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## Trip Generation Study of a Shuttle Service System in a Relocation Site: A case in the Philippines

Maria Cecilia Paringit<sup>a\*</sup>, Reil Dominic Catolos<sup>b</sup>, Angelo Josh Custodio<sup>b</sup>, Jacob Layug<sup>b</sup>, Jonathan Uy<sup>b</sup>, Joenel Galupino<sup>a</sup>, and Paolo Lucero<sup>a</sup>

<sup>a</sup>Faculty, Civil Engineering Department, De La Salle University, 2401 Taft Avenue, Malate, Manila, 1004 Philippines

<sup>b</sup>Student, Civil Engineering Department, De La Salle University, 2401 Taft Avenue, Malate, Manila, 1004 Philippines

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### Abstract

The current income of the relocation site residents of Southville 7 in Calauan, Laguna, Philippines is not sufficient to support their everyday expenses and one of the main reasons why they could not save is that they are spending too much on transportation costs. Therefore, it is imperative for the researchers to propose a new transportation plan that will cater to the needs of the working class.

The researchers based their proposed plan in one of the four-steps in transportation planning, which is trip generation. Various methods such as basic analysis of survey results, floating car technique, and linear and multi-regression modelling were performed. The researchers were able to garner data such as the population in each site, skillsets, monthly income, preferred mode of transportation and corresponding cost, and several other factors.

The results of the proposed transit made a significant difference in the transportation expenses in which the working class would be able to save more than half of what they normally spend in their usual travel expenses through the group's proposed shuttle service.

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### 1. Introduction

Rural areas are bound to rely on freight and passenger transportation services to unite neighboring areas that contribute to its development. People living in these areas commute to their work and other daily destinations. Commuting requires various modes of transportation such as automobiles, trains, buses, bicycles, or even on foot. In addition to this, goods and services are also being transported daily in these areas for the livelihood of the residents (Dye Management Group, 2011).

Development of appropriate transport services requires the help of both the government and the community therefore; a partnership approach is an ideal way for local communities to respond to their transport and accessibility needs. The government needs the knowledge of important factors such as significant local destinations or even of the days of the week when people are most likely to travel this is where the local government organizations and community comes in. The partnership of the above also provides an ideal solution for the governments who, faced with resource constraints, need innovative, effective and preferably low cost solutions (Wear, 2009).

The studied 107-hectare site (as shown in Figure 1 is categorized as a basic rural relocation site (Dye Management Group, 2011) at Southville 7 in Calauan, Laguna, Philippines. The residents located in the site were those affected by one of the Philippines' strongest typhoon, 'Ondoy', and those affected by the rehabilitation of Pasig River. Along with the growing population of the residents living in Southville 7.

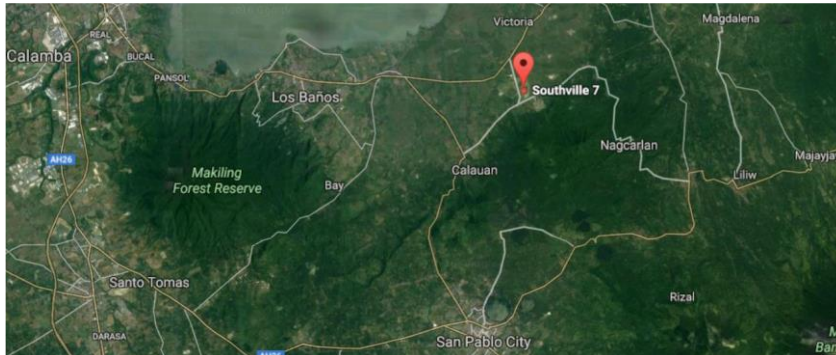


Fig. 1. Location of the site, Southville 7, in Calauan, Laguna.

A major problem faced by most of the working class was that a sizable portion of their total income is spent on transportation costs going to and from their respective work areas. Most of which are located within Laguna and Metro Manila. The absence of a cheaper point-to-point (P2P) commuting alternative is a problem for most the working class of the community because of their minimal income.

The issue this study aimed to tackle was the absence of a transit plan which was needed by the. The minimum wage rate is around Php 260.00 to Php 380.00 or around Php 1,320.00 to Php 1,900.00 per week. The absence of proper transportation options contributes to the demographic paralysis within the community retaining their poverty. One of the four-step process (Schroeder, 2016) in planning and forecasting traffic demands and future conditions of the transportation system was studied. Trip generation is the process of determining the number of trips that will begin or end in each traffic analysis zone within a study area (Garber and Hoel, 2009). This process focuses on two functions: a) to establish a relationship between trip production (beginning of trip) or attraction (end of trip) and land use, and b) use the relationship to estimate the number of trips produced/attracted at a point in the future. The method to be used would be a regression analysis to estimate the travel generated with the income generated by the residents, which were gathered from the surveys conducted.

The main objective of this study is to be able to develop and schedule a shuttle service that will transit users from Southville 7 to Itikan, where the residents have access to several modes of public transportation, and better the commuting plan based from the currently available transportation modes in the area. Thus, increasing and promoting the use of an efficient and systematized mode of transportation that would provide residents an effective transportation plan from the community to Itikan. Transportation cost would also be maximized as an effect of the strategically planned trips and the maximized accommodation of passengers, ensuring the trips to be economical.

## 2. Methodology

An interview with Fr. Salvador Pablo, the Don Bosco Salesian in-charge of Southville 7, regarding the main transportation problems of the site and what their main intentions were in solving it. The on the site data such as the employment rate, and currently available modes of transportation to common destinations of the people in the site

were garnered. These data were used in the development of the social survey. The household and population count of the site was requested from the Philippine National Housing Authority (NHA). The population count was used to verify the margin of error per site and was used to be able to consider the data as a representative of the total population.

A road survey was conducted by performing traffic counts of buses, and jeeps passing through *Itikan*. The vehicle headway during the time at which the residents travelled was determined and was verified by the survey questionnaire as the researchers inquired the time of departure from their respective sites.

After having analyzed available data, generation of costing, and creating the necessary statistical models considering all factors affecting the data, the researchers finalized the plan and schedule.

### *2.1. Survey and Interview*

The survey questionnaires were distributed among a random sample of at least 142 residents site one, 108 in site two, and 143 in site three of the study area. This generated data that yielded an 8% margin of error and a 95% confidence level. The population size was obtained from the NHA stationed on site. It was assumed that only one member per family was considered working. As a result, the population size used in the calculation is the recorded number of families per site. A social survey was used to determine the travel demand of the community, trips produced and attracted, waiting and departure time of the users, and the socioeconomic characteristics of the residents. The data obtained from the surveys were used to generate the regression models needed to interpret and analyze the data.

Some of the information (e.g. total number of households of Southville 7) which may not be obtained through survey and other modes of research were acquired through interviews with Fr. Salvador Pablo and Miss Susan Pullarca, head community organizers who are most familiar with the site and distribution of people. Information from them was used in creating survey questionnaires as they would know additional factors that should be considered. In addition, interviews would include consultation on the generated questionnaires prior to distribution.

An interview with a head of a bus company was performed to determine the consumption of their vehicle, required maintenance, and other operating costs. It is essential for the transit system to be self-sustaining due to the socioeconomic situation of the site. Knowledge on the operating and maintenance costs was used for the costing of the shuttle service system which aims to only reach the breakeven point.

### *2.2. Travel Time Determination*

The travel time determination was performed using the Floating-Car Technique wherein a test vehicle was used to drive along the traffic at various times using different routes determined using road maps. Specifically, it was performed by using a test vehicle to assess the overall traffic condition, which includes the traffic flow and the journey time of the transit plan. In addition, this technique considers the basic vehicle information such as speed, path, and the position of the vehicle.

### *2.3. Trip Generation*

Data in determining the travel demand or trip generation were from the conducted social survey. A linear regression analysis was performed to determine the relationship between the incomes of each household with the trips produced per household. This will represent a sizable proportion of trips in the future.

### *2.4. Headway Determination*

A traffic count on the buses and jeepneys passing through *Itikan* along National Highway was conducted to determine the vehicle headway and traffic volume count. The counts were performed during the determined day of travel of the people. The time at which these were performed was determined post the social survey; as it inquired the typical hours of travel of the people who use public transportation to and from *Itikan*.

### 2.5. Zonal Analysis

Multiple maps of the site were generated with graphs displaying the different results from the survey questionnaires. This was used to better understand the numerous factors affecting transportation within each site. The factors were weighed-in in the creation of the final plan, in which it accommodated the most number of people.

### 3. Results and Discussions

The demographics shows majority of the interviewees of the working class are male and are middle aged. Most of the working class in site one were only able to reach secondary education or less. They are working as construction workers, drivers, and machine and production. Majority earn the minimum wage, shown on Figure 2, but a significant amount of people working near Calauan, as stated by some of the respondents during some interviews, earn below the prescribed minimum wage by the government making it hard for the families to save money since their transportation costs greatly affect their budgeting.

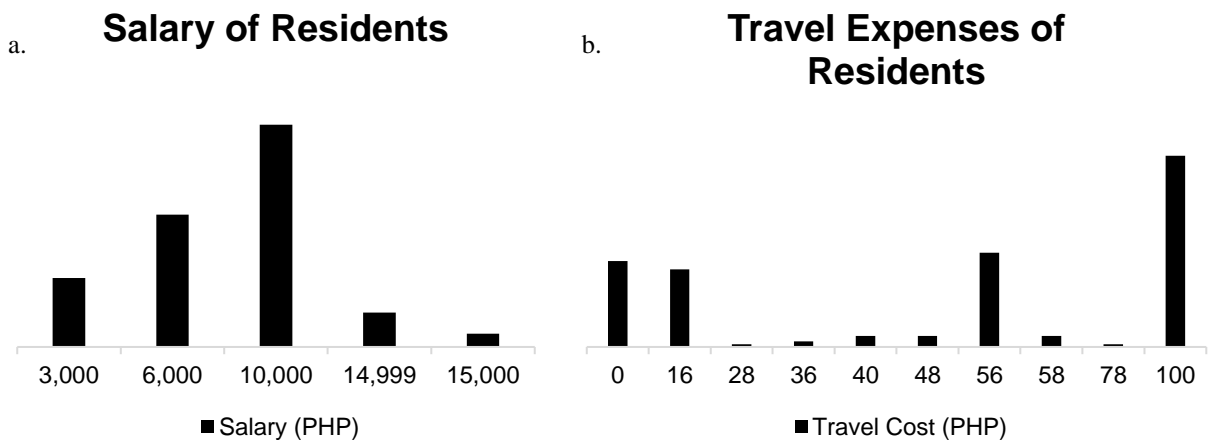


Fig 2. (a) Salary and (b) Travel Cost of Southville 7 Residents

The residents' primary modes of transportation are composed of public tricycles and jeepneys but majority of them preferred the use of tricycles because of the convenience over cost. The fares of the tricycles on site is not consistent as each price differs from one driver to the next, and also because of the vast area. Most of the tricycle drivers usually demand 50PHP per ride from the site to Itikan and vis-à-vis but others fare higher depending on the time the commuters' ride, as well as how much passengers they have accommodated during their shifts. Some of the tricycle drivers whom the group interviewed stated that their fare is higher than 50PHP when it is late at night or very early in the morning since there are only a few of them roaming in the area. Drivers take advantage of this and demand higher fares to the passengers because they have no choice but to agree since that is their only mode of transportation at the moment. One of their usual reasons why they opt to use tricycles for their mode is that most of the working class only commute once going to and from their workplace. As most of them work in Manila or at farther parts of Laguna, they rent dormitories or other inexpensive places to live for the week. Commuting only once a week going to and from their house to Itikan is one of the reasons why they could afford to spend 100 pesos on their weekly budget.

The time when the residents depart their respective houses are usually in the morning in between 3 A.M. to 7 A.M. A large fraction of commuters leave their homes at 4 A.M., a time where numerous buses are available to occupy when they reach Itikan.

The residents from Southville 7, who are mostly working in Metro Manila, earn higher income as compared to residents working within the vicinity. One of the factors encouraging the residents to work far from their homes is due to the available opportunities to earn more. Most locations mentioned strictly enforce the minimum wage salary that they are entitled to; while on the other hand, workplaces near their area do not comply with the minimum wage salary.

It was also observed that a greater distance from Southville 7 would yield a higher transportation cost. The ANOVA models produced an inversely proportional relationship between travel cost and place of work along with mode of transportation. This indicates that as farther one works, the higher the travel cost; whereas the nearer the workplace is to the site results in a decrease in travel cost. Along with this, the travel cost is higher when the mode of commuting used is a trike directly going to Itikan, followed by a trike and jeep combination, and so on as. The residual plots, sample shown on Figure 3, show a randomly distributed data in the independent variable axis, which indicates that the linear regression model is appropriate for the data obtained. The regression model predicted that a large portion of the respondents commute daily using the trike, indicating that the strike is the most used mode of transport in Southville 7. Also, the regression models produced, it shows that whether the residents work either in Manila or Calauan, the same travel expense going to and from Itikan is the same for all. Therefore, the three variables namely; workplace, cost, and mode of commuting, are interdependent as either the workplace and mode of commuting greatly affects the residents’ total travel cost.

### Workplace Residual Plot

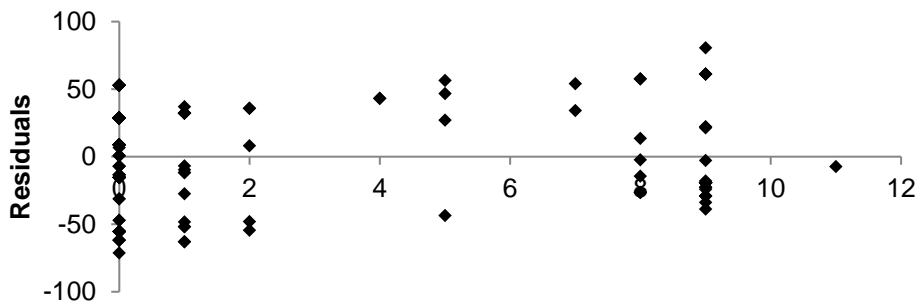


Fig. 3. Workplace Residual Plot of the Residents

To match the shuttle schedule to the frequency of incoming transit vehicles minimizing the waiting time for the residents, a headway survey was conducted on a weekday starting 2:45 A.M. until 6:00 A.M. The waiting time of the residents in Itikan varied depending on the destination and type of transportation system. Although, the intervals were found to be mostly less than 10 minutes. Thus, the waiting time of residents in Itikan before boarding their next trip was considered negligible in the scheduling of the proposed transit.

To obtain the approximate time of travel between five set stations in the site which was assumed to be set as the five transit stations. The route was assigned through the basic observation of road quality and accessibility. The results of the time recorded between stations, shown in Figure 4. The distance between stations was obtained through Google maps. It was observed that the travel time, (assuming a speed of 30 to 40 km/ hour) including stops exclusive of a waiting time, would be a total of around 14 minutes roundtrip.

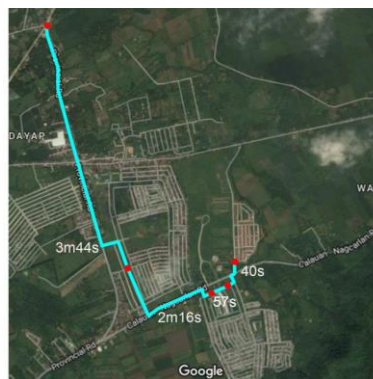


Fig. 4. Travel time for going direction recorded between stations through the floating car technique

The data obtained was narrowed down into only the most crucial factors affecting the transit: schedule of travel, destination, and demand. It was discovered that the most efficient way of operating the transit would be only during peak hours of travel demand on Mondays as a number of commuters only travel once a week going to their job. The trips generated are inversely proportional to the time of departure of the residents, indicating that more trips are generated at an earlier time, which would be at 3:00 A.M, and lesser trips generated later. The relationship of the trips generated with the total income earned per person yielded p-values for all sites that are less than 0.5 percent, indicating that model produced is valid. In addition to this, the coefficients for the total income in all three sites yield a positive value, showing that a directly proportional relationship exist between the two variables. However, the coefficients produced both in the statistical model yield a zero-value, therefore indicating that the total income earned does not have an implication on the trips generated by the residents. This was expected since most of the residents in all three sites commute, whether they earn little or larger income.

With the regression models generated along with the other factors obtained, such as the travel route and corresponding time and distance, approximate fuel cost, driver’s salary, and maintenance cost, the researchers designed the economic characteristics of the proposed shuttle service. In obtaining the travel route and travel time, a floating car technique was used and resulted to a total travel distance of 6.2 kilometers, with a corresponding roundtrip travel time of approximately 24 minutes, including the 2-minute waiting time for the shuttle to accommodate the passengers in each stop, shown on Figure 5.

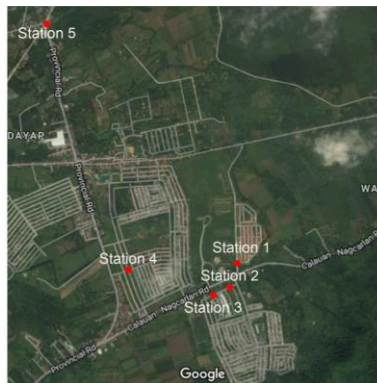


Fig. 4. Proposed station mapping for the transit

For the integration of the operating cost, according to Gina Trinidad, CEO of Eagle Star Transit Corporation, a single bus unit consists of three factors for operating cost, namely: fuel, maintenance and driver’s salary. For fuel, the basis for which depends on the number of liters consumed within 7 kilometers of distance traveled. With the roundtrip distance of 6.2 kilometers and an average fuel cost of Php 29.00 per liter, the fuel cost per trip is equivalent to Php 26.00. Driver’s salary would be based on the minimum wage, which is Php 350.00 per day, with the total operating time of 3 hours (3:00 A.M. to 7:00 A.M.). With this, the driver’s salary will amount to Php 35.00 per trip. With the 13 percent added maintenance cost based from the operating cost referenced from Eagle Star Transit Corporation, the total operating cost per trip then would be approximately amounting to Php 70.00. Computing the cost with a minimum passenger capacity of 5 persons and a maximum of 40 persons, this would result to an average cost of Php 6.00 per person per trip. This is to assume that all values used are of the minimum standard, meaning the cost per person per trip can still increase in value if the passengers accommodated does not meet the full seating capacity, the cost projection is shown on Figure 5.

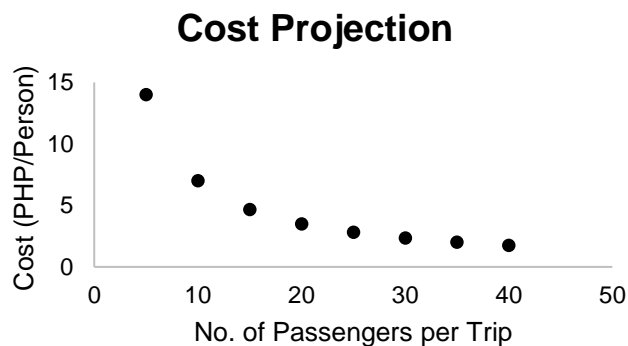


Fig. 5. Cost of shuttle service in terms of passengers

In order to maximize the seating capacity of the shuttle service, a bus scheduling would also be designed to inform passengers in all three sites. The schedule will be based on the arrival and headway of the different modes of transportation (e.g. bus and jeep) passing through Itikan, especially during peak hours at 3:00 A.M. to 7:00 A.M. The schedule also incorporates the travel time and the two-minute waiting time for each stop. With the proposed shuttle schedule, there will be 10 trips in total starting 3 A.M. to 7 A.M.

The fee of 6.00 per person per trip was obtained by taking the average of the maximum and minimum cost depending on the accommodated passengers per trip.

#### 4. Conclusions and Recommendations

A scheduled transit plan was developed which would transit the residents from Southville 7 to Itikan. The said transit would operate on Mondays. This would run from 3:00 A.M. to 7:00 A.M., the peak hour for travelling commuters. The shuttle would be waiting for two minutes per station of the five stations and each round trip would take a maximum of around twenty-five minutes if the bus would run on a speed of around 30 to 40 kilometers per hour. The plan accommodates a maximum of forty passengers per trip. The cost of each trip would be six pesos to breakeven with the operating and maintenance costs.

The data gathering results included the current socioeconomic standing of the residents and as well as their travel characteristics such as their departure time or cost of travel. The headway results for each transportation mode passing Itikan showed no need for minimizing the waiting time of residents in Itikan. The comparison between the proposed plan and the currently existing modes of transportation from Southville 7 to Itikan. It was proven that the planned transit was more economic than the other commonly used modes of transportation and the tradeoff would be a few minutes added time to get to Itikan.

It is recommended that further studies would include the variation of different vehicles to be used as the shuttle service, mainly its economical characteristics, and is to be compared with the proposed bus shuttle service. It is also recommended to conduct the other steps of the four-step process in traffic planning as this research only dealt with the first step namely trip generation.

The results and observations obtained from the regression models were used as basis in determining the factors that greatly had an impact to the trips generated by the residents in all the sites. It showed that the time of departure was greatly scattered in the study framework of the study, concluding that there will be residents commuting evenly distributed at the hours of 3:00 to 7:00 A.M. As for the influence by the total income earned, it was not in favor of any site, thus also concluding that the trips generated are evenly distributed among all the sites. These are then used to correspond to the design of the shuttle service, including the travel route and waiting time per station. The arrival of the shuttle service to the last station will also be in par with the arrival of the public modes of transportation passing through Itikan, which results in the maximization of the accommodation of passengers for sites one and three, and as well as the travel time of the shuttle along its travel path.

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