Proposed Improvement of the Public Transport Service Routes in Northern Iloilo, Region VI, Philippines

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Abstract: The population growth rates in Philippine provinces, like Iloilo, threatens the capability of its existing public transport system in accommodating the growing transportation demand. Locals have expressed that the current transportation issues include outdated operation systems, traffic congestion, and overcrowding. The objective of this study, therefore, is to improve the public transport system in Northern Iloilo through proposing new transit routes and services. Three scenarios were established in the model: Existing Routes (Scenario 1), Local Public Transport Route Plan (LPTRP) Recommended Routes (Scenario 2), and Proposed Routes (Scenario 3). Results from the baseline model and LPTRP recommended routes were assessed. Subsequently, a total of 37 transport routes composed of express, limited, and regular services were proposed for Scenario 3. Upon comparison between scenarios, the proposed scenario (Scenario 3) yielded the best results, having a lower passenger-hour total and a reduced travel time average, indicating an improvement if implemented.

Keywords: Public Transport, LPTRP, Iloilo, Scenario Modelling

1. INTRODUCTION

1.1 Background of the Study

The Public Utility Vehicles Modernization Program (PUVMP) is an ongoing reform project that focuses on improving not only modernizing the public transportation modes but also the whole public land transportation industry of the Philippines (Sunio et al., 2019). This program ensures to benefit both drivers and commuters as it aims to provide modern and efficient public transportation. With that being said, it is mandatory for the LGUs to submit their own Local Public Transport Route Plan (LPTRP). For Iloilo province, the LPTRP designed for the area focuses on each municipality (within their political boundary). On the other hand, this study aims to improve the intra-provincial public transport service. The focus of this study is the coastal towns of Northern Iloilo, specifically Ajuy, Anilao, Balasan, Banate, Barotac Nuevo, Barotac Viejo, Batad, Carles, Concepcion, Estancia, Leganes, San Dionisio, and Zarraga. As seen from Figure 1, the corresponding blue arrows represent the service route that will be assessed and analyzed to further improve the public transport system along the area. The said route covers from Iloilo City until the farthest municipality of Northern Iloilo, Carles. All 13 municipalities of Northern Iloilo will be observed as the behavior and characteristics of the people residing in these areas affects the flow of traffic demand and public transport system in district 6.

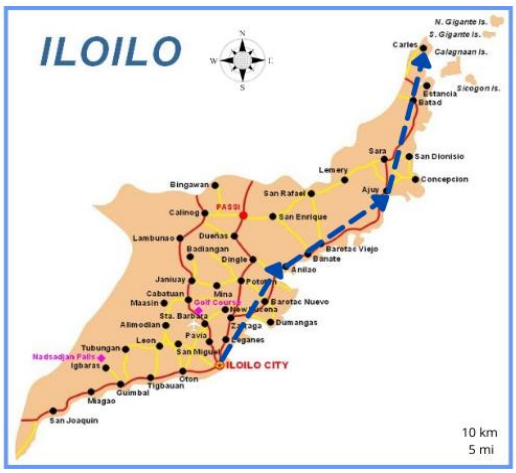

Figure 1. Road Map of Iloilo Province

The main objective of this study is to find possible ways to further improve the public transport services in the coastal towns of Northern Iloilo. With the help of software such as QGIS, descriptive analysis could be done which could serve as an initial view of the study area's spatial characteristics. The EMME software, on the other hand, would be utilized in the bulk of the modelling process. With the focus being on finding differences and improvements between the current public transport system in Iloilo, the scenario applying the LPTRP recommendations, and a scenario applying the researchers' new proposed routes, scenario modelling would be done. A total of 3 scenarios would be introduced in this study, namely Scenario 1 – Current/Baseline Model; Scenario 2 – LPTRP Recommended Routes; and Scenario 3 – Proposed Routes.

It could be highlighted that the three scenarios differ in terms of the routes implemented along the study area. Scenario 1 would consist of the currently implemented routes in Northern Iloilo. This data would be extracted from Iloilo's LPTRP. Scenario 2, on the other hand, would consist of the modified route plan from the same LPTRP. The said modifications are centered on eradicating some routes as well as merging most overlapping routes. Lastly, Scenario 3 would consist of new proposed routes and service schemes based on the results that would be analyzed from the baseline model. The basis of introducing these scenarios would be to compare and analyze the results of each so as to find justifications for improvement such as differences in travel times, passenger-hours, etc.

1.2 Statement of the Problem

The transportation system is essential to the progress and success of modern society as this contributes to economic development and maintaining sustainable growth along with society (Stjernborg & Mattisson, 2016). However, as time passes by, the public transportation system in Northern Iloilo due is becoming detrimental to the growing population and transportation demand of Filipinos (PSA, 2018). One of the major problems in Northern Iloilo is there is no efficient public transportation system due to the lack of integration of mass transit lines and the availability of common stops or stations in the area. Based on the observations and interview surveys conducted by the Provincial Planning and Development Office to drivers, operators, and commuters ("Iloilo Provincial Public Transport Route Plan," c.a. 2020), issues are commonly found regarding transportation terminals, outdated operation systems, and traffic congestion. Transportation terminals are found to be placed redundantly and poorly maintained. There are no designated terminals in some municipalities for loading and unloading of passengers that greatly affect the mobility, accessibility, and convenience of commuters in

using the public transportation.

Another major problem is the gap between supply and demand in terms of passenger demand which creates the problems experienced by the providers and users of transit services ("Municipality Batad Local Public Transport Route Plan," c.a. 2022). The demand can be too high during peak hours that greatly affect the traffic load of the PUVs. It is also stated in the Iloilo Provincial Public Transport Route Plan (c.a. 2020) that the PUV's are sometimes overloaded or crowded that compromises the safety and comfort of the passengers. In addition to that, there is no fixed schedule of trips or exact interval of departure time for each public utility vehicle which can cause long queues of empty or only partially filled transit services, or long queues of passengers waiting for transport services that can lead to waste of time and reduce the productivity of people.

1.3 Objectives

The primary objective of the study is to propose improvement in the current PUV service routes serving the coastal towns in Northern Iloilo. Specifically, the study aims:

- To determine the existing public transport demand along the proposed route in Northern Iloilo.
- To model and evaluate the existing traffic conditions and public transit services.
- To model and analyze the public transport routes recommended by the LPTRP of Iloilo Province.
- To propose rationalized public transport routes and structured service schemes such as express, limited, and local stops service depending on passenger demand.

1.4 Significance of the Study

The underdeveloped public transportation sector present in Northern Iloilo produces outdated data, models, and schemes that are detrimental to the development of the region. The model produced may provide a more accurate and updated simulation of the existing transportation system in the region. Subsequently, the study provides a scheme that would not just focus on the capital city but rather linking Northern Iloilo through public transport. Subsequently, the impact assessment on the proposed public transportation scheme may provide an essential framework for future feasibility studies conducted by the local government of the region. This is done through a more thorough analysis of the commuting community which will be conducted as the proposed public transportation scheme will cater the growing demand. The development of such schemes is dependent on the data in relation to the commuters' behavior, travel pattern, and decision-making. With this, a more apt solution addresses not only the needs of the region but also relieves the current public transportation issues experienced by the commuters. With regards to academia, the study provides an additional body of knowledge regarding the transportation characteristics, behavior, and socio-demographic data in general for Northern Iloilo in the field of transportation engineering. The study aims to fill in the gaps present regarding transportation studies within the study area and aims to provide a framework for future studies in relation to Western Visayas, transportation planning, and development. This holds true as the study employs a different method contrary to the metrics found in the LPTRP manual through the utilization of the EMME software allowing the altering and improvement of proposed routes in the manner that would benefit the passenger.

2. REVIEW OF RELATED LITERATURE

2.1 Public Transport in Iloilo

An article published by the Asian Development Bank (2012) states that Iloilo City's transportation system is nearly exclusively based on roads. Public utility vehicles (PUVs) such as jeepneys, taxis, tricycles, and pedicabs that are privately owned make up most of the transportation services. Along primary and secondary roadways, Iloilo's passad jeepneys, jeepneys with slightly different designs, serve defined routes. In relation to this, according to Sosuan and Fillone (2014), the jeepney is the main mode of public transportation available in the city, while private vehicles such as cars and motorcycles are also available to those who can afford them.

According to the 2020–2025 Iloilo City Comprehensive Development Plan (2019), the public transportation system in Iloilo City is composed of a total of about 6,931 units. Moreover, it was stated that the inter-provincial routes between Iloilo City and the Province of Iloilo were covered mainly by passenger vans, tricycles, taxis, and PUJs. Each of these transport modes makes up 5.66%, 13.88%, 27.31%, and 53.76% of the total public transport units, respectively. As for the general registered vehicle consensus in December of 2017, 82.49% of the total vehicles are private, 17.53% are public utility, and 0.98% are government-owned vehicles. On city roads, motorcycles/tricycles make up most of the vehicles having 35,856 units registered. Jeepneys and other utility vehicles come in second with 28,197 units, while cars/SUVs and trucks/buses shortly follow at 17,110 units and 6,401 units, respectively, as per the Iloilo City District Office of Land Transportation Office.

2.2 Planning and Implementation of Public Transport Schemes

Prior to the proposal of public transport schemes may it be introducing a new system, a mode, or a route, studies must first be conducted on the existing public transportation system available appropriate to the context of the study area. Data must be gathered first to determine the travel behavior, pattern, and characteristics, and then will be modeled along with integrating the proposed scheme. A study conducted by Narboneta and Teknomo in 2016 investigates the implementation of a multimodal public transportation route planner to address the growing woes of congestion in Metro Manila and induce a modal shift to public transport. The 5-step methodological process is adopted to produce a route planner through the software OpenTripPlanner (OTP), specifically: data gathering, data formatting modification of the OTP web application, testing and revision, and system deployment. The route planning scheme aims to provide various modes of public transport that are not limited to bus and rail, but also Jeepneys and Tricycles which are predominantly used by most commuters in the city. The study made use of socio-demographic data, demographics, travel behaviors, and travel characteristics of the commuters through the Metro Manila Public Transport Travel Survey. While the data for existing public transportation modes such as LRT, MRT, and jeepneys alike are taken from government offices such as MRTA, LRTA, and LTFRB. It was concluded that a multimodal public transportation route is possible given that the OTP software was able to compute for at least one multimodal public transportation route. It can be noted however that it is because of the lack of enforcement of the LTFRB to the specified stops for buses and jeepneys that allowed these modes to not follow the existing transportation scheme; these modes often stop anytime a passenger opts to board or alight the said mode hence propagating the existing disorganized public transportation system.

2.3 Travel Behavior of Iloilo Province

Understanding travel behavior calls for a wide range of factors that influence an individual's pattern of travel. According to Gonzales. et al. (2012), most individuals opt to travel for a brief period, meaning, their travel distance is short as well. On the other hand, a small number of regular travelers chose to travel for a long drive. This statement is also similar for the people in Iloilo Province wherein a study conducted by Despabilideras (2021) showed that tricycles and jeepneys are the chosen mode of transportation within the municipality. It can be denoted that municipalities tend to have shorter trips in Iloilo province which is why the transportation modes were chosen for these are relatively cheap and more accessible. Furthermore, the study of Despabilideras (2021) proved that most of the trips made within the province were associated with work-related trips. School trips are the next reason the people of Iloilo travel within the province. It was also found that household size is the biggest factor influencing trip production. It is also important to note from his research that southern towns in the province of Iloilo generated a high number of trips going to the city proper - Iloilo City. In comparison to the northern towns in Iloilo Province, it was observed that they generated fewer trips going to Iloilo City.

2.4 Public Transport Supply and Demand

Transportation supply is the capacity of an infrastructure or mode to support traffic. Transportation demand, on the other hand, is about the amount of movement of people and goods through travel to satisfy a need (Charles, 2010). For fast-growing cities with high rates of private vehicle ridership, identifying the public transportation demand proves to be a complex yet necessary step toward successful transport planning (Tu et al., 2018). Although many incentives have been applied to increase the use of public transportation, automobiles still have the upper hand in terms of daily trip shares according to a study by Buehler & Pucher (2012).

2.5 Effects of Public Transit Supply Operations on the Vehicle Travel Demand

Public transportation is frequently promoted to alleviate traffic congestion in metropolitan transportation networks. In a study conducted by Beaudoin and Lawell (2018), the effect of past public transit investment on the demand for automobile transportation was estimated. It was found that a 10% increase in the transit capacity would result in a 0.7% reduction in auto travel in the short run when only the substitution effect is accounted for. Despite the transit having no effect on auto travel in the medium run due to the induced demand canceling out with the substitution effect, in the long run, when taking both factors into account, it was found that on average a 10% increase in transit capacity is associated with a 0.4% increase in auto travel. Aside from this, Beaudoin and Lawell (2018) state that public transport supply generally does not have significant effects on auto travel if the traffic congestion is below the critical limit.

2.6 Travel Demand Processing Using Four-Step Model

Four-Step Modelling is a process which plays a vital role in determining the travel demand. As such, several studies for every step were published as to prove the importance of this step through the results shown in every research. For instance, in trip generation, a study by Gadepalli et al. (2014) regarding the analysis of the household data of Patna City, India was done by utilizing multiple classification analyses and linear regression for the trip production

model. The linear regression method has been widely used in predicting trip generations and this was compared with category analysis to determine the efficiency of the analysis. While for trip generation, one study that distributed trips was through the Household Interview Survey (HIS) which explicitly provided the origin and destination per respondent. Such method was accomplished in the study of Judiantono and Susanto in 2020 regarding their study on the transportation movement patterns based on the home base approach. As for modal split, this step plays a significant role as the results are especially useful in transportation planning. Along with the determination of transportation mode, the evaluation of travel behavior in an area can be assessed using modal shifts (Ungvarai, 2019). Lastly, in the study of Madar, Maoh & Anderson in 2018, the researchers assessed the potential impacts of an unexpected closure of a major crossing between the United States and Canada using Trip Assignment. Using origin-destination flow matrices that were generated in the previous steps of the four-step model, the trips are then assigned by a user equilibrium traffic assignment routine in EMME4. After utilizing EMME4 for trip assignment, calibration was done in validating a transit assignment model. In this way, it tells whether the model is relevant by generating close results simulating the actual flow.

3. METHODOLOGY

3.1 Baseline Model Generation (Scenario 1)

Using EMME Software, the estimated household trip rates were imported into the road network to stipulate the trips being produced and attracted per zone as well as the travel demand of the study area. It was able to model the coastal towns of Northern Iloilo with its corresponding links and nodes, apply the respective transportation modes available in the towns, layout the transit lines, and establish zoning boundaries within the study area through the process of categorizing areas by locating which towns are nearer to each other. Subsequently, an Origin-Destination (OD) matrix was imported onto the model to produce the trips generated in the study area which are the OD histogram and desired line of the trips. Furthermore, the results of transit and traffic assignment were determined by EMME which includes passenger boarding and alighting at specific stops and traffic congestion in the coastal towns. 3 Scenarios are modelled, where a baseline scenario model would represent the current transportation network, a scenario model integrated with the LPRTP recommended routes and a scenario model with the proposed improvement of routes offering various types of services such as Express, Limited, and Local.

To accurately depict the actual public transportation network of Northern Iloilo the LPTRP of Iloilo and the LPTRP Manual Volume 1 were the primary references utilized in inputting necessary attributes to the EMME4 model. For the number of units available per mode, the existing registered vehicles units are utilized from the LTFRB for all three scenarios.

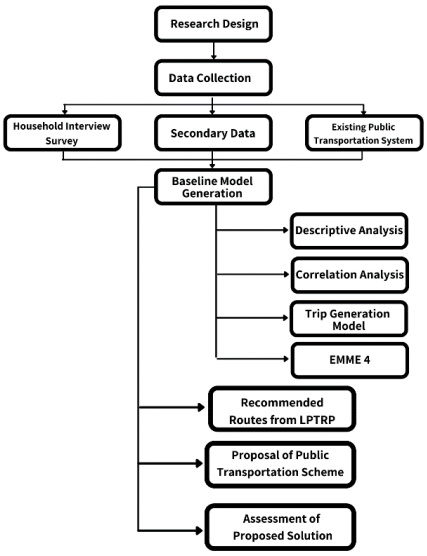

Figure 2. Methodological Framework

Table 1. Typical Travel Characteristics of Public Transportation Modes of the LPTRP Manual Volume 1

LTFRB-2018	**Mode of Transportation**	**No. of Units**
FCR	Fil Cab (Regular)	27
PUB	Public Utility Bus	164
PUJ	Public Utility Jeepney	2700
PUV	Public Utility Vehicle	267
UMB	Utility Mini-Bus	37
	Total	3195

Average capacity is based on Table 1 Typical Travel Characteristics of Public Transportation Modes of the LPTRP Manual Volume 1 for all three scenarios. In conjunction with the LPTRP Manual Volume 1, headways of the service modes are considered through the observable testimonial of a local expert.

3.2 Recommended Routes from the LPTRP Province of Iloilo (Scenario 2)

In line with the recommendations of the LPTRP from the Province of Iloilo in improving the transit routes, these were modelled in the EMME software in order to compare the results from the baseline model. Through baseline model established in the software, the transit lines were replaced based on the recommendation of the LPTRP Province of Iloilo. The said results were also used in comparing to scenario 3 to further determine which scenario did have a bigger impact in improving the public service routes in Northern Iloilo.

3.3 Proposal of Public Transportation Schemes (Scenario 3)

The results of the baseline model were used to propose a new public transportation scheme. The travel demand along the coastal towns traversed by the proposed route in Northern Iloilo as well as the concept behind the new service routes were the basis in introducing and designing a public transport service route. The solutions were made to improve the public transportation system and to ensure it can accommodate the demand of the area. Given that scenario 2 focuses on eradicating or merging overlapped routes of the LPTRP, scenario 3 is centered on

introducing various bus services to all poblacións (town-center) depending on their demand thus creating the systematized network of services. Such demand is obtained from the EMME4 software model, in which the routes were also tested in an iterative manner. Such services include the proposal of express, limited stop, and local service; the nature of such services are based on the National Association of City Transportation Officials' Transit Street Design Guide. The express service will cater to long-haul point to point from major terminals to the poblacións (town-center) of the specified town, the limited service will cater all the poblacións (town-center) of the route while local services will traverse in between poblacións (town-center) stopping even at minor points. Like scenario 2, the transit lines from the baseline model were replaced by the proposed routes to see the effect of the scenario 3 to the study area.

3.4 Impact Assessment of Proposed Solution

The use of EMME software provided significant parameters such as number of operating units, passenger-trips, passenger-kilometers, and passenger-hours. Defining the parameters, the number of operating units indicates the number of vehicles needed to service all the routes, passenger-trips would pertain to the count at which a passenger would utilize the service, passenger-kilometers is the total distance all the passengers have taken with their respective trips, and passenger-hours refers to the amount of time spent by the passengers in transit to their destination. With this, comparing this data from the baseline model helped determine the effect of the proposed solution to the study area. Getting the results mainly from the transit assignment results by line was the basis whether the proposed routes did improve the study area. The existing and proposed improvement was put into comparison to determine which scheme is more effective. As such, a lower passenger-hour indicates that the scheme has a more positive impact among the commuters where collectively the time spent in-transit was decreased.

4. RESULTS AND DISCUSSION

4.1 Baseline Model (Scenario 1)

Through assessing the travel patterns and existing routes in coastal towns of Iloilo, a baseline model was modeled in EMME which is essential in transportation planning. The baseline data was utilized and calibrated in acquiring a comprehensive transport assessment of the area and was used as the basis in proposing PUV routes in the area.

4.1.1 Traffic assignment: private trips

Traffic flow on the road network was estimated through modeling the traffic assignment of the baseline. This allowed the researchers to acquire the volume of traffic between origin and destination (O-D) pairs. The network topology, link characteristics, and link performance functions were also acquire using the model.

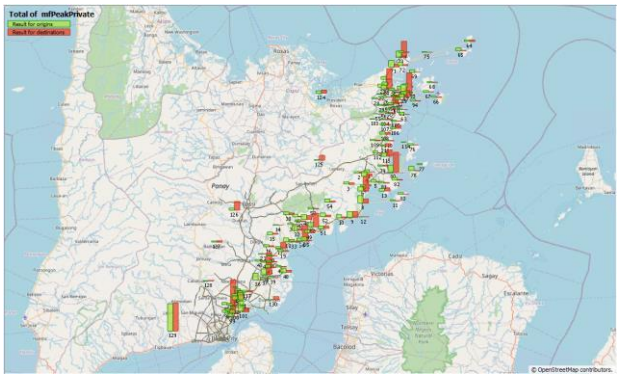

Figure 3. Day-Long Peak Private Zone Values

Shown in Figure 3 are the OD histograms which provides the zone values from certain area. These histograms show the number of people going to a certain location using private modes in terms of trip origins and destinations. The green bar in the histogram indicates origin while the red bar is for destination. As it can be seen, all the trips originate in all coastal towns and most of them are destined to the población of the municipality.

Figure 4. Traffic Assignment Results (Scenario 1)

The estimated passenger trip flow along the road network of the coastal towns in Iloilo is shown in Figure 4. This passenger demand indicates that many people are utilizing the road since it is evident in the flow of their trip along the road network. As can be seen, Iloilo City has the thickest color which means that it has the highest vehicular flow and has the greater demand of transportation. However, in the modal split, it was found out that only 23.1% of the total trips are utilizing public transport (UV, bus, jeepney and Filcab) while 76.9% of the total trips are utilizing private modes (own vehicle, motorcycle, tricycle, walking, etc.). Given the presence of colorum motorcycle in the municipality, it is possible that a portion of the high motorcycle count is colorum. As a result, if these colorum motorcycles are outlawed, more people will utilize public transportation.

4.1.2 Transit assignment: public trips

The existing public transport routes along the coastal towns in Northern Iloilo were plotted in the software. A total of 47 transport routes were extracted from the existing routes in Iloilo's LPTRP encompassing the study area. The public transport routes were spread into 4 modes: bus, jeepney, Filcab, and UV. Among the 47 routes, 11 were bus routes, 30 were jeepney routes, 5 were UV routes, and the last 1 being a Filcab route.

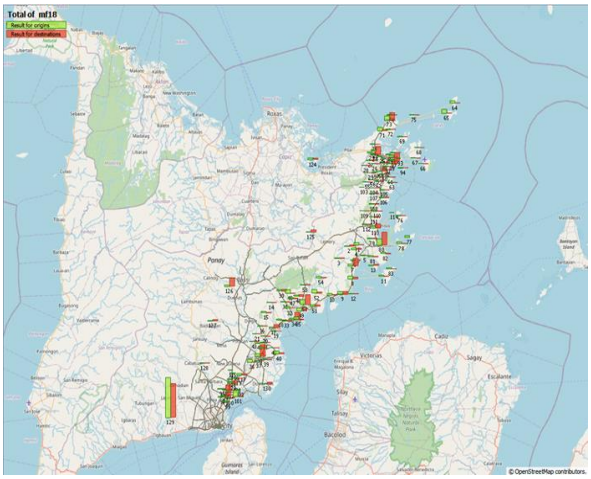

Figure 5. OD Histogram of the Total Calibrated Day-Long Peak Public Trips

As seen in Figure 5, like the initial results, most trips are generated from the external zones heading towards the South of Iloilo Province. It is observed that the distribution of trips is spread towards the Northern Iloilo coastal towns with most destinations heading towards the city centers or the población of each municipality. It could be noted that the baseline public transport system operates only a Local type of service. Given that the alightings for the public trips concentrate heavily on the city centers, the proposal of new service schemes, such as the Express and Limited services, may provide a more efficient route plan due to the controlled boarding and alighting points based on where the demand is highest.

Figure 6. Travel Patterns of the Total Calibrated Day-Long Peak Public Trips

As seen in Figure 6, the desire lines justify the movement of trips from which majority of the destinations are found in the South towards the main city center. However, it can be noted that Concepcion attracts a significant number of trips as depicted by the blue arrow line from the south thus indicating that it is a favorable destination for trips towards the north.

The estimated demand values from the baseline public trips were derived through the application of an Extended Transit Assignment. As for the transit assignment results with both boardings and alightings, Figures 7-8 show the volumes for every transit segment along the plotted transit lines. Having most routes originating along the metropolitan area, specifically from the Tagbak Terminal, Ceres Terminal, and Iloilo City Terminal Market, it is apparent that both the boardings and alightings appear to be centered heavily in these areas. Moreover, the transit segment volumes also appear to have larger values surrounding the areas close to Iloilo City while progressively decreasing in volume as the transit segment moves farther away.

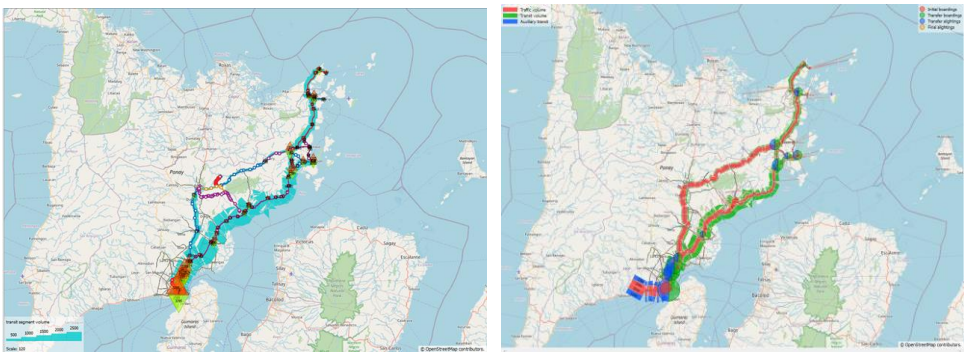

Figure 7-8. Transit Assignment (left) and Combined Results with Boardings and Alightings (right) - Scenario 1

In summary, Figures 7-8 shows the combined results of both the traffic and transit assignment for the baseline model. It can be inferred through the green highlight that the current transit volume is much heavily concentrated along the coastal roads or the National Highway. Additionally, aside from the traffic volume scattered around the areas, auxiliary transit was also noticed along the West portion of Iloilo City. Also, at roughly this area, the boardings and alightings were found to be at their highest, as compared to those nodes located near the Municipality of Sara and Concepcion.

4.2 Recommended Routes (Scenario 2)

The existing routes in Northern Iloilo contains multiple routes with the same origin and destination but different modes causing an overlap. In view of this reason, the LPTRP proposed routes to aid the problems found from the existing routes.

Scenario 2 is allocated for the recommended routes as stated in the LPTRP of the province of Iloilo. Basically, the recommended routes are either merging of existing routes or eradicating routes with the same origin and destination.

For scenario 2, there were exactly 16 new routes established in the model with only 5 routes retained from the previous scenario. In total, 21 routes were simulated in the model wherein 6 of which are bus lines while the other 15 are the jeepney routes. Provided below is the map of the proposed routes recommended by the LPTRP Province of Iloilo.

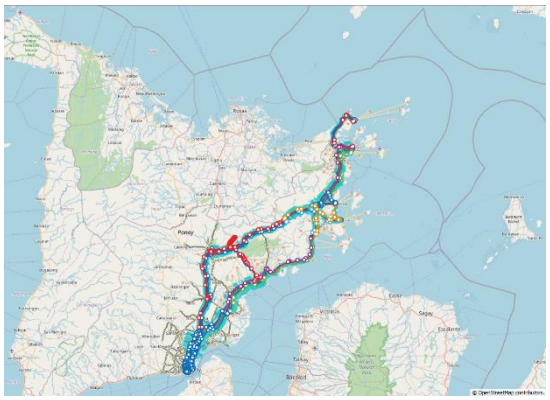

Figure 9. Recommended Routes from LPTRP in Northern Iloilo

The figures below are the results from running the Second Order Linear Approximation (SOLA) traffic assignment and Extended transit assignment. Figure illustrates the results of boardings and alightings in the transit assignment. It can be inferred that the boarding and alightings are located mostly in Iloilo City where most of the major terminals are located. This

includes Tagbak Terminal, Ceres Terminal and Terminal Market. In addition, boarding and alightings were present in the Poblacion of Ajuy, Sara and Concepcion. While smaller boarding and alightings were seen in the Poblacion of the rest of the towns.

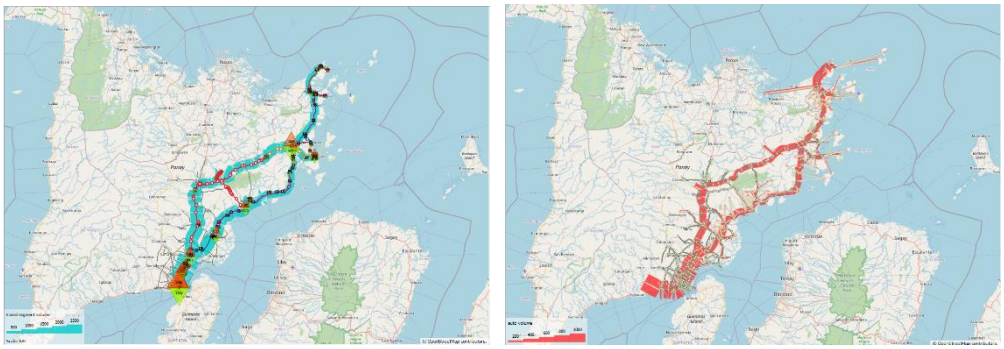

Figure 10-11. Transit Results with Boardings and Alightings (left) and Traffic Assignment Results (right) – Scenario 2

Figure 10-11 exhibits the estimated passenger trip flow for scenario 2. Results have shown that traffic volume can be seen in the roads where the transit lines are placed. More vehicular flow can be observed in both transit roads which means that more private and public trips were accumulated in this scenario. Since the recommended routes reduced the number of available transit lines and modes, the volume became higher considering the limited transit lines available.

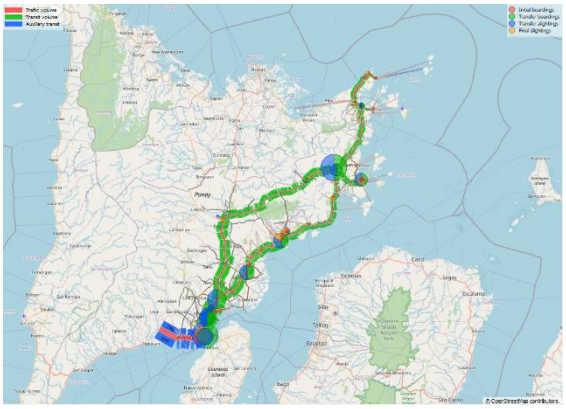

Figure 12. Combined Results of Traffic and Transit Assignment with Boardings and Alightings - Scenario 2

Overall, Figure 12 shows the summary of results for both transit and traffic assignments with boardings and alightings. It can clearly be seen that there is a high transit volume along the transit roads which was represented in green. Also presented in the figure are the passenger boarding and alighting at specific stops. Since there are three terminals existing in the Iloilo City and the goal of the scenario two is to merge line with the same route, it is understood that the capital of the Iloilo Province, Iloilo City, contains the initial boarding and final alighting as well as the transfer boarding and transfer alightings. Moreover, since Sara, Concepcion and Barotac Nuevo have their own terminal. transfer boardings and transfer alightings were spotted in these area as seen from the figure above.

4.3 Proposed Routes (Scenario 3)

The baseline scenario as stated in the LPTRP currently has numerous services that provide the

same route this in turn would create competing services among the local franchises for ridership. This is evidently seen in the eradication and merging of the same routes found in scenario 2, which was the LPTRP recommended method. However, from the results, such solution may not be the best to address the demand. It can be observed that most of the routes in the baseline scenario are long haul destinations and provides local services all the way. This is not beneficial for both the operators and passengers as travel time increases and low ridership is not addressed. Therefore, various services that vary in length and stops may help address the issues.

Following the existing and recommended routes is the third scenario or the proposed routes from this study. There are three types of public transport service operation this study wants to implement: Express Service, Limited Service, and Local Service. The main difference between the express service and limited service is their pick-up points. The idea of express service's pick-up points is solely at the ends of each route or the origin and destination. While limited service provides pick-up points in every población that the transit route can pass through. In terms of drop-off points, these two services allow alightings at any point of the transit route. However, in modeling this, it was assumed that no alighting will take place within the first town of every transit route using express service. This is because it is unlikely that passenger will be willing to spend a higher fare considering only a short distance. On the other hand, the concept behind regular services is the same as the ordinary public transport services wherein boardings and alightings can be done at any point.

The new routes were created based on the transit route types and their distinct services that are applicable to the study area. According to the National Association of City Transportation Officials' Transit Street Design Guide, the local service that would serve between neighborhoods addressing short distances to serve areas with low ridership. The current routes from the baseline model are often long hauled and lacks ridership in between, by introducing this setup, low ridership may be addressed while not compromising the coverage of the towns. Such is the basis for introducing the local service in between 2 poblacións (town-centers), by offering service that would not financially strain the operator due to its short route, the demand is addressed economically. Subsequently, for rapid service or "limited service" are designed to provide most of the routes in the local service in a consolidated line. This addressed the long, direct, and high demand transit routes on major corridors like that of the national highway found in the coast of Northern Iloilo. Such service provides the means of transfers given the intersection of the same routes thus working in conjunction with the local short distance routes. With this, the limited service traverses all major poblacións from a main terminal such as Tagbak without the need of passing by minor pick-up points as the demand for that was addressed through the local service. Lastly, the express service provides a point-to-point service and is mainly utilized for day-long peak-period ridership between city centers to other destinations thus connecting neighborhoods to may terminals. In the case of Northern Iloilo, this is to link neighborhoods to the main terminals of Tagbak, Barotac Viejo and Sara to all coastal towns, this is done to effectively provide a faster service to high demand destinations. Such service is introduced to relieve the congestion for the local and limited services. The observable demand was jointly evaluated as well from the results found in scenario 1 and 2.

For this study, express service provides bus and UV for the mode of transportation. Limited service caters to bus only while regular services are for jeepneys alone. Figure provides the map of the proposed transit routes from EMME. Moreover, Figure 14. Proposed Routes in Northern Iloilo shows the proposed routes in Northern Iloilo in a different perspective with Table 2 as its corresponding legend.

Figure 13. Map of Proposed Routes in Northern Iloilo

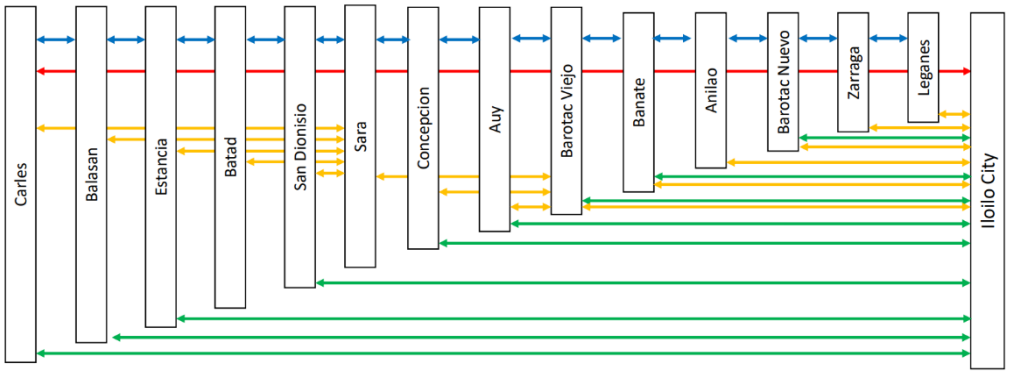

Figure 14. Proposed Routes in Northern Iloilo

Table 2. Summary of the types of Proposed Services

Legend	Type of Service	Modes
	Express	Bus
		UV
	Limited	Bus
	Regular	Jeepney

With the introduction of the 3 transit services, the assumed speed values were lifted from Local DOTr LPTRP Volume 1. Based on the routes' corresponding mode and service, the speed would be assumed as shown in Table 3.

Table 3. Assumed Speed by Type of Service

Service	**Speed (kph)**
Bus (Express)	40
Bus (Limited)	35
Jeepney (Regular)	25
UV (Express)	40

Upon running an Extended Transit Analysis on the 3rd scenario, it was found that the proposed routes yielded 27,708 passengers in total. The summarized transit assignment results totaled 16,338.7 passenger-hours with a passenger distance of around 619,778 passenger-kilometers in all.

The left figure below provide the transit assignment results with boardings and alightings. As observed, boardings and alightings are in Iloilo city and Barotac Viejo. Alightings were also accumulated in between the towns as all the proposed services allow dropping off at any point.

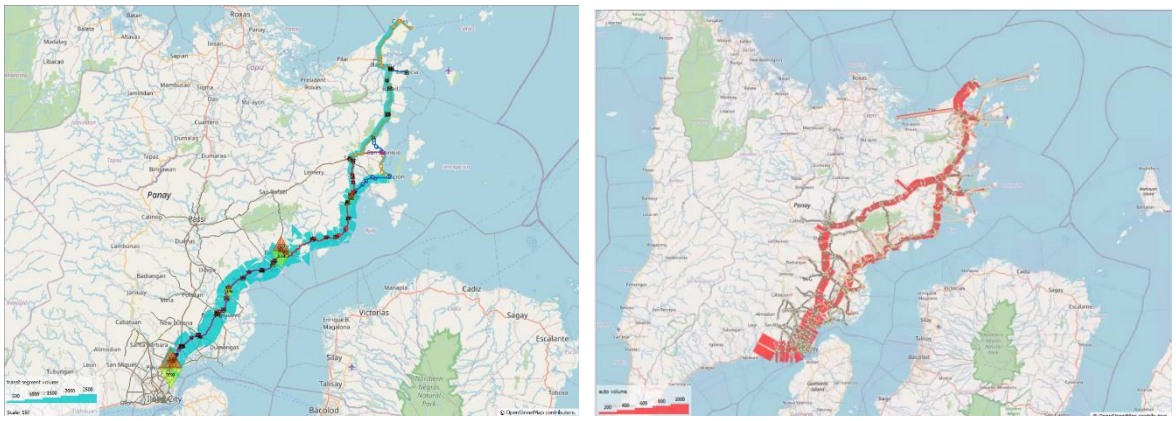

Figure 15-16. Transit Results with Boardings and Alightings (left) and Traffic Assignment Results (right) – Scenario 3

Similar process from the previous scenarios, the traffic results was obtained to determine the volume of the proposed routes. As such, Figures 15-16 show the results of the traffic assignment. Additionally, it can be inferred that the average total volume of 130 is present especially in the main thoroughfares as illustrated in the figure.

The combined results for traffic and transit assignment with boardings and alightings are shown in Figure 17. Since the transit routes were designed along coastal roads of Northern Iloilo, the transit volume did reflect in these areas. Aside from the transit volume, the boardings and alightings were revealed in the areas of población per town but most importantly in Iloilo City and Barotac Viejo where most of the designed origins are located here.

Figure 17. Combined Results of Traffic and Transit Assignment with Boardings and Alightings (Scenario 3)

4.4 Comparison of the Three Scenarios

After obtaining the results of the three scenarios, the results were put in comparison to see which scenario had the best results among the three scenarios. As such, Table 4 shows the summary of lines by scenarios from running extended transit assignments.

Table 4. Summaries of Lines by Scenarios from Extended Transit Assignment

Scenario	Description	Number of Operating Units	Total Passenger-Trips	Total Passenger-Kilometer Traveled	Total Passenger Hour
1	Baseline/Do Nothing	532	40151	707097.2	23610.3
2	LPTRP Recommended	230	41040	734241.5	24919.2
3	Offering Various Services	285	27708	619777.5	16338.7

As seen from the table above, the collated results from the Extended Transit Assignment, it is evident that the third scenario has the most promising results when it comes to the passengers involved. This is due to the low number of operating units required, the lowest total passenger trips, total passenger kilometers and passenger-hours. Which would translate that the system in scenario 3 addresses the same demand with fewer operating units, a smaller number of transfers, the least distanced travelled, and in a shorter time frame, as reflected in the total passenger-trips, total passenger-kilometers traveled and total passenger-hours respectively.

Evaluating the number of operating units utilized per scenario, scenario 3 requiring 285 units sits in between scenario 1 and 2 of 532 and 230 units respectively. The operating units of scenario 1 and 2 depicts the inefficiency of the utilization of vehicles as scenario 3 requires slightly more than scenario 2 but covers all the routes that scenario 1 offers with fewer units needed but more modes and services offered as compared to scenario 2.

With regards to the total passengers involved, the results evidently point out that scenario 3 produces the least passenger-trips of 27,708 as compared to scenarios 1 and 2 with 40,151 and 41,040 passenger-trips respectively. The decrease in passengers for scenario 3 may be attributed to the fact that passengers are less likely to utilize station transfers due to the variety of services from the improved transportation scheme. Justified by a study by Grise and El-Geneidy in 2019, it is verified that transfers decrease the trip satisfaction of passengers thus in public transportation planning transfers are minimized due to their negative perception. This, in turn, produces fewer passengers as fewer embarkments are necessary to reach destinations as compared to scenario 1 and scenario 2, which would require more transfers thus also inducing higher passenger distances of 707097.2 and 734241.5 passenger-kilometers: in contrast with scenario 3 of 619777.5 passenger-kilometers.

It is highlighted that scenario 3 produces the least total passenger-hours of 16,338.7 passenger-hours as compared to scenario 1 and 2 of 23610.3 and 24919.2 passenger-hours respectively. This would indicate scenario 3 collectively produced the least time it takes for the passengers to travel whilst covering the same destinations through the route structure.

The results imply that introducing services such as express, limited, and local buses by operationalizing a transit structure is beneficial to the study area. Subsequently, the proposed routes of scenario 3 did improve the existing routes by tallying the lowest passenger-hours. Lower passenger-hours being the primary indicator of improvement, was also utilized in the transportation study of Basbas in 2009, where EMME scenario modelling was also deployed and the scenario having the lowest passenger-hours was preferred.

5. CONCLUSION

A proposal of new transit routes and services along the proposed route in Northern Iloilo was made to improve the current public transport system in the area. The existing data of the public transportation system were gathered and utilized in modeling and analyzing the system in

coastal towns of Northern Iloilo. The travel demand along the coastal towns was the basis in designing routes and introducing a type of public transport service operation. This was done through the four steps of transportation planning which are trip generation, trip distribution, modal split, and traffic assignment. Three scenarios were established in the model which are the Existing Routes (Scenario 1), LPTRP Recommended Routes (Scenario 2), and Proposed Routes (Scenario 3). The data acquired in Scenarios 1 and 2 aided in the suggestion of alternate service routes and other transport schemes which can be found in Scenario 3.

The existing public transport routes in the area have a total of 47 transport routes that are divided into bus routes, jeepney routes, UV routes, and Filcab routes. The volume for each transit segment was determined and it was found that Tagbak Terminal, Ceres Terminal, and Iloilo City Terminal Market have the most routes originating along the area. It was also observed that the transit segment volumes have larger values surrounding the areas close to Iloilo City while progressively decreasing in volume as the transit segment moves farther away. For passenger demand, the jeepney garnered the highest value as compared to other modes at about 20,328 passengers. The bus has the second highest value with about 11,157 passengers, followed by UV with 8,623 passengers and Filcab with 42 passengers. In terms of passenger-hours, UV was able to get the highest passenger-hour value indicating that UV has low passenger demand due to long travel time. It was also observed in Scenario 1 that there were multiple routes with the same origin and destination but different modes which caused overlap. Because of this, Scenario 2 was created to aid the problems found in the existing routes. Scenario 2 was based on the recommended routes as stated in the LPTRP of the province of Iloilo. In this scenario, 16 new routes were created in the model with only 5 routes retained from the previous scenario. It was observed that more passengers took the jeepney since it had more transit lines and had the fastest passenger-hour compared to other modes. It was also observed that traffic volume became higher since the recommended routes reduced the number of available transit lines and modes.

The data acquired in Scenarios 1 and 2 aided in the suggestion of alternate service routes and other transport schemes. With this, it was able to provide a proposed public transportation system that can accommodate the demand of the people in the area. Scenario 3 was created containing the proposed solutions which include the proposal of 37 routes that cover all the towns in Northern Iloilo and public transport service operations which are composed of Express Service (bus and UV), Limited Service (bus), and Local Service (jeepney). Among the services implemented, regular jeepneys had the smallest passenger-hour value. It was also observed that the limited bus service had multiple stops and had the longest transit route, which resulted in having the highest passenger demand as compared to the other services.

From the results collated from the Extended Transit Assignment of the three scenarios, the third scenario yielded the lowest passenger-hours. Hence, making the proposed routes reliable in improving the transit service routes. Since low passenger-hours entail having faster travel time and essentially saving more time, implementing the third scenario in the area could possibly lessen the usage of private modes and more people will be encouraged to utilize public transport. It can also be concluded that the use of express and limited services is faster than regular services. Based on the comparison of travel times between express and local service justifies that utilizing the type of services introduced in the proposed routes is deemed effective in reducing travel time.

6. RECOMMENDATION

It is recommended that vehicle count surveys be deployed on strategic locations simultaneously with the household interview surveys to accurately determine necessary volume counts in the study area. Determining the actual volume counts and not relying on secondary data provides

more accuracy in creating a baseline model that would reflect the actual transportation conditions of the study area.

Various trip assignment methods should be explored to see their effects on developing a better model. Trip assignments utilized specifically for this study focused on SOLA traffic analysis and extended transit assignment with this various assignment methods may be explored such as Stochastic and fare-centric assignment methods thus producing results to simulate various circumstances.

Increasing the size of the study area is recommended as it would provide a better picture of the transportation issues presented in Region 6 as compared to focusing on the coastal corridor of the study area. This would also entail a greater number of sample surveys that are required thus being statistically advantageous to the study itself.

Disaggregate methods may be utilized to cross check the overall transportation network model created for large study areas such as this. In doing so, this may provide greater insights on intra-zonal modelling and yield a more specific model in conjunction with a general model.

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