Improving Rural Accessibility through PUV Route Optimization: A Case Study of the Island Province of Guimaras

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Abstract: The Public Utility Vehicle Modernization Program (PUVMP) is a key national reform in the Philippines. However, its application in island provinces like Guimaras has received limited attention. This study addresses that gap by evaluating the province's Local Public Transport Route Plan (LPTRP). A questionnaire survey and transport modeling were used to assess travel behavior, accessibility, and network performance. Results show that many essential facilities, such as schools and health centers, are not served by formal PUV routes. As a result, residents rely on informal modes that are often unsafe and expensive. The analysis also revealed issues with route overlap and inefficient coverage. To address these, the study recommends redesigning routes, establishing transfer hubs, and adopting coordinated fleet management. These strategies aim to improve safety, accessibility, and system reliability. Overall, the findings offer a model for context-sensitive public transport planning in rural and island settings across the Philippines.

Keywords: PUVMP, LPTRP, Guimaras Province, Route Accessibility, Fleet Management

1. INTRODUCTION

The Public Utility Vehicle Modernization Program (PUVMP) is a nationwide initiative launched by the Philippine government in 2017 to overhaul the country's public transportation system. It positions both local and national government agencies as key actors in reshaping policies, practices, and operations to ensure that public transport services are safe, reliable, environmentally sustainable, affordable, and efficient. The program addresses long-standing issues of supply-demand imbalances and operational inefficiencies that have historically plagued public transport services in the country.

Prior to the implementation of the PUVMP, the system allowed individual drivers and operators to function independently, often without coordination with other service providers along the same route. This lack of integration resulted in inconsistent service levels (i.e., oversupply during off-peak hours and severe undersupply during peak periods). Moreover, the competitive nature of on-street operations led to unsafe driving behavior, frequent unsanctioned stops, and a race for passengers rather than the provision of quality service.

A key component of the PUVMP is the rationalization of routes through the development of Local Public Transport Route Plans (LPTRPs). Under the Omnibus Franchising Guidelines (OFG), franchise approvals now require an LGU-prepared LPTRP that reflects local transport needs (Sunio et al., 2019). In line with this, Guimaras Province developed its own LPTRP, outlining a proposed network of PUV routes to improve island-wide accessibility. These proposed routes, shown in Fig. 1, aim to provide structured and equitable public transportation services across the island. While previous studies have examined PUVMP's implementation in

urban settings or mainland provincial cities, limited research exists on how the program is applied in rural areas like Guimaras. The PUVMP and LPTRP have improved the planning and rationalization of public transport routes in the Philippines; however, the main problem addressed in this study lies in the operational management of these routes once implemented at the local level. In Guimaras, the distinct geography and dispersed settlement patterns create operational conditions that differ from those in more urbanized settings. A key challenge is the fluctuating nature of travel demand, which is typically concentrated during peak hours and significantly lower during off-peak periods, especially in remote or isolated barangays. This variation affects service reliability, because operators are often reluctant to serve low-demand areas where revenue is uncertain. As a result, formal PUV routes in these locations become less frequent, and in some cases shortened, to reduce operational costs. While this improves efficiency from the operator's perspective, it reduces accessibility for residents who live farther from main corridors, forcing them to depend on informal modes such as habal-habal. These informal modes provide flexibility but are generally more expensive, unsafe, and unregulated. Therefore, the LPTRP faces the task of balancing economic viability for operators with equitable access for commuters. Limited-frequency schedules may be necessary in rural areas, yet if these schedules are consistent and well-integrated, they can still attract demand over time by offering a safer and more affordable alternative to informal transport. The challenge lies in determining the appropriate balance between cost, service frequency, and geographic coverage to ensure that PUV operations remain sustainable without compromising rural accessibility.

Thus, this study aims to examine the proposed PUV routes in Guimaras Province, identify service gaps, and highlight potential areas for improvement. Through transport modeling and accessibility analysis, the research seeks to provide actionable insights that can serve as a guide for designing optimized, inclusive, and context-sensitive public transport networks in rural and island provinces. Ultimately, the goal is to contribute to a more equitable and sustainable mobility system that meets the needs of all residents, regardless of location.

Figure 1. Proposed transit lines in the LPTRP Plan of Guimaras Province

2. REVIEW OF RELATED LITERATURE

2.1 Implementation of PUVMP

The PUVMP represents a significant and ambitious reform initiative within the Philippine transport sector, aiming for a wholesale transformation of the public land transportation industry. The program was primarily conceived to address long-standing and complex issues such as severe traffic congestion, high carbon emissions, and a high incidence of accidents, all of which are persistent problems in urban mobility globally. Beyond environmental and economic concerns, social pressures related to commuter welfare and the general acceptance that existing transport systems needed change also fueled the program's creation. The PUVMP mandates the

modernization of vehicles to meet Euro IV emission standards or better, the inclusion of modern features like GPS, automatic fare collection systems, and CCTV cameras, and a shift towards consolidated transport operations (Sunio et al., 2019).

While the PUVMP is a national initiative, its implementation has varied across different regions and cities in the Philippines. In Metro Manila, the program's rollout has been a focal point due to the region's immense transportation challenges, including significant congestion costs and air pollution levels (Sunio et al., 2019). The national government, through agencies like the Department of Transportation (DOTr) and the Land Transportation Franchising and Regulatory Board (LTFRB), has issued regulatory and policy documents to create enabling conditions for the PUVMP's experimentation and implementation within the capital and other areas.

Beyond Metro Manila, various studies have analyzed the application and impact of the PUVMP in specific cities, highlighting diverse challenges and approaches. For instance, General Santos City served as a pilot area for the PUVMP, leading to the development of its initial Local Public Transport Route Plan (LPTRP). Tacderas et al. (2021) examined the effects of the PUVMP on jeepney operations in General Santos City, noting that several modernization costs were overlooked in the program's initial formulation, exacerbated by the COVID-19 pandemic. Similarly, Arcaño et al. (2022) focused on improving public transport service routes in Northern Iloilo, a region where population growth strains existing systems. Their study proposed new transit routes and services; thereby, demonstrating how local studies contribute to optimizing route planning under the modernization framework. Furthermore, Mangontarum & Laurente (2018) applied graph theory to design optimal PUV transportation routes for cleared areas in Marawi City, showcasing a methodological approach to route planning in a post-conflict urban setting.

However, while existing research has largely concentrated on the PUVMP's implementation in small-scale urban cities, there is a noticeable gap in studies examining its application in an island-wide context, such as Guimaras. Given Guimaras' distinctive geography and scattered population, the planning and execution of PUV services there pose unique challenges and opportunities that warrant further investigation.

2.2 Rural Accessibility

Rural accessibility is a central concern within global development agendas, particularly under the Sustainable Development Goals (SDGs). SDG Target 9.1 calls for the development of quality, reliable, sustainable, and resilient infrastructure that supports economic development and human well-being, with a specific emphasis on ensuring affordable and equitable access for all. A key measure associated with this target is SDG Indicator 9.1.1, which tracks the proportion of the rural population living within two kilometers of an all-season road. An all-season road is defined as one that remains motorable throughout the year using the prevailing means of rural transport, which in many monsoon-prone countries corresponds to paved or otherwise weather-resilient roads. This indicator highlights the importance of basic transport connectivity as a prerequisite for social and economic participation.

Beyond this physical measure of access, transport provision represents only one dimension of a multifaceted challenge (Vitale Brovarone & Cotella, 2020). Enhancing accessibility may also involve reducing the need for travel by bringing essential services closer to residents, strengthening local capacities, and supporting localized development. These complementary strategies recognize that accessibility is not solely defined by distance or road quality. Instead, it reflects how effectively people can reach services, opportunities, and social networks that contribute to overall well-being.

Because of this, transport infrastructure is a crucial driver of growth, especially in low and middle income countries. It influences agricultural productivity, market access, and household livelihoods. It also shapes access to essential services such as healthcare and education, and it contributes to environmental outcomes by enabling more efficient mobility patterns.

Kaiser & Barstow (2022) provide a comprehensive review of the rural transportation sector, highlighting the intricate relationships between infrastructure and broader sustainable development goals. According to them, improvement of rural transport significantly influences economics and agriculture by improving market access, lowering transport costs, and diversifying livelihoods. Health outcomes benefit through better healthcare access, while gender equality improves as reduced travel burdens empower women economically and socially. Reliable transport also boosts education by increasing student attendance. Environmentally, rural transport interacts with climate change, necessitating sustainable solutions to balance mobility and emissions. Moreover, the economic impacts of rural transportation infrastructure extend beyond local boundaries. According to Abdullah & Wang (2024), infrastructure development in local districts effectively reduces food insecurity not only within the immediate area but also in neighboring districts, fostering broader regional development. This underscores the critical importance of robust rural transport networks for efficient agricultural produce movement, which ensures food availability and enhanced market access for both farmers and consumers throughout interconnected regions.

Looking at specific sectors, transportation profoundly influences public health, as systemic barriers within the sector often exacerbate existing health disparities. According to Neely & Ponshunmugam (2019), South Africa's healthcare system, though spatially hierarchical, overlooks rural realities where transport networks prioritize commerce over healthcare. This forces residents to rely on costly private transport or face ambulance delays, deepening health inequalities, especially for low-income. Kinship ties help some reach urban hospitals, but this highlights systemic issues like economic-driven migration. Beyond this, transport networks are also crucial for the tourism sector in rural regions. Tomej & Liburd (2020) point out that tourist attractions in rural areas are often spatially dispersed. Consequently, inadequate transport planning can severely limit accessibility for visitors who do not drive. They emphasize the scarcity of sustainable planning tools tailored for non-urban tourism contexts, underscoring the need for effective transport solutions to unlock the economic potential of tourism-dependent rural economies.

In the Philippine context, rural transport infrastructure development, such as roads and bridges, directly benefits rural farmers and local economies. Vana et al. (2020) studied the effects of infrastructure development projects on the travel activities of farm families in Nueva Ecija. Their findings illustrate how the construction of concrete roads significantly improves connectivity, which in turn supports agricultural productivity and enhances the economic well-being of rural communities. Ultimately, the consensus across these studies, as underscored by Kaiser & Barstow (2022), is that the enhancement, improvement, and extension of rural transportation infrastructure brings significant and multifaceted benefits to rural communities, improving their quality of life and fostering sustainable development.

2.3 Improving Rural Route Accessibility

While rural accessibility, as defined by the United Nations (UN), is the proximity to roads, this perspective overlooks the reality that many rural residents do not have access to private vehicles. As mobility trends increasingly shift away from car-centered models toward public transportation, the limitations of rural transport systems become more pronounced. Rural areas typically have low population densities, which result in infrequent public transport services,

long waiting times, and extended travel durations. Consequently, many households continue to rely on private cars to meet daily needs, even though such access is not universal. This emphasizes the importance of strengthening public transport availability as a core component of rural accessibility; thus, ensuring that mobility opportunities are equitable (Frank et al., 2021).

However, due to the unique landscape of rural areas, they often have distinct accessibility challenges when compared to urban areas. Looking at a case study by Jeon et al. (2016) in Chungju-si, Korea, analysis of walking time, bus travel time, and transfer waiting time revealed that nearly 20% of villages required over 10 minutes to reach the nearest bus stop. With average bus speeds at 21.9 km/h and infrequent service in many areas, overall access to essential facilities was limited. Emergency centers had the longest average access time at 35.15 minutes, while health centers and schools ranged from 8.70 to 22.61 minutes. Additionally, spatial disparities were evident, with mountainous and low-density areas in the eastern and southern parts of the region showing the poorest accessibility. These findings underscore how physical geography, limited infrastructure, and service frequency contribute to unequal transport access in rural settings.

Brovarone & Cotella (2020) argue that improving rural accessibility requires a multilayered policy approach that goes beyond physical distance. They emphasize that conventional public transport in rural areas is often unsustainable and subject to service cuts, reinforcing social exclusion. Key challenges include socioeconomic disparities that lead to car dependency and exclude vulnerable populations (e.g., elderly, low-income households), institutional resistance to flexible models like ride-sharing, and limited digital infrastructure that constrains the rollout of smart mobility solutions. They suggest that while demand-responsive transport solutions are often seen as a cure-all solution, their implementation is complex due to varying socioeconomic, cultural, and institutional features of places. Similarly, Truden et al. (2022) discuss how public transport systems in rural areas face unique challenges due to vast geographical varieties and sparse population density. They argue that good "reachability" for rural populations is not solely defined by walking distance to the nearest stop but also by geographical factors like elevation. To encourage the use of public transport in rural areas, routes should be designed to be easily accessible, not just through walking, but also through integrated and connected transport options that consider the specific geographical and social contexts, differentiating rural accessibility needs from those in dense urban environments where multiple transport means are readily available.

In the Philippines, the informal nature of public transport in remote areas, further complicates accessibility. A common mode of transport is the habal-habal, which refers to a motorcycle modified to carry multiple passengers, along rural roads. This mode of transport, while ubiquitous and often the only option, highlights the lack of formal, regulated public transport services in many rural barangays. This reliance on informal transport directly impacts the daily lives of professionals working in these remote locations. For instance, Flores et al. (2021) examine factors affecting the retention of healthcare workers in the Philippine National Rural Physician Deployment Program (Doctors to the Barrios). While their study covers multiple factors, it implicitly points to the significant travel burden faced by these doctors, who often have to commute long distances from more accessible areas to reach their assigned rural barangays. Similarly, Equipado & Gilbas (2021), in their study on the experiences of elementary teachers in a remote school in Sorsogon, discuss transportation as a key challenge affecting teachers' daily sustenance and their ability to deliver instruction. These studies collectively illustrate how the absence of robust, formal public transport networks in rural Philippines necessitates long and often difficult journeys for essential service providers, impacting their work and well-being.

3. METHODOLOGY

3.1 Study Area

Guimaras, officially the Province of Guimaras, is an island province located in the Western Visayas region of the Philippines. The province is composed of five municipalities (i.e., Buenavista, Jordan, Nueva Valencia, San Lorenzo, and Sibunag) and is subdivided into a total of 98 barangays. Jordan serves as the provincial capital, while Buenavista is the largest municipality in terms of land area and population. Geographically, Guimaras is situated in the Panay Gulf, nestled between the islands of Panay and Negros. It is bordered to the northwest by the province and city of Iloilo and to the southeast by Negros Occidental. The province is part of the Metro Iloilo–Guimaras area, one of the twelve official metropolitan regions in the country.

The province consists primarily of Guimaras Island, along with several smaller surrounding islets, including Inampulugan, Guiwanon, Panobolon, Natunga, and Nadulao. Despite its relatively compact size, Guimaras features a dispersed settlement pattern, with many barangays located in inland, coastal, and upland areas. The local economy is largely driven by agriculture, fisheries, and tourism, supported by a network of secondary and circumferential roads. However, transport infrastructure remains limited, with many barangays relying on a few primary corridors, such as the Guimaras Circumferential Road, for mobility.

Another key consideration in developing the revised route plans is the spatial distribution of essential socio-economic and business facilities across the province. An inventory of these facilities (i.e., schools, health centers, markets, government offices, and other public services) was conducted to identify key activity nodes. The specific locations of these facilities were obtained and geospatially mapped. Fig. 2 presents the province of Guimaras and the location of these essential facilities within the island.
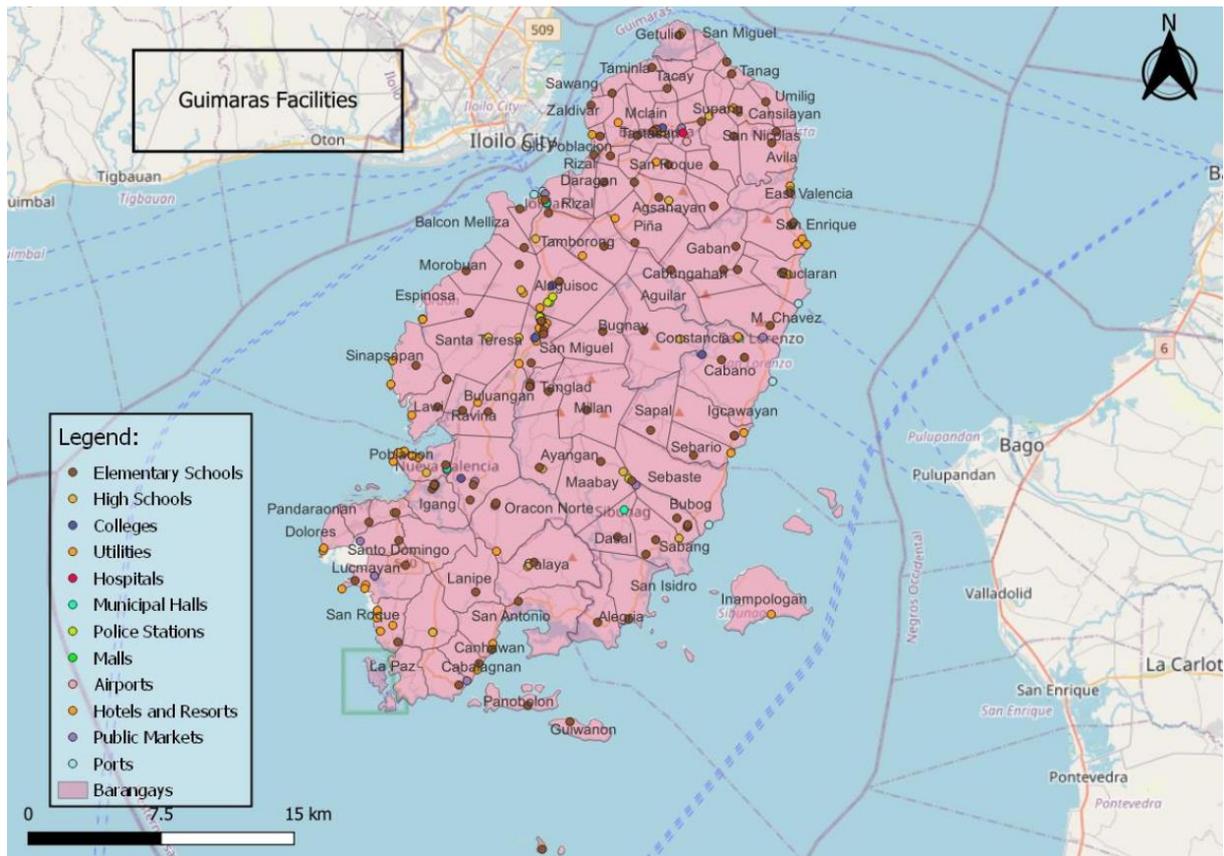
Figure 2. Guimaras Island facilities map

3.2 Questionnaire Survey

A home interview survey (HIS) was conducted in 2018 to gather detailed information on the day-to-day travel behavior of residents across Guimaras Province. The objective was to capture general patterns of commuter movement and provide a foundation for analyzing local mobility dynamics. The survey was administered in various locations throughout the province and at different times of the day to ensure that the resulting dataset reflected a wide range of travel activities. The sampling framework followed a stratified approach in which households were selected from multiple barangays across the five municipalities to capture both densely populated and remote rural areas. Moreover, although the questionnaire was written in English, surveyors were trained to administer the questions in the local dialect and later encode the responses into the survey forms.

The questionnaire consisted of several sections covering socio-demographic information, household composition, travel characteristics, and transport-related expenditures. For socio-demographics, data on age, gender, income, household size, and vehicle ownership were collected. Travel-related questions included trip purpose, travel time, departure and arrival times, primary and secondary modes of transport, access and egress times, and trip costs. Respondents also identified their origin and destination barangays, which enabled spatial mapping of trip flows within the province. Additional items captured information on access modes used to reach PUV stops or terminals, as well as rankings of preferred public transport amenities.

Once collected, the data were encoded and cleaned using Microsoft Excel, then anonymized and aggregated for analysis. The results of the survey served as the basis for understanding the population of Guimaras Province, and the travel patterns across the region.

3.3 Transport Model

Using EMME transport planning software, a network model of Guimaras was developed that included the full extent of the province's road system. This model consisted of nodes and links representing intersections and road segments. Zoning boundaries were defined based on barangay and municipal divisions, grouping areas according to geographic proximity and connectivity. Available transportation modes within the province were also encoded into the model to accurately reflect existing mobility conditions. In addition, the proposed transit lines from the Guimaras Local Government, as shown earlier in Fig. 1, were individually inputted and modeled to represent their routing and intended operational characteristics.

To ensure the model accurately represented the operational characteristics of the study area, each road type was assigned specific parameters, including free-flow speed, lane capacity, and a volume–delay function (VDF). These model parameters are summarized in Table 1.

Table 1. Model parameters

Type	Length	Free-flow Speed	Lane Capacity
Primary National Road	15.64	60	900
Tertiary National Road	285.55	40	800
Collector Road	88.36	40	700
Local/Service Road	327.11	30	500
Zone Connector	-	20	9999

The VDF is particularly important, as it captures how road performance varies according to functional classification. Major road were assigned more efficient VDFs to reflect their higher capacities and smoother traffic flow, whereas collector and local roads were given less efficient VDFs to account for roadside friction, narrower carriageways, and frequent interruptions. In this study, the volume–delay relationship follows the Bureau of Public Roads (BPR) function, expressed as:

$$T = T_f \left[1 + \alpha \left(\frac{q}{C} \right)^\beta \right]$$

(1)

where T is the actual travel time on a road, while T_f is the free-flow travel time. The value q represents the actual traffic volume, and C represents the road's capacity. The two parameters, α and β, determine how quickly travel times increase as a road gets closer to its maximum capacity. In practice, this means that when the road is lightly used, travel times stay close to free-flow levels, but as traffic builds up, travel times increase sharply. Table 2 provides the VDFs used in this study, expressed in the format understood by the software. In this formulation:
  o *length* – the length of the road segment (km)
  o *Q* – total volume of vehicles on the road segment (veh/hr)
  o *el1* – design free-flow speed (kph)
  o *el2* – roadway capacity per lane (veh/hr/lane)
  o *lanes* – number of lanes in the segment

Table 2. VDFs used per road classifications.

Type	Travel Time Expression (minutes)
Primary National Road	length*60/el1*(1+0.6846*((volau+volad)/(lanes*el2))^5.1644)
Tertiary National Road	length*60/el1*(1+0.7312*((volau+volad)/(lanes*el2))^3.6596)
Collector Road	length*60/el1*(1+0.7312*((volau+volad)/(lanes*el2))^3.6596)
Local/Service Road	length*60/el1*(1+0.8774*((volau+volad)/(lanes*el2))^4.4613)
Zone Connector	5

Trip distribution patterns were simulated using an Origin-Destination (OD) matrix

developed from the results of the household questionnaire survey. This matrix was loaded into the EMME model and produced an OD histogram and a desired line diagram, which illustrated the directional flow and volume of trips across the network. Transit and traffic assignments were then carried out using EMME's built-in functions. The model output included estimates of passenger boardings and alightings at specific stops, as well as load levels on individual road segments that indicate potential congestion points.

To enhance model accuracy, inputs were calibrated using actual transport metrics, including observed travel times, trip volumes, and the availability of vehicle units. Key attributes such as vehicle capacity and average service headways for each mode were based on the LPTRP Manual Volume 1. This ensured that the modeled service characteristics aligned with the standards and assumptions of local transport planning practice.

Rural accessibility, in this context, refers to the degree of ease by which residents can reach essential services such as schools, health centers, commercial areas, and government offices through the available transport network. Using the provincial transport network database, a shortest distance analysis was performed to determine the average, nearest, and farthest travel distances from each barangay to the nearest facility of each type. These metrics were derived from the calibrated network model and served as indicators of spatial accessibility for each municipality. The results provided a quantitative basis for assessing transport equity across the island. In this manner, the transport model translated the abstract concept of rural accessibility into measurable indicators that could be analyzed under varying operational and policy scenarios.

4. RESULTS & DISCUSSION

4.1 Demographics

The demographic profile of the respondents (see Table 3) indicates a predominantly young population, with individuals aged 21–30 comprising the largest proportion at 39.27%, followed by those aged 31–40 at 23.68%. This suggests a significant segment of the population is within the productive and working-age group. In terms of gender, females account for a slightly higher share at 58.51%, while males represent 40.30% of the total, with a small percentage (1.23%) not specifying their gender. Income distribution reveals that a substantial majority (75.78%) of respondents earn ₱7,500 or less per month, highlighting the prevalence of low-income households within the study area. Only a small fraction report monthly incomes exceeding ₱15,000, indicating limited economic diversity. Household composition further reflects traditional family structures, with 67.15% of respondents living in households of four to six members, and an average household size of 4.72.

Table 3. Socio-demographic data (N = 2195)

Age		Gender	
1–10	4 (0.18%)	Male	884 (40.30%)
11–20	108 (4.92%)	Female	1284 (58.51%)
21–30	862 (39.27%)	Others	27 (1.23%)
31–40	520 (23.68%)		
41–50	337 (15.35%)	Monthly Personal Income	
51–60	219 (9.98%)	< 2500	408 (18.68%)
61–70	114 (5.20%)	2501–5000	549 (25.14%)
71–80	23 (1.05%)	5001–7500	698 (31.96%)
≥81	8 (0.36%)	7501–10000	235 (10.76%)

Mean	35.72	10001–15000	163 (7.46%)
		15001–20000	56 (2.56%)
Household Size		20001–25000	45 (2.06%)
1–3	475 (21.64%)	25001–30000	20 (0.92%)
4–6	1474 (67.15%)	30001–40000	4 (0.18%)
7–9	214 (9.75%)	40001–50000	1 (0.05%)
10+	32 (1.46%)	50001–75000	2 (0.09%)
Mean	4.72	75001–100000	1 (0.05%)
		100001–150000	1 (0.05%)
		150001 & above	1 (0.05%)
		Mean	6531.59

The data on transport mode and trip purpose (see Table 4) reveals distinct patterns in mobility behavior among respondents. A substantial portion of individuals rely on motorized two-wheelers, with own motorcycles being the most used mode at 39.13%, followed by tricycles at 23.64% and jeepneys at 21.59%, indicating the dominance of both private and semi-public low-capacity transport in Guimaras. While only a small percentage use buses (0.68%) and UV/FX shuttles (0.36%), this may suggest limited availability or preference for smaller, more flexible transport options. Notably, walking still accounts for 4.15%, reflecting either proximity to destinations or the lack of motorized options in certain areas.

In terms of trip purpose, work-related travel overwhelmingly dominates at 57.04%, underscoring the importance of commuting in daily travel demand. This is followed by market or shopping trips at 31.57%, a critical indicator of local economic and household needs. Travel for school (6.88%) and recreation (1.28%) appears much less frequent, suggesting that education and leisure trips are either more localized or less prioritized.

Table 4. Transit data

Transport Mode		Trip Purpose	
Own Passenger Car	78 (3.55%)	Work	1252 (57.04%)
Own Motorcycle	859 (39.13%)	School	151 (6.88%)
Tricycle	519 (23.64%)	Market/Shopping	693 (31.57%)
Trisikad	45 (2.05%)	Recreation	28 (1.28%)
UV/FX/Shuttle	8 (0.36%)	Church/Mosque	13 (0.59%)
Bus	15 (0.68%)	Others	49 (2.23%)
Jeepney	474 (21.59%)		
Habal-Habal	66 (3.01%)		
Multicab	2 (0.09%)		
Others	38 (1.73%)		
Walking	91 (4.15%)		

The relationship between income and transport mode choice in Guimaras Province reflects the limited fiscal capacity of most residents. With a mean monthly personal income of around ₱6,500, the majority of respondents belong to low-income households that cannot afford high-cost modes such as private cars. This economic limitation is evident in the dominance of motorcycles, which serve as the most common private vehicle due to their low purchase and operating costs. In contrast, jeepneys function as the primary formal public transport option, offering fixed routes that cater to daily commuting needs. Meanwhile, tricycles and habal-habal are classified as informal public transport modes, providing short-distance services where formal routes are unavailable. The high usage of these modes indicates that affordability and accessibility take precedence over comfort or regulation in travel decisions. Overall, income is a strong determinant of mode preference—lower-income individuals depend heavily on affordable informal and public transport, while those with slightly higher earnings opt for motorcycles as a low-cost private alternative. The minimal share of private car users underscores the need to strengthen affordable, reliable, and safe public transport options across the province.

4.2 Route Accessibility

Figs. 3 and 4 illustrate the overlain map of essential facilities in Guimaras Province in relation to the proposed PUV routes. The yellow lines represent the proposed transit corridors, while the blue shaded areas indicate the catchment zones of each transit line within a 500-meter radius, signifying the areas with direct access to public transport services. The figures show the relationship between the proposed PUV network and the location of essential facilities in Guimaras. Even when excluding those located in island barangays, there are still numerous essential facilities on the main island that remain underserved by public transport. This lack of direct service is especially evident in the northern and western portions of the island, where clusters of schools, health centers, and commercial areas fall outside the immediate reach of the proposed routes.

Informal modes of transport (i.e., habal-habal), are widely available throughout the island. However, relying on these modes raises several concerns. First, fare rates for these modes are often unregulated and considerably more expensive compared to standard public transport, placing a financial burden on daily commuters, especially those from lower-income households. Second, the safety of these modes is a critical issue. Passengers are often exposed to unsafe road practices, lack of proper safety equipment, and overloading. These conditions increase the

risk of road accidents. These services are also not ideal for transporting the elderly, children, or those with mobility challenges because of their limited space and poor stability.

Given these limitations, it is important that underserved areas be included in the formal public transport network. Even if service is limited to peak travel periods, the availability of more affordable and regulated public transport options would provide residents with a safer and more accessible alternative. This would allow people to plan their trips around scheduled services, improving mobility while reducing dependence on high-cost, informal modes.
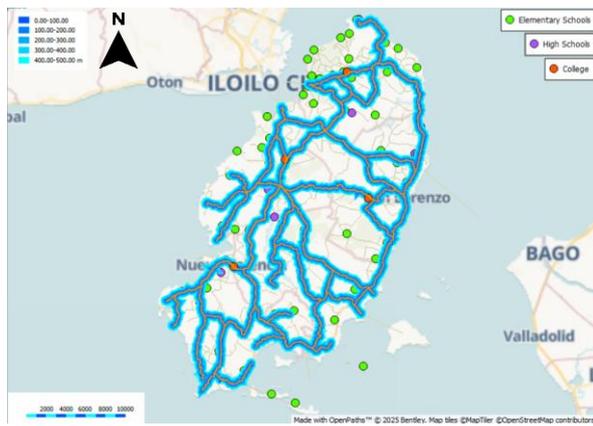
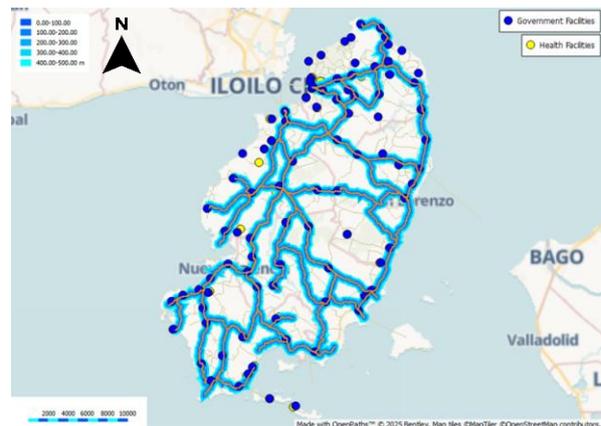Figure 3. Location of schools with respect to PUV routes

Figure 4. Location of government and health facilities with respect to PUV routes

To analyze this more thoroughly, the straight-line distances between essential facilities and the nearest PUV routes were measured, and the distribution is presented in Fig. 5, which is derived from the facility maps previously shown in Figs. 2 to 4. These earlier figures served as the spatial basis for identifying the proximity of each facility to the proposed transit network. For elementary schools, the data reveals a widespread, with numerous outliers extending significantly beyond the typical range. This indicates that while many schools are situated near transport routes, a notable number are in more remote areas. This spatial pattern reflects a common practice in rural provinces where elementary schools are established near clusters of residential populations to enable young students to walk to school without requiring vehicular transport. However, this setup does not accommodate the mobility needs of teachers, who are often assigned to distant postings far from their homes. Equipado & Asis-Gilbas (2021) highlight that, in such cases, teachers frequently purchase motorcycles, rent tricycles, or ride habal-habal to reach their schools. These transportation options, while necessary, are financially burdensome and physically risky, especially during the rainy season when roads become slippery and hazardous. Thus, the need for better PUV access to these locations.

In contrast, high schools demonstrate a much more compact distribution of distances, with values tightly clustered near zero. This indicates that most high schools are in close proximity to PUV routes, enhancing their accessibility for both students and teachers. The narrow interquartile range and minimal presence of outliers suggest a relatively equitable spatial arrangement, likely due to the fewer number of high schools compared to elementary schools and the need to centralize secondary education facilities for broader catchment areas. In practice, this means students may have to travel longer distances compared to their elementary counterparts, but their access to public transport infrastructure is generally more direct and reliable.

In this study, commercial establishments are defined primarily as malls and public markets for simplicity. The measured distances from these facilities to the nearest PUV routes are generally low, indicating good overall accessibility. This aligns with the common practice of

situating commercial areas along major roads to maximize visibility, foot traffic, and transport connectivity. However, the presence of a few substantial outliers suggests that some markets or commercial nodes are located in more isolated areas, potentially limiting access for both vendors and consumers. These cases highlight the need for better transport linkages to peripheral economic hubs.

The accessibility of tourism facilities varies widely, with distance values ranging from near-zero up to nearly two kilometers. This wide dispersion highlights the nature of tourism infrastructure, which is often situated in coastal or mountainous areas that are not necessarily close to main transport corridors. While such locations enhance the appeal of tourist destinations, they also create access barriers, especially for visitors without private vehicles. For local economies that depend on tourism, poor integration with PUV routes can limit visitor volumes and undermine the potential for inclusive growth. Additionally, the reliance on habal-habal or special trips for last-mile access raises issues of affordability and safety, particularly for local workers employed in these tourism zones.

The dataset for health facilities reveals a moderate spread in distances, with most values clustered at the lower end and only a few outliers. This suggests that many health centers are relatively well-positioned near PUV routes. The small number of distant outliers may represent rural clinics or health posts located in more remote barangays. Like the spatial logic behind school placements, health facilities in rural provinces are often established near clusters of residential populations to ensure that basic healthcare is locally available. However, this also creates access challenges—not for patients alone, but for healthcare providers as well. Doctors and medical staff are frequently required to travel long distances to reach these remote postings, often relying on informal modes of transport, particularly in the absence of direct public transport routes (Flores et al., 2021). Moreover, health facilities in these areas are often less equipped to handle specialized or advanced medical needs, prompting patients to travel even farther to reach better-equipped hospitals or diagnostic centers. Nonetheless, the relatively compact distribution supports the idea that primary healthcare is spatially integrated with transport corridors in many areas.

In this study, government facilities are classified to include both barangay halls and municipal halls. These serve not only as administrative centers but also as important proxies for understanding the general accessibility of each barangay. Since barangay halls are typically located at or near the population centers of their respective communities, the measured distances from these facilities to the nearest PUV routes can be interpreted as indicative of how accessible a barangay is in general. The data show a widespread in distances, with several barangays located far from PUV routes, suggesting significant variation in how connected different areas are to the broader transport network. While some barangays are located near main corridors where PUV routes are readily accessible, others are more isolated due to the absence of nearby routes, making it difficult for residents to access services or travel to other parts of the province. This uneven accessibility highlights the need for more inclusive transport planning that ensures all barangays, especially those on the periphery, are better integrated into the public transport system.
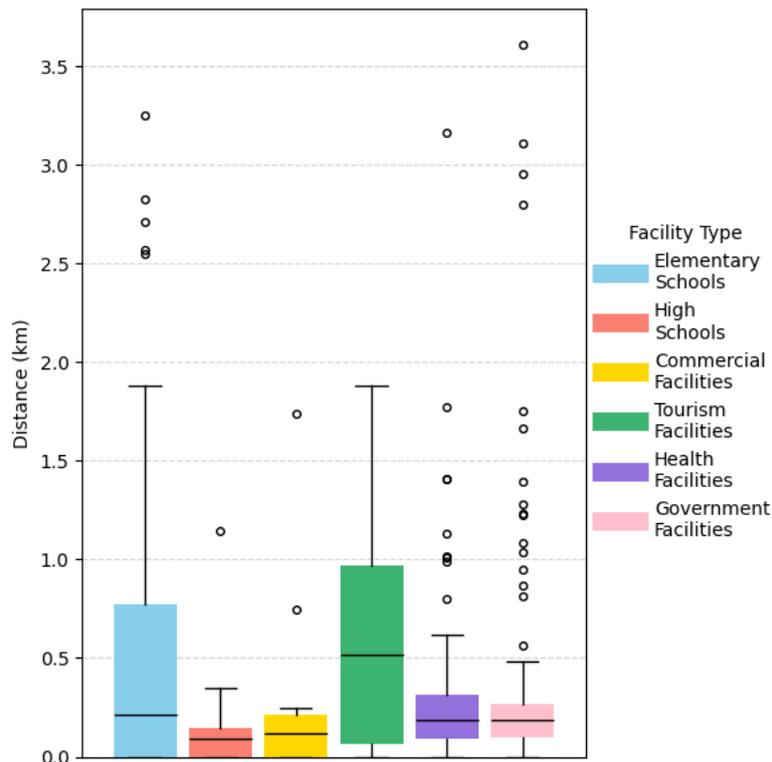
Figure 5. Comparison of distances to the nearest PUV route

Fig. 6 presents the mean values of travel time, public transport cost, and private transport cost across the five municipalities. From the graph, it is evident that private transport consistently incurs higher costs than public transport, with the gap being most pronounced in municipalities like San Lorenzo and Sibunag. However, despite the lower cost of public transport in general, travel time remains substantial, indicating that affordability does not always equate to efficiency.

Notably, public transport fares in municipalities such as Jordan, San Lorenzo, and Sibunag are significantly higher compared to Buenavista, where the mean fare is relatively low. This disparity is largely attributed to the reliance on habal-habal, which drives up transport costs in more remote or less connected areas. This data reinforces the need to improve accessibility and strengthen connectivity to established PUV routes. While walking or using habal-habal to reach these routes is technically feasible, such alternatives are often costly and time-consuming. According to Truden et al. (2022), even in regions with public transport coverage, about 50% of departure and destination points are not realistically accessible on foot due to long walking distances or steep paths. This highlights how physical access barriers can effectively make public transport unusable for a large portion of the population. Ensuring that PUV routes are extended or made more accessible is therefore critical, especially in rural areas, to provide affordable and practical mobility options for all residents.
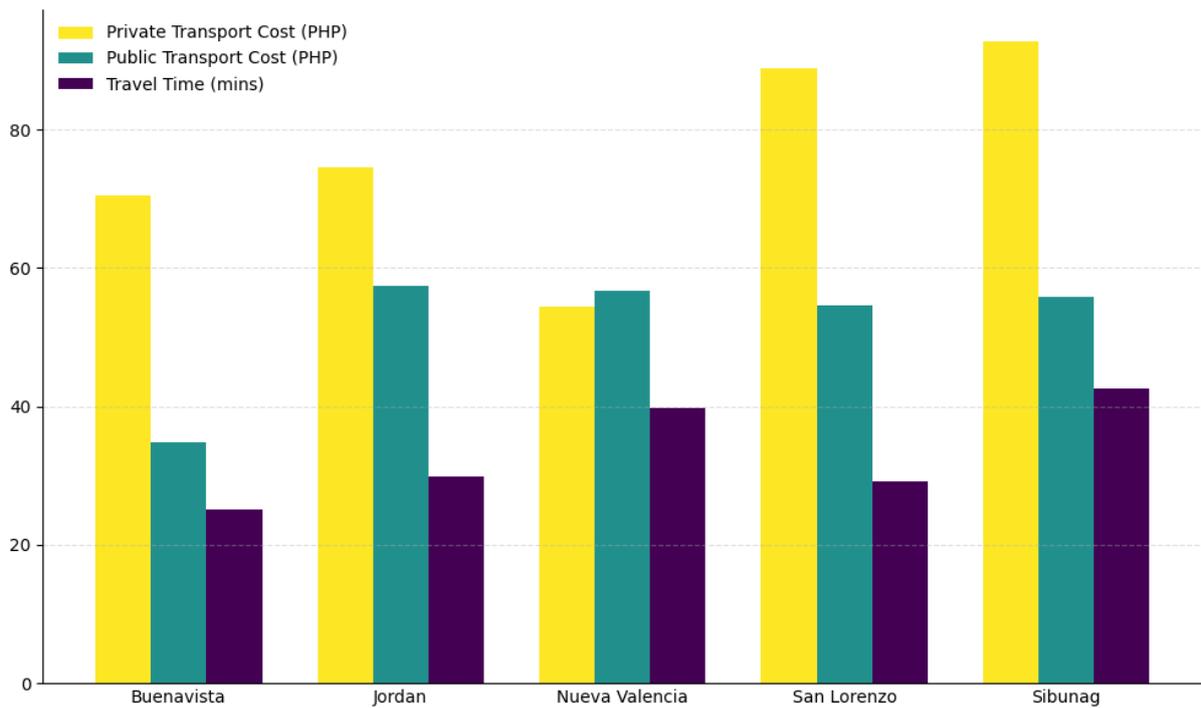
Figure 6. Comparison of costs (private and public) and time

4.3 Route Optimization

Another key feature of the PUVMP is industry consolidation. Under this requirement, transport operators must form a cooperative, consortium, or corporation before being granted a franchise. This shift is mandated because the current franchising guidelines follow a "one route, one franchise" model, awarding the rights to operate a particular route to a single juridical entity rather than to multiple individual operators.

While this approach is intended to streamline operations and promote more efficient route management, it may lead to unintended challenges. One major issue is fleet coordination in areas with overlapping routes. As shown earlier in Fig. 1, the approved inter-municipality routes in Guimaras reveal several cases of significant route overlap. For example, six routes along the Nueva Valencia–Jordan corridor exceed the maximum overlapping limit allowed under the OFG. Additionally, the LPTRP document notes that there are at least two routes where approximately half of their total length overlaps with each other.

This level of redundancy poses difficulties for fleet planning and day-to-day operations. Overlapping segments can create competition among consolidated entities, dilute passenger demand per route, and complicate the assignment and scheduling of vehicles. Moreover, the presence of multiple overlapping routes may lead to underutilization of some units during off-peak periods, further straining financial sustainability. From a planning perspective, this scenario undermines the intent of consolidation by reintroducing inefficiencies it seeks to eliminate.

A possible way to address the issue of route overlap and inefficient fleet deployment is to reconfigure the structure of the routes themselves. One approach is to reduce the overall length of individual routes and instead establish designated stopover or transfer points at key locations across the island. This would allow for the creation of shorter, more manageable routes that connect to specific interchange hubs, rather than long, overlapping lines that span multiple municipalities. Fig. 7 presents the transit movement patterns of residents in Guimaras overlaid with the newly proposed PUV routes. The figure reveals that certain locations along the

Guimaras Circumferential Road experience a high volume of passenger transfers. These are indicated by blue and green circles, representing clusters where multiple route connections intersect. These hotspots, which are in major barangay centers and junctions, highlight the natural convergence points of travel activity. As such, they can serve as key interchange points in a restructured transport network.

Establishing these transfer points as formal interchange hubs can offer multiple benefits. First, they help minimize unnecessary route overlap by allowing different routes to terminate or connect at fixed boundaries. This ensures that each PUV operator serves a defined geographic segment, rather than overlapping with others for most of the journey. Second, it enables more efficient fleet scheduling, since routes become shorter and easier to manage, especially for cooperatives or corporations operating under the "one route, one franchise" system. Third, it gives passengers more flexibility. Instead of waiting for a single vehicle to complete a long trip across the province, they can transfer between routes at designated points, ideally supported by aligned service schedules and waiting areas. In the long term, implementing this form of nodal or hub-and-spoke transport system may help alleviate congestion at terminals, reduce operational costs for operators, and improve service reliability.
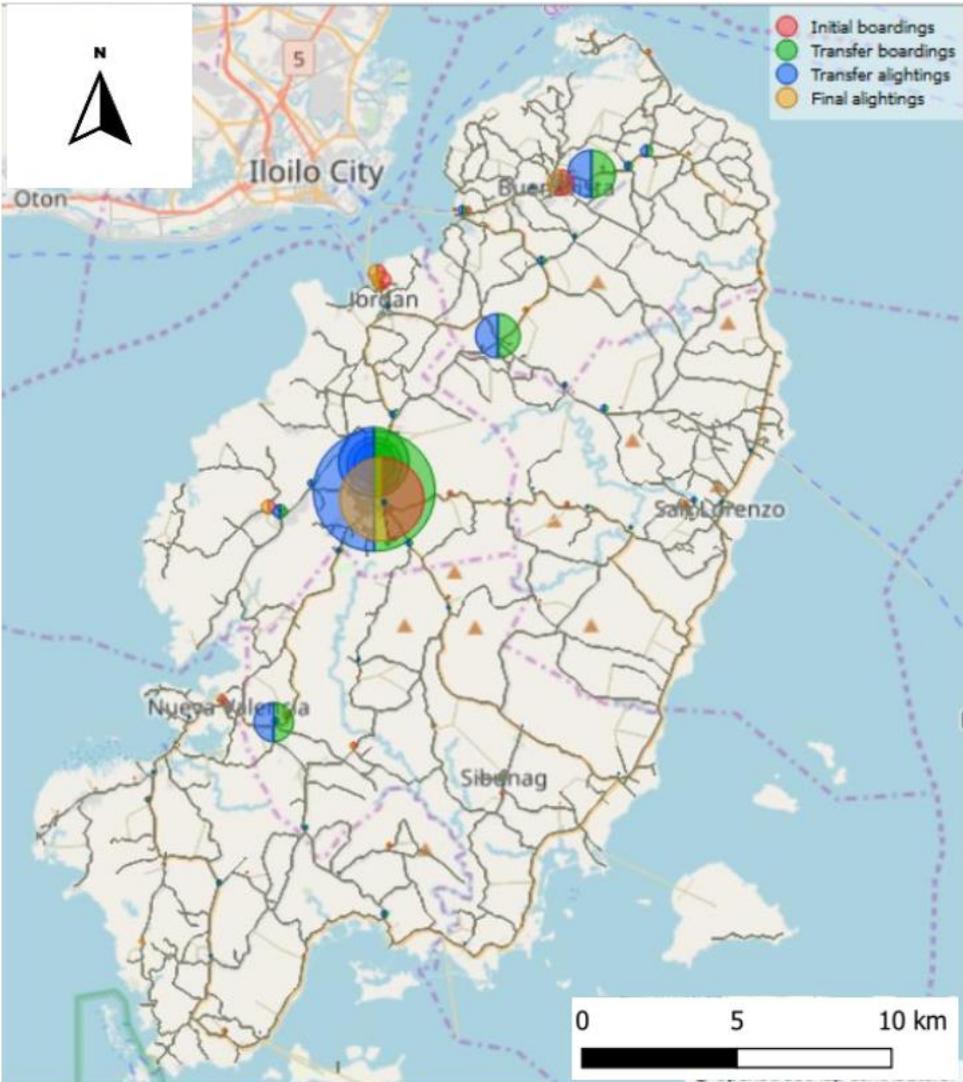

Figure 7. Major boarding, alighting and transfer points in Guimaras

Moreover, a major component of this optimization lies in fleet management, specifically how vehicles are deployed, how routes are organized, and how service coverage is maintained throughout the day, particularly in areas with varying levels of demand. In developing a public transport system suitable for Guimaras, it is important to consider local realities, such as dispersed rural settlements, uneven demand across routes, and the limitations of current vehicle types.

In one potential scenario, transport services operate under the existing "one route, one franchise" policy implemented by LTFRB. Applying this to Guimaras would require issuing 41 separate franchises to cover the entire island, with each route independently operated. While this approach ensures that each service area has a dedicated operator, it also leads to significant overlaps along the national roads, especially where routes from different municipalities converge. Most of these overlaps occur when vehicles that originate from interior barangays reach the main highway, resulting in multiple units operating along the same corridor. This concentration raises operational challenges, including route congestion and competition for passengers. While assigning staggered stops for overlapping routes can minimize the bunching of vehicles at pick-up and drop-off points, managing dispatch and headway intervals remains complex, particularly in shared segments. In this setup, dispatching may still be controlled at the terminal level, given the unique origins of most routes. However, off-peak service may remain inconsistent, as drivers often wait to fill their vehicles to a breakeven capacity before departing. This operational behavior, while responsive to real-time demand, undermines schedule reliability and limits the accessibility of public transport for passengers traveling outside peak hours.

A more refined scenario involves consolidating routes that share major corridors, particularly along the national roads, into grouped franchises. Instead of treating each route as an isolated operation, this approach merges complementary services into larger operational clusters (see Fig. 8). For Guimaras, three main route groups were identified, each formed by consolidating the proposed PUV routes of the Guimaras LGU that share common origin–destination patterns. The first group consists of routes primarily originating from Nueva Valencia and connecting to San Miguel in Jordan, serving the southern municipalities. The second group includes routes from Sibunag and portions of San Lorenzo, which also terminate in Jordan, reinforcing the municipality's role as a key transport hub. The third group comprises routes from Sibunag and Buenavista, linking to the ports of Buenavista and Jordan, as well as the provincial capital. These terminal points correspond to the main urban centers and port areas, which are identified in the LPTRP as major transfer and interchange locations for both inter- and intra-island travel. This consolidated setup reduces redundancy by streamlining overlapping services and enables more centralized fleet allocation and scheduling. High-capacity buses can be introduced along the main corridors to improve efficiency and reduce operating costs through economies of scale. While some transfers between services may be required, this model supports a planned and structured transfer system rather than uncoordinated overlap.

Figure 8. Proposed grouping of PUV services routes

The most integrated scenario envisions the management of all transport services under a single provincial-level entity. In this arrangement, route overlaps cease to be a problem, as all services are coordinated to complement, rather than compete with, one another. Vehicles can be allocated dynamically, shifting to meet fluctuating demand across different times and locations. This structure also allows for the introduction of key transfer terminals at strategic points across the island, particularly along the Guimaras Circumferential Road, where transit flow patterns indicate frequent transfers. These terminals would be equipped with multiple bays to accommodate mainline PUVs, as well as feeder modes such as tricycles and habal-habal serving outlying barangays not directly covered by the PUV routes. By centralizing control of the entire network, this scenario facilitates better scheduling, improved service coverage, and consistent operations, especially in areas with lower demand. Terminals could also function as coordination hubs, improving the passenger experience through reliable transfers and providing sheltered waiting areas, posted schedules, and information systems.

Ultimately, the choice of fleet management strategy will shape the effectiveness and equity of Guimaras' public transport system. Whether through route-level franchising, grouped operations, or centralized provincial control, each model offers trade-offs between operational complexity, cost-efficiency, and user experience. However, aligning route design with realistic demand projections, minimizing redundancies, and investing in transfer infrastructure are key to realizing a system that meets the needs of both operators and the commuting public.

5. CONCLUSION

The Public Utility Vehicle Modernization Program (PUVMP) represents a critical transformation of the Philippines' public transportation system, yet its implementation in island provinces like Guimaras presents unique challenges. The province's dispersed settlement patterns, distinct geography, and reliance on informal transport modes create accessibility gaps that the current Local Public Transport Route Plan (LPTRP) does not adequately address.

This study's analysis reveals significant service gaps in Guimaras' proposed PUV network, particularly in northern and western portions of the island where essential facilities including schools, health centers, and government offices remain underserved. The spatial analysis demonstrates that numerous elementary schools and several health facilities are located beyond reasonable access to formal public transport routes, forcing residents and service providers to rely on expensive and potentially unsafe informal modes such as habal-habal and motor-tricycles.

The findings highlight three critical policy recommendations for improving public transport accessibility in Guimaras. First, route optimization through the establishment of strategic transfer points along the Guimaras Circumferential Road can reduce redundancy and improve operational efficiency while maintaining comprehensive coverage. Second, extending PUV services to underserved areas, even if limited to peak travel periods, would provide residents with safer and more affordable alternatives to informal transport modes. Third, implementing a consolidated fleet management approach, whether through grouped franchises or provincial-level coordination, can address the current route overlap issues while ensuring more equitable service distribution across the island.

These recommendations underscore the need for transport planning that considers the unique geographical and socioeconomic characteristics of provinces. By addressing service gaps and optimizing route structures, Guimaras can develop a more inclusive and sustainable mobility system that serves all residents effectively, ultimately contributing to the broader success of the PUVMP in provincial communities.

However, it is important to acknowledge that transport mode preference is shaped not only by quantitative factors, but also by personal experiences, perceptions of safety, and socio-cultural conditions. Because of this, future research would benefit from adopting a mixed-methods approach to gain a more comprehensive understanding of user needs. Integrating interviews, focus group discussions, or community consultations with the existing quantitative framework would help uncover motivations and constraints that cannot be captured through modeling and spatial analysis alone. This can result in more nuanced and context-sensitive solutions that further advance the development of inclusive and effective public transport systems. It should also be noted that this study represents an initial exploratory step in identifying potential strategies for optimizing PUV routes in Guimaras. While the proposed recommendations are grounded in spatial analysis, they remain conceptual. Subsequent studies should build on these findings by conducting more detailed operational assessments, scenario modeling, or feasibility analyses to quantitatively evaluate the performance, cost implications, and ridership impacts of the proposed routes. This ensures that future interventions are both evidence-based and practically implementable.

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