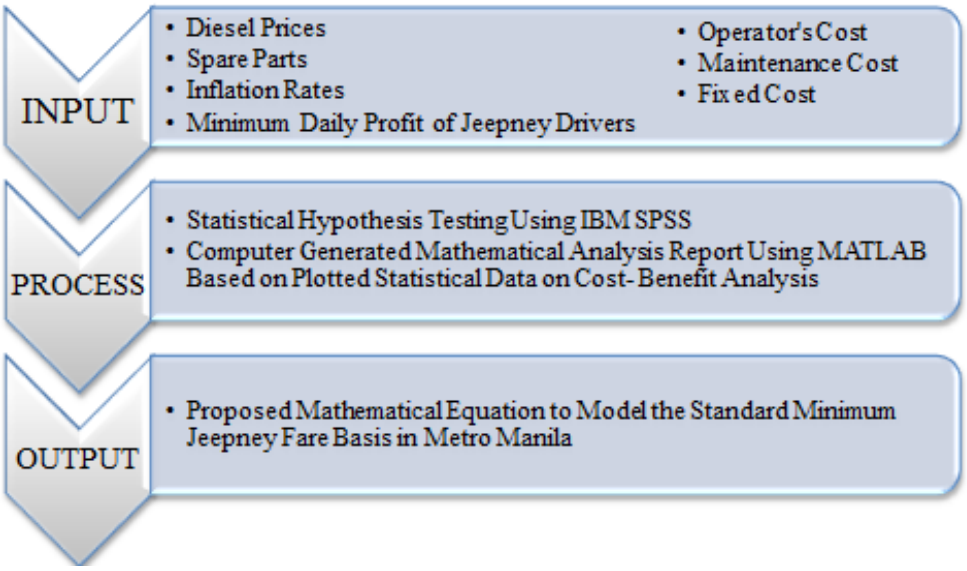

Figure 1. Conceptual Framework

The use of MATLAB; a mathematical modelling software will also be employed in order to idealize the gathered data and design the line of best fit from where the equation can be derived.

In view of this, respondents are selected from jeepney drivers and/or operators traveling Blumentritt–Pasay Rotonda via Sta. Cruz, Taft. The Blumentritt–Pasay Rotonda via Sta. Cruz will be selected as sample site by the researchers due to the convenience to the researchers, overall route length and jeepney population.

The questionnaire survey method was the statistical instruments to be used for data gathering and hypotheses verification.

Jeepney drivers and/or operators that are chosen as samples in this study will accomplish a quantitative data questionnaire to evaluate the variables that affect the overall cost of jeepney fares. The data gathered from the surveys will then be processed by the software, to compute the corresponding cost and benefit. The cost-benefit curve was formed by plotting the cost versus benefit. The data was used to conduct a standard statistical hypothesis test in order to verify the hypothesis and assumptions that were adopted. After which, the line of best fit was obtained using the software, from which, the equation was obtained.

3.2 Research Method

This study employed the use of experimental research method due to its cause-and- effect nature and the correlation among variables. According to Manuel and Mendel, The basic purpose of experimental research is to discover the influence of one or more factors upon a condition, group, or situation, purpose of which is to discover "what will be". It described and analyzed variables in a carefully controlled condition as a basis for inferring or concluding. An experimental research, therefore, consists of manipulating an experimental variable under highly controlled conditions to determine how and why a particular event occurs. (Manuel and Mendel, p.37) Relatively, experimental method is appropriate to this study since there is a cause-and-effect relationship among variables and parameters.

The researchers opted to use the quantified data questionnaire method as their tool in data gathering because it enables them to formulate generalizations based on actual statistical figures and not merely on vague descriptions. Only a primary data from the survey was gathered due to the time constraint of the research completion. It is noted that the survey used Filipino language for better understanding amongst non-technical individuals.

Standard statistical hypothesis testing is made in order to check and verify the validity of drawn hypothesis and assumption using a 5% level of significance.

In order to come up with a sound decision, based with a factual basis from the cost of a project and its corresponding benefit, the Cost-Benefit analysis is used. The cost-benefit analysis provides a systematic approach in estimating the strengths and weaknesses of a decision alternative. It also provides basis for comparing decision alternative cost and benefit whether the cost outweighs the benefit, and by how much.

3.3 Direct Data Survey

Direct-data survey aimed on collecting pertinent data about technical analysis. Accordingly, direct-data survey was used to reveal the status of some phenomenon within an identified class of people, organizations, or regions at a particular time through questionnaire and interview to directly collect information (Brubaker & Thomas, 2000).

The survey aimed to acquire pertinent data that the researchers can use to achieve the research objective. The site of the study was in Blumentritt− Pasay Rotonda route via Sta. Cruz - one of the longest jeepney routes in Metro Manila. The respondents were chosen on the basis of their knowledge of the information desired. After reading and studying several other sample surveys from other related studies, the researchers proceeded in making their own questionnaires. The researchers made sure that all items in the questionnaire will cover the all the answers pertaining to the specific questions under the statement of the problem. Then, the researchers submitted their questionnaire to their adviser for further evaluation before it was finalized.

3.4 Respondents of the study

The respondents of this study were the jeepney drivers and/or operators traversing the Blumentritt−Pasay Rotonda route via Sta. Cruz. This included full time driver and owners, together with part time drivers and their corresponding operators. All of these participants were selected using purposive sampling. This sampling method involved determining the target population on the basis of their knowledge of the topic. It surmised that the size of the population is the actual population of jeepney drivers travelling along Blumentritt− Pasay Rotonda route via Sta. Cruz.

3.5 Jeepney Driver's Average Daily Revenue

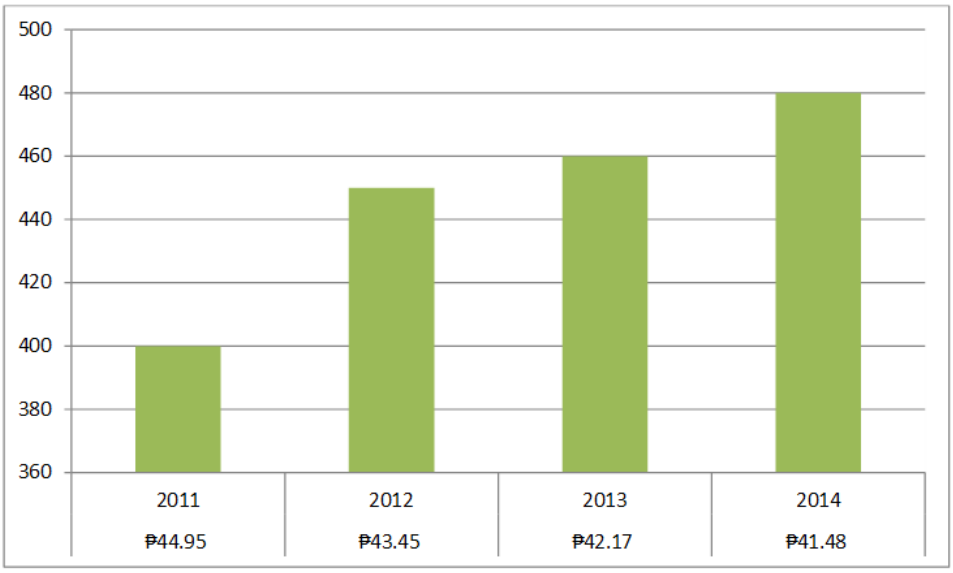

Figure 1. Jepney Driver's Average Daily Revenue from 2011-2014

Figure1 shows a historical data of jeepney driver's average daily revenue from year 2011–2014. The values on the Y-axis of the graph represent the average daily revenue of jeepney drivers in Philippine Pesos. On the other hand, the values on the X-axis of the graph represent the time (year) and the average price of fuel that corresponds to the average revenue of the jeepney drivers. The graph reflects that diesel prices increased gradually from year 2011-2014. Consequently, these periodic changes in diesel prices also affect the revenue earned by jeepney drivers. As the diesel price increases, the revenue of jeepney decreases.

3.6 Revenue Comparison

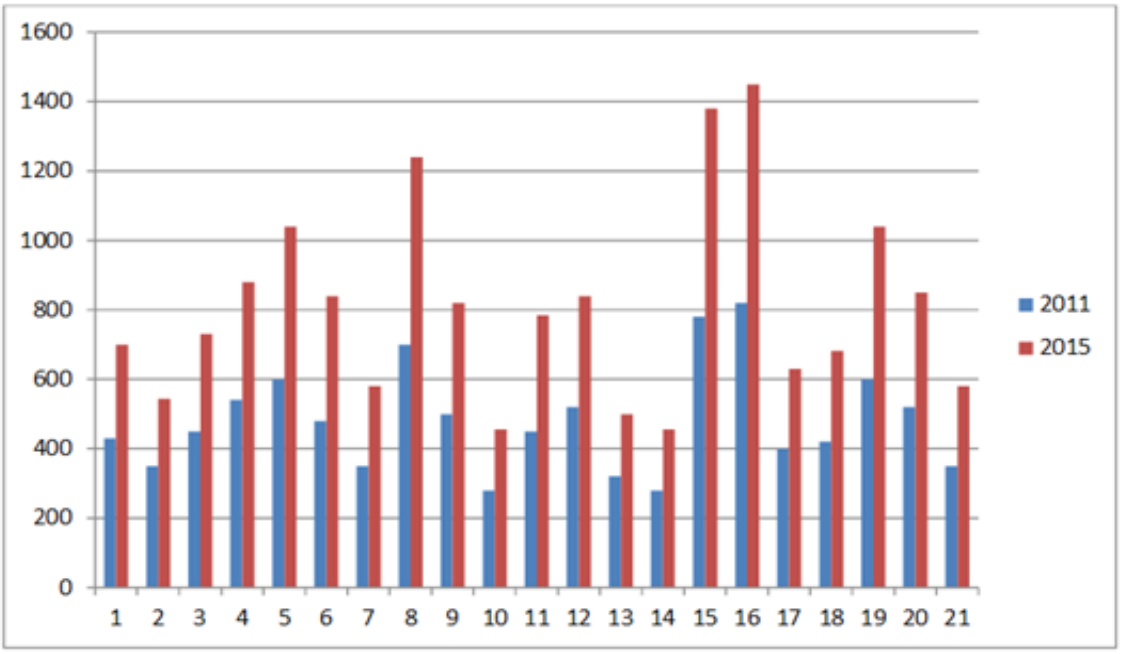

Figure 2. Comparison of Revenue from 2011-2015

Figure 2 shows a comparison of revenue earned by the 21 jeepney drivers interviewed, from base year 2011 and present year 2015. The values on the Y-axis of the graph represent the total revenue of the jeepney drivers. On the other hand, the values on the X-axis of the graph represent the sample jeepney drivers. The blue bar graphs represent the revenue of the jeepney drivers in the base year 2011 while the red bar graphs represent the revenue of the jeepney drivers in the present year 2015.Changes in the prices of the above mentioned factors took place during the four year time span. These changes in the factors caused significant changes in the total revenue earned by jeepney drivers as well.

3.7 Diesel Cost

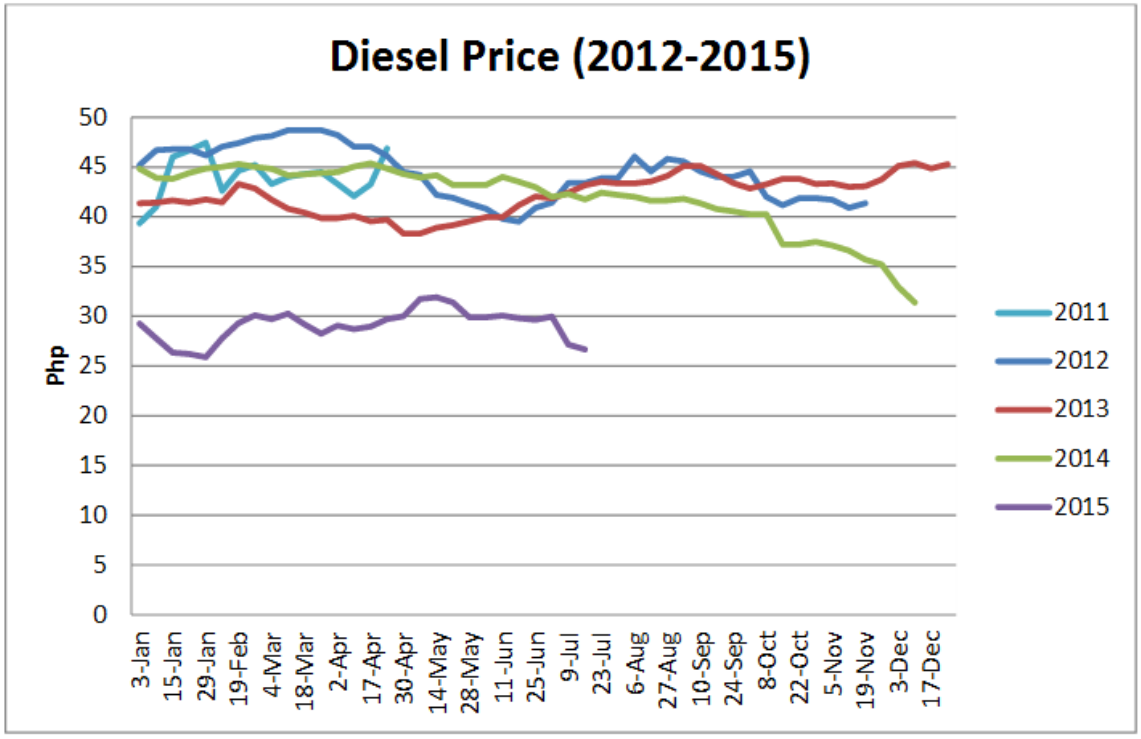

Figure 3. Diesel Prices from 2011-2015

Figure 3 shows a cost versus time graph of diesel from for the years 2011, 2012, 2013, 2014, and the first half of 2015. The blue line stands for the price behavior of diesel for the year 2012. On the other hand the red line stands for the price behavior of diesel for the year 2012. The green line stands for the price behavior of diesel for the year 2014. On the contrary, the purple line stands for the price behavior of diesel for the first half of the year 2015. From the table above, it can be inferred that there is a decline in diesel prices in the last four years. The diesel cost shall be taken as the summation of all diesel cost incurred in a 12-hour workday.

3.8 Fixed Cost per day

The fixed cost per day is shall be taken as the summation of jeepney unit cost per day, vehicle registration cost per day, route franchise fee per day, and license fee per day.

$$FC = J + U + R + D \tag{1}$$

Where: FC = fixed cost per day, in Php
J = jeepney unit cost, in Php
U = unit registration fee, in Php
R = route franchise fee, in Php
D = driver's license renewal fee, in Php

3.9 Jeepney Unit Cost

According to Bacero et al. (2009), the companies practice with regard to mode of payment for sales are usually on cash and installment basis. The usual number of terms is 1 to 5 years. Computing for the unit cost per day for maximum installment period of 5 years, the formula shall be taken as:

Jepney Unit Cost per Day (J) = $Total\ Cost/1825\ days$ (2)

3.10 Route Franchise Fee (R)

Based on the data gathered from the survey, the franchise fee being paid by jeepney drivers based on the latest information from the Land Transportation Franchising and Regulatory Board is with a sample mean of the total franchise fee of Php 30 000. Computing for the franchise cost per day for maximum franchise effectivity period of 5 years, the formula shall be taken as:

Route Franchise Fee (R) = $Total\ Cost/1825\ days$ (3)

3.11 Diver's License Renewal Fee (D)

Table 1. License Renewal Fee Breakdown

FEES AND CHARGES	RATES (Php)
Certificate Fee	100.00
Clearance Fee	30.00
Computer Fee	67.63
License Fee	350.00
Medical Test	100.00
TOTAL	**Php 647.63**

The table above shows the cost breakdown of license renewal fees from the latest rates of Land Transportation Office (LTO). Computing for the driver's license cost per day for maximum franchise effectivity period of 3 years, the formula shall be taken as:

Diver's License Renewal Fee (D) = $Total\ Cost/1095\ days$ (4)

3.12 Unit Registration Fee (U)

Table 2. Unit Registration Fee Breakdown

FEES AND CHARGES	RATES (Php)
Registration	2000.00
Sticker	50.00
Computer Fee	170.00
LRF	10.00
Grand Total	**Php 2230.00**

The table above shows the breakdown of cost upon vehicle registration. Computing for the vehicle registration cost per day for maximum franchise effectively period of 1 year, the formula shall be taken as:

$$\text{Unit Registration Fee (U)} = Total\ Cost/1095\ days \quad (5)$$

3.13 Operator's Profit

Based on the data gathered, the ratio of the average fixed cost to the operator's profit was found to be 0.4. Therefore operator's profit shall be taken as:

$$\text{Operator's Profit} = 0.4FC \quad (6)$$

3.14 Maintenance Costs

According to the statements of our sample respondents, the total cost for operations are being increased by events such as jeepney unit malfunction/ defect and during the occurrence of traffic violations.

Spare Parts

Table 3. Most Common Jeepney Mechanical Part to Malfunction

PARTS	FREQUENCY (per month)
Brake System	1
Wheel	3
Wheel Cylinder	2
Clutch	2
Wheel Cap	2
Alternator	1
Engine	1
Battery	1
Horn	1
Rim	1

The table above shows the most common jeepney mechanical part to malfunction and its corresponding frequency per month. From the table, the average frequency of mechanical malfunction is two (2) times per month.

Table 4. Cost to Repair of the Most Common Jeepney Mechanical Part to Malfunction

MECHANICAL PART	**YEAR AND PREVAILING (Php)**				
	2011	**2012**	**2013**	**2014**	**2015**
brake system	280	360	440	520	600
wheel	30/ wheel	30/ wheel	40/ wheel	40/ wheel	50/ wheel
wheel cylinder	350	380	400	450	500
clutch	150	175	190	210	240
wheel cap	350	350	420	420	500
alternator	500	500	550	600	650
engine	-	-	-	-	-
battery	780	810	840	870	900
horn	180	220	220	250	250
steel rim (4 pcs)	600	525	650	670	700

The table above shows the cost to repair of the most common jeepney mechanical part to malfunction. From the base year 2011, the prices to replace of these mechanical parts increase up to the present year. With a frequency rate of two (2) times per month, the probability of mechanical malfunction to occur twice per month can be computed using Poisson distribution and shall be taken as:

$$\text{Probability} = ((e^{-2} * 2^{0})/0!) + ((e^{-2} * 2^{1})/1!) = 0.4060 = 40.60\% \text{ per month} \quad (7)$$

From Table 4, in the year 2015, the maximum possible cost that will be incurred upon the repair of a malfunctioned mechanical part shall be taken as the sum of the two highest costing materials. Based on the data provided by the survey, the average value of SP_{max} shall not be less than the sum of the two highest costing materials. Furthermore, it shall be taken as:

$$SP_{max} = 0.1FC \quad (8)$$

Violation

The average sample frequency for charged violation is two (2) times per month. Also, based on the data provided by the survey, the average value of violation cost was not less than the minimum violation penalty. Furthermore, it shall be taken as:

$$\text{Violation Cost} = 0.1FC \quad (9)$$

3.15 Total Cost Breakdown

From the results of the study, a total cost breakdown table was formed.

Table 5: Total Cost of Summary

Cost Parameters	Total Cost (per day)	Remarks
Diesel	2500	Diesel cost per day
Fixed Cost/ Boundary		
Jeepney Unit Cost	300000/1825	Total Jeepney Unit Cost/ 1825
Unit Registration	2230/365	Unit Registration/ 365 days
Route Franchise Fee	30000/1825	Route Franchise Fee/ 1825 days
Driver's License Fee	647.63/1095	Driver's License Fee/ 1095
Operator's Profit	75.00917991	0.4*(J+U+R+D)
Maintenance Cost		
Spare Parts	18.75229498	0.1*(J+U+R+D)
Maintenance Cost	18.75229498	0.1*(J+U+R+D)
Grand Total	**2800.03672**	Summation of all cost parameters

3.16 MATLAB software analysis

The use of MATLAB software was employed in order to determine the equation for the line of best fit also known as Regression Line Equation. By utilizing the curve-fitting functionality of MATLAB, the researchers were able to form an equation corresponding from the set of plotted data points. From MATLAB analysis, the Benefit Estimation Curve was determined with a coefficient of determination of 0.7304, and shall be taken as:

$$B = -1.20x10^{-10}C^4 + 1.49x10^{-6}C^3 - 5.80x10^{-3}C^2 + 8.89C - 3831.8 \quad (10)$$

Where: B = Total Benefit
C = Total Cost from Total Cost Summary Sheet

3. 17 Correction Factor for Effects of Inflation

Since the benefit estimation equation were constructed in the current year 2015, it is recommended to use a correction factor that will take into account the general increase or decrease of goods in a specific time of reference. The correction due to change in inflation rate shall be multiplied to the benefit estimation equation (B.E.E) for years succeeding 2015 and shall be taken as:

$$i = 1 + \Delta I.R \quad (11)$$

Where: i = correction factor
$\Delta I.R$ = change in inflation rate from present year and preceding year

3. 18 Minimum Fare Equation

Based on the data gathered from the survey conducted, a non-deterministic minimum jeepney fare equation was constructed by empirical methods. The minimum jeepney for Metro Manila (NCR) shall be taken as:

$$MF = \frac{\frac{R}{\tau}}{P\left(\frac{M_D}{T_D}\right)+P\left(1-\frac{\left(\frac{T_D!}{M_D!}\right)}{T_D^{T_D-M_D}}\right)} \quad (12)$$

Where:
R = B + C (from B.E.E and cost summary sheet)
P = riding average per route (average number of people that rides on single trip of the jeepney)
M_D = 4 km (constant distance for minimum fare)
T_D = total route distance in km
τ = total trips in 12 –hour workday

4. CONCLUSION

One of the major dilemmas that the overall jeepney transport system is currently facing is the lack of a scientific tool as a basis in fare regulation. This dilemma not only affects the benefit earned by transportation investors, but also deteriorates the quality of transportation services. Thus, this study was undertaken.

The study shows that the benefit of jeepney drivers is dependent upon the total operational cost that they incurred in the transportation business. By employing the use of standard student t- test, the researchers found out that the factors stated above have a significant effect on both total cost and total benefit, therefore the null hypothesis was rejected and the alternate hypothesis was accepted.

Furthermore, using the independent variable (cost) as a predictor value for the dependent variable (benefit), an estimation curve to predict the value of dependent variable was derived using MATLAB software.

Since the annual change in prices of commodities affects the total cost of operation of transport investors, the benefit estimation equation requires to be adjusted in order to take account these changes. Thus, a correction factor for inflation is to be multiplied to the benefit estimation equation for years other than the experimental year (2015).

From the values estimated by the equation of the curve, the minimum fare formula was established using empirical methods. Using the minimum fare formula for the current condition of prices, the minimum jeepney fare is 7.61 Php.

5. RECOMMENDATION

In order to further improve the accuracy of the non-deterministic formula derived in this study, the researchers recommend that the study shall be duplicated in other localities in order to develop a contrast and comparison basis for the data gathered.

Also, the researchers recommend a re-calibration of the benefit estimation equation every five (5) years upon the publishing of this paper. This is to improve the correlation between the data and the model.

Since the duration of this study is limited, it is recommended to increase the period of time in data gathering to accurately plot the data points needed to derive the benefit estimation equation.

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APPENDIX A
SAMPLE COMPUTATIONS

Total Cost of Summary

Cost Parameters		Total Cost (per day)	Remarks
	Diesel	2500	Diesel cost per day
Fixed Cost/ Boundary			
	Jeepney Unit Cost	300000/1825	Total Jeepney Unit Cost/ 1825 days
	Unit Registration	2230/365	Unit Registration/ 365 days
	Route Franchise Fee	30000/1825	Route Franchise Fee/ 1825 days
	Driver's License Fee	647.63/1095	Driver's License Fee/ 1095
	Operator's Profit	75.00917991	0.4*(J+U+R+D)
Maintenance Cost			
	Spare Parts	18.75229498	0.1*(J+U+R+D)
	Maintenance Cost	18.75229498	0.1*(J+U+R+D)
	Grand Total	**2800.03672**	Summation of all cost parameters

$\tau = 9$ trips
P= 45 person/ trip
M_D=4 km
T_D=12 km
C = Php 2800.03672

$$B = -1.20x10^{-10}(2800.03672)^4 + 1.49x10^{-6}(2800.03672)^3 - 5.80x10^{-3}(2800.03672)^2 + 8.89(2800.03672) - 3831.8$$

$$\boldsymbol{B = 920.8417042}$$

$$R = B + C$$

$$= \mathbf{920.8417042} + \mathbf{2800.03672}$$

$$\boldsymbol{R = Php\ 3720.878424}$$

$$MF = \frac{\frac{2800.03672}{9}}{45\left(\frac{4}{12}\right) + 45\left(1 - \frac{\left(\frac{12!}{4!}\right)}{12^{12-4}}\right)}$$

$$\boldsymbol{MF = Php\ 7.139}$$