RESEARCH ARTICLE OPEN ACCESS

Alteration of PUJ's Transportation: Optimizing Routes for Systematize Transportation in Plaza Burgos, Guagua, Pampanga

Mary Pearl Dianne D. Duaso[1], France Lester M. Macam[2], Jiezel Z. Nicdao[3], Mar Angelo B. Pangan[4], John Daniel M. Pangilinan[5], Catherine A. Peralta[6], Rolando M. Tanig Jr.[7], Aaron S. Malonzo[8]

[1](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: pearldianne23012@gmail.com)

[2](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: francemacam29@gmail.com)

[3](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: jzlnicdao@gmail.com)

[4](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: marangelo.pangan@gmail.com)

[5](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: engrpangilinan24@gmail.com)

[6](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: catherineperalta97@gmail.com)

[7](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: rolandotanig@gmail.com)

[8](Department of Civil Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines
Email: asmalonzo@dhvsu.edu.ph)

--************************----------------------------------

Abstract:

The public transportation system facilitates social interaction by allowing people, goods, and services to travel to various destinations worldwide. This stimulates closer connections among individuals and promotes globalization and economic advancement. Advancements in technology have led to the emergence of more economical, efficient, and environmentally friendly transportation systems. These innovations can potentially revolutionize how people live and interact with one another in the future. The research titled "Alteration of PUJ's Transportation: Optimizing Routes for Systematized Transportation in Plaza Burgos, Guagua, Pampanga," focuses on the reconfiguration and optimization of transportation routes in order to address the issue of traffic congestion, which is a societal concern. The researchers employed a quantitative methodology to determine the components contributing to the traffic delays. This entailed gathering data on the number of cars, the condition of the roads, and various transportation methods used by the regional government offices through firsthand observation. The report emphasizes that traffic congestion can arise from an excessive number of cars, worsening road conditions, and inadequate transportation system policies. Hence, to tackle these concerns in further investigations, the study examines the gathered data and proposes remedies, particularly in relation to public transportation systems and the design of terminal stations, with the primary objective of attaining sufficient transportation for the populace and ensuring convenience for all.

Keywords —Public Transportation, Civil Engineering, Re-routing System

---------------------------------------***********************---------------------------------

I. INTRODUCTION

In society, transportation refers to the destinations of every individual, goods, and transportation services, as well as the effectiveness and accessibility of routes for travel. Transportation changed human civilization by allowing individuals and goods to travel long distances, promoting globalization and economic progress. It has fostered the interchange of ideas, products, and cultures while offering access to markets, jobs, education, and healthcare. With technological advancements, the future of transportation offers more efficient, secure, and sustainable travel alternatives, transforming the way of life and interactions with the world.

There is no denying that transportation is essential to human existence. A poorly functioning transportation system can lead to a number of negative outcomes, such as wasted time, increased fuel consumption, increased car emissions, a higher chance of accidents, and higher transportation costs. Over the past thirty years, metropolitan areas in the Philippines, particularly in Metro Manila, have seen widespread growth in the number of vehicles on the road, resulting in catastrophic levels of traffic congestion. In addition, the megapolis's expansion into adjacent regions became a solid metropolis with permanent heavy traffic and newly erected high-rise buildings, thus drastically changing their skylines (Cervero, 2013, quoted in Bouquet, 2013).

Transportation provides access to employment, schooling, and retail businesses for the individual sector. It links individuals to public, social, entertainment, and medical institutions for personal use and enjoyment. It is an essential driver of social and economic growth, as it significantly affects the country's economic growth. Thanks to technology, transportation has changed throughout the last century. Especially in the Province of Pampanga, the land transportation system is critical to economic activities and the transportation of people, products, and services within and across regions.

Public transportation refers to the vehicles and equipment that offer shared transportation services to everyone. Think buses, trains, subways, trams, ferries, and other modes of transportation that follow specific routes and are open to anyone who wants to use them. Guevara R. (2023) asserts that the Philippine public transportation system requires updating due to its aging machinery, unstable operators' finances, and insufficient infrastructure, which hinders ongoing development and modernization. Transportation has always been a massive problem in the Philippines, especially for commuters [12].

R. F. Jabal (2023) stated that the lack of suitable public transportation infrastructure is also a significant issue in the Philippines. The relatively underdeveloped public transit system in the Philippines makes going around with a car easier. This is especially true in rural areas, where public transportation is occasionally scarce or non-existent [11]. A. Bull (2004) concluded that traffic congestion is the one critical transportation problem in the Philippines. Whether in a developed or developing country, traffic congestion threatens the quality of urban life. Its most evident form is a progressive slowing of traffic speeds, which increases journey durations, fuel consumption, other operational expenses, and environmental pollutants compared to an uninterrupted traffic flow [14].

Additionally, Ma. E.A. Bayona et al. (2016) stated in their study that if there were a vehicular terminal, the number of public vehicles that had to stop at different places, especially along the route, to pick up passengers would go down. The provision of a terminal would streamline passenger choices and simplify their travel experience. A terminal's facilities for passengers are equally as significant as parking spaces for public transit vehicles [10].

Directing vehicular traffic to improve traffic situations is crucial; however, relying solely on traffic information for route recommendations can be unsatisfactory in meeting transportation management requirements. A multi-objective and context-aware rerouting method is necessary for effective traffic control. Although existing deterministic processes may show potential, they may not address the rigid requirements of contemporary traffic management applications. They could be the root cause of traffic jams where many vehicles choose the same route. As a result, conventional techniques can reduce the overall effectiveness of vehicular traffic. (de Souza, A. et al., 2019)

A. *Objectives of the study*

The main objective of this study is to optimize the routes for a systematized traffic flow in Plaza Burgos, Guagua, Pampanga. The specific objectives of this study are the following:

Specific Objectives:

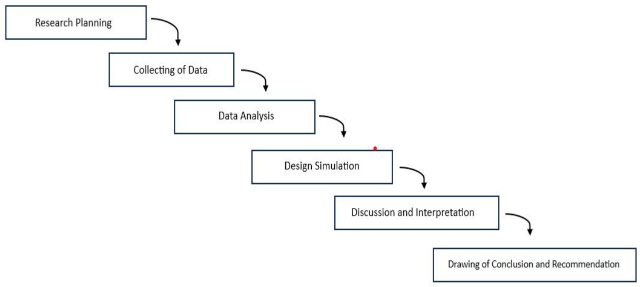
1. To identify the primary factors affecting the efficiencies in the current PUJ transportation system in Plaza Burgos, Guagua.
2. To assess the current condition and behaviour of the traffic flow in the existing routes.
3. To theoretically design transportation routes that systematize vehicle flow and reduce traffic congestion in Plaza Burgos, Guagua, and Pampanga.

B. *Scope and Limitation*

The research primarily focused on advancing the public transportation system. It aimed to suggest a practical remedy for the problem of traffic congestion in the Plaza Burgos neighborhood in Guagua, Pampanga. Prior to commencing, the researchers recognized specific scopes and constraints. This entails evaluating and proposing improvements for transportation routes and vehicle movement, focusing on jeepneys and microbuses. The analysis used PTV Vissim, a software specifically designed for conducting 3-D simulations of traffic flow. Despite its limitations to the student form, PTV Vissim enjoys widespread recognition for its effectiveness in traffic flow planning and micro-simulation.

It focused on redirecting and planning routes within the region. However, the evaluation did not cover flyovers, fines for violating regulations, traffic signals, law enforcement staff, erecting structures, or non-essential incidents.

C. *Conceptual Framework*



This research framework presents a systematic approach that involves meticulous preparation to establish clear study objectives and scientific approaches. Data collection involves a variety of sources and methods to guarantee comprehensive and dependable coverage. Using precise data analysis methods, such as statistical and qualitative analysis, to uncover patterns and trends. Creating simulation pathways simplifies testing hypotheses and analyzing scenarios, enhancing the results' precision. The discussion and interpretation of the findings provide an analysis of current research and theoretical frameworks. Utilizing the gathered evidence to derive conclusions and generate recommendations, thereby advancing knowledge and providing guidance for practical applications and future research endeavors.

II. DATA GATHERING PROCEDURES

The researchers employed the cordon volume count (CVC) technique. This approach measures traffic in a specific area when traffic flows in one direction. The purpose is to determine the regional movement of vehicles and people in that area. The collected data includes counts of cars and passengers using a wide range of vehicle types and modes of transportation. As part of the survey technique, meticulously observed all vehicle entrances and exits within the designated inner limit during the data gathering procedure.

Most important regional stations use the manual counting technique of automotive traffic to collect raw data. Processing raw vehicle traffic counts involves estimating average daily traffic and calculating the annual average daily traffic (AADT). Establishing the strategic stations by placing a cordon line at vehicles' entry and departure ports around Plaza Burgos, Guagua. Assigning each researcher to specific locations, they manually tallied the number of automobiles arriving and departing from the station. Considering patterns when recording the necessary data. For instance, an hourly pattern can be employed to identify the peak hours when many cars are present. In addition, the researchers categorized the recorded cars into different classes based on the "Manual Classified Traffic Count" form of the Department of Public Works and Highways (DPWH). The researchers collected data for seven (7) days.

Additionally, the researchers manually counted cars on the same stationing as per the Cordon Line on various days in order to calculate the Average Daily Traffic (ADT), gathering data during 12 hours

After finalizing the stations, the researchers' solved for the Peak Hour Factor (PHF) to know the traffic condition at Plaza Burgos.

$$\mathbf{PHF} = \frac{V_{hr}}{maximum\ volume\ per\ 15mins\ interval} = \frac{V_{hr}}{4 \times V_{15}}$$

With these, the researchers manually counted the vehicle for an hour in the morning and another hour in the afternoon during the peak hours with fifteen (15) minutes intervals.

If the PHF number is closer to 1, this indicates a steady traffic flow, however the lower the PHF, the more unsteady the traffic flow. The average PHF for a small town is 0.63 to 0.90.

Subsequently, the gathered traffic information is used to calculate the volume capacity ratio (VCR) and assess the road network's level of service (LOS). The Level of Service (LOS) technique offers a thorough framework for assessing and calculating the magnitude of traffic flow inside the transportation network. The LOS approach offers a comprehensive assessment of the efficiency and efficacy of existing traffic conditions, which is crucial for establishing the necessity of any enhancements.

The provided method calculates the volume-capacity ratio to determine a specific road network's current level of service

A. *Analyzation Of Traffic Congestion*

Basic Hourly Car Capacity

Carriageway Width	**Hourly PCU**	
	Rural	**Urban**
Single 4 meters	600	600
4-5 meters	1200	1200
5.1 - 6.0 meters	1900	1600
6.1 - 6.7 meters	2000	1700
6.8 - 7.3 meters	2400	1800
2 x 6.7 or 2 x 7.3 meters	7200	6700

Passenger Car Unit (PCU)
PCU = Summation of AADT of all vehicle types

Vehicle Types / PCE Factors

No.	**Description**	**PCEF**
1	Motor-Tricycle	2.5
2	Passenger Car	1.0
3-5	Passenger and Goods Utility and Small Bus	1.5
6	Large Bus	2.0
7	Rigid Truck, 2 Axles	2.0
8	Rigid Truck, 3+ Axles	2.5
9	Truck Semi-Trailer, 3 and 4 Axles	2.5
10	Truck Semi-Trailer, 5 Axles	2.5
11	Truck Trailers, 4 Axles	2.5
12	Truck Semi-Trailer, 5+ Axles	2.5

multiplied with the Passenger Car

Annual Average Daily Traffic (AADT) represents the yearly volume of traffic within a specific road network. Average Daily Traffic (ADT) reflects the average volume of traffic over a predetermined time span within 24 hours. For example, ADT could be measured over 12 hours from 7 am to 7 pm, though this time frame can vary depending on specific circumstances.

Formulas:
AADT = ADT x Adjustment factors

Adjustment Factors

Scenarios	Urban	Inter-urban	Recreation
High	1.016	1.115	1.271
Medium	1.000	1.060	1.141
Low	0.989	1.016	0.962

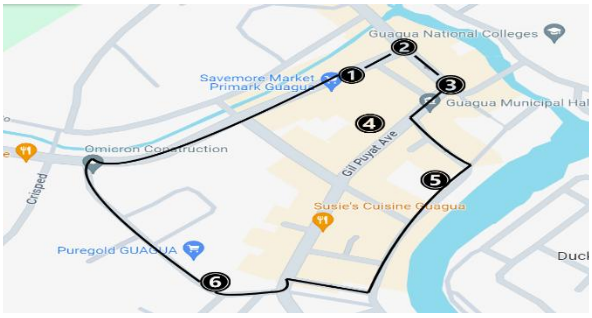
Classification of Levels of Service Based on the computed VCR

Vehicle Capacity Ratio	Description	Traffic Condition	LOS Rating
0 – 0.20	Free flow, Low Volume and Densities; Drivers can maintain their desired speeds with little or no delay and are unaffected by other vehicles.	Very Light	A
0.21 – 0.50	Reasonably free flow, operating speeds beginning to be restricted somewhat by traffic conditions. Drivers still have reasonable freedom to select their speeds.	Light	B
0.51 – 0.70	Speeds remain near free flow speeds, but freedom to maneuvers noticeably restricted	Moderate	C
0.71 – 0.85	Speeds begin to decline with increasing volume. Freedom to maneuver is further reduced and traffic stream has little space to absorb disruptions.	Moderately Heavy	D
0.86 – 1.00	Unstable flow, with volume at or near capacity. Freedom to maneuver is extremely limited and the level of comfort afforded the driver is poor. Heavy Traffic	Heavy	E
> 1.00	Saturation Traffic volumes, stop and go situations	Very Heavy	F

III. RESULT AND DISCUSSION

A. *Main Research Site Data Analysis Results*

The researchers present the relevant data for accomplishing this study in this chapter. The Peak Hour Factor for seven (7) consecutive days was discussed, the results from the conducted survey were analyzed, and the planned re-design of transportation routes for PUJs was thoroughly discussed among members.



Peak Hour Factor

Station 1: Along Savemore
PHF values : Morning 7:00am - 8:00am
Entry and Exit: PHF Values

Day	**PHF**	**PHF**
1st	0.8214285714	0.8212719298
2nd	0.8763345196	0.8498168498
3rd	0.8849765258	0.882629108
4th	0.8675799087	0.8755924171
5th	0.8923766816	0.8935406699
6th	0.8744148605	0.8877314815
7th	0.8977272727	0.8916256158
PHF	**0.8735483343**	**0.8717440103**

The average PHF value of the entry lane is 0.8735483343, and the average value of the exit lane is 0.8717440103, indicating that the traffic flow in the entry and exit lanes is slow. Since both lanes have an average value lower than one, it indicates that this station during morning has an unstable traffic flow.

PHF values : Afternoon 4:00pm - 5:00pm
Entry and Exit: PHF Values

Day	**PHF**	**PHF**
1st	0.8193717277	0.8604368932
2nd	0.8651685393	0.8566666667
3rd	0.8554347826	0.83
4th	0.8818181818	0.8795045045
5th	0.8744680851	0.8685344828
6th	0.8611111111	0.8706521739
7th	0.844866074	0.8589449541
PHF	**0.8574626431**	**0.8606770965**

During the afternoon, the traffic flow in this station is also the same as during the morning, which is considered unstable. The average PHF of the entry and exit lanes are 0.8574626431 and 0.8606770965 consecutively.

Station 2: Along Jollibee

PHF values : Morning 7:00am - 8:00am

Entry and Exit: PHF Values

Day	**PHF**	**PHF**
1st	0.8259911894	0.814479638
2nd	0.8009032258	0.827357724
3rd	0.815371024	0.8697318008
4th	0.8274058577	0.8264705882
5th	0.7875	0.8039419087
6th	0.8836538462	0.911328125
7th	0.8291015625	0.8621323529
PHF	**0.8242752437**	**0.8450631625**

The entry lane has an average PHF value of 0.8242752437 for the morning, while the exit lane has 0.8450631625. Since both lanes almost have the same value, it indicates that both lanes have similar unsteady traffic flow.

PHF values : Afternoon 4:00pm - 5:00pm
Entry and Exit: PHF Values

Day	**PHF**	**PHF**
1st	0.8051948052	0.8074468085
2nd	0.8025793651	0.7995867769
3rd	0.8012152778	0.8009803922
4th	0.7985074624	0.802919708
5th	0.7715686275	0.7994505495
6th	0.8097609562	0.7998120301
7th	0.8311808118	0.8153061224
PHF	**0.8028580963**	**0.8036431971**

In the afternoon, the average PHF of the entry and exit lanes is 0.8028580963 and 0.8036431971, respectively. Both lanes' PHF values are lower than those during the morning. And it also means that the traffic flow during the afternoon is a little more unsteady than in the morning.

Station 3: Along KFC

PHF values : Morning 7:00am - 8:00am
Entry and Exit: PHF Values

Day	**PHF**	**PHF**
1st	0.767287234	0.7859116022
2nd	0.8608108108	0.8762626263

3rd	0.8495024876	0.8756410256
4th	0.8616751269	0.884057971
5th	0.8704954955	0.8691588785
6th	0.8945086705	0.8863636364
7th	0.9148148148	0.9123134328
PHF	**0.8598706629**	**0.8699584533**

The first day of entry and exit at this station has a value of 0.767287234 and 0.7859116022 PHF, which indicates that the traffic flow is not consistent or slow in this lane. Although the seventh day for entry and exit is close to 1, it is still considered to have an unstable traffic flow. Entry and exit lanes had average values of 0.8598706629 and 8699584533, respectively, indicating slow vehicle flow.

PHF values : Afternoon 4:00pm - 5:00pm

Entry and Exit: PHF Values

Day	**PHF**	**PHF**
1st	0.7954545455	0.8407894737
2nd	0.8298122066	0.7912371134
3rd	0.8365853659	0.837628866
4th	0.8266331658	0.8586956522
5th	0.9064039409	0.8397435897
6th	0.9289215686	0.883248731
7th	0.9543650794	0.9172794118
PHF	**0.868310839**	**0.8526604054**

Compared to the morning values, the PHF of both lanes in the afternoon is almost the same. The entry lane has an average PHF of 0.868310839, and the exit lane has 0.8526604054. Both lanes are also considered to have inconsistent traffic flow. Both lanes have a PHF value of 0.79, with the first day being the entry lane and the second day being the exit lane.

Station 4: Along Pandayan

PHF values : Morning and Afternoon

Morning: PHF Values

Day	**PHF**
1st	0.7697841727
2nd	0.8040540541
3rd	0.8238255034
4th	0.7638888889
5th	0.7954545455
6th	0.8137254902
7th	0.8051470588
PHF	**0.7965599691**

Afternoon: PHF Values

Day	**PHF**
1st	0.7333333333
2nd	0.7878289474
3rd	0.8141447368
4th	0.7722222222
5th	0.7676282051
6th	0.8311688312
7th	0.8484848485
PHF	**0.7935444464**

This station has one of the lowest PHF values, with an average of 0.7965599691 during the morning. While in the afternoon, its value is 0.7935444464, this indicates that the traffic flow is also the same as the morning vehicle flow.

Station 5: Along Gleemart

PHF values : Morning 7:00am - 8:00am

Morning: PHF Values

Day	PHF
1st	0.9015151515
2nd	0.8841911765
3rd	0.8903061224
4th	0.9361702128
5th	0.9121621622
6th	0.9166666667
7th	0.9638554217
PHF	**0.9149809877**

On the 7th day in the morning, the traffic is much smoother compared to the rest of the days. The morning's average PHF value is 0.9149809877. This station is one of those that was close to having a smooth flow of vehicles compared to other stations.

PHF values : Afternoon 4:00pm - 5:00pm

Afternoon: PHF Values

Day	PHF
1st	0.8954545455
2nd	0.941588785
3rd	0.9108527132
4th	0.9352678571
5th	0.8665413534
6th	0.89
7th	0.9441176471
PHF	**0.9119747002**

The table shows that values in the afternoon are the same as in the morning. The lowest is on the 5th day with a value of 0.8665413534, and the highest is on the 2nd and 7th days with a value of 0.941588785 and 0.9441176471, respectively. Although the average value is close to 1, this indicates that there is still a small, unsteady flow of vehicles at this station.

Station 6: Along Feeder Road

PHF values : Morning 7:00am - 8:00am

Entry and Exit: PHF Values

Day	PHF	PHF
1st	0.9	0.7717948718
2nd	0.7724719101	0.9036885246
3rd	0.9655963303	0.9619565217
4th	0.9253926702	0.9457671958
5th	0.9295774648	0.9291044776
6th	0.9708333333	0.9204545455
7th	0.7595108696	0.8458737864
PHF	**0.889054654**	**0.8969485605**

The entry lane for this station has the highest PHF value on the 1st, 3rd, 4th, 5th, and 6th days, with values closest to 1, showing that on those days it has a smooth flow of traffic. And The 2nd and 7th days for entry and the 1st day for exit have the lowest values, indicating a slow flow of vehicles. The PHF average values for the entry and exit lanes are 0.889054654 and 0.8969485605, respectively. Since these values are less than 1, this means that this station has unstable traffic flow during the morning.

PHF values : Afternoon 4:00pm - 5:00pm
Entry and Exit: PHF Values

Day	PHF	PHF
1st	0.9335106383	0.9013157895

2nd	0.898255814	0.9291666667
3rd	0.9517045455	0.9464285714
4th	0.943877557	0.9276315714
5th	0.9704301075	0.9147727273
6th	0.8977272727	0.8932291667
7th	0.8156779661	0.8915662657
PHF	**0.9158834144**	**0.9148729655**

The traffic in the afternoon is smooth compared to the morning. The entry lane averages 0.9158834144 PHF, and the exit lane has 0.9148729655. It may have high PHF values, but it is still considered to have an inconsistent traffic flow since these values are below 1.

Analysis and Observations in Peak Hour Factor

The examination of traffic flow at various stations yielded diverse observations. At Station 1 (referred to as "Save More"), it was noted that the traffic dynamics appeared less fluid compared to other stations. Station 2 (designated as"Jollibee") was identified as experiencing congestion arising from simultaneous vehicular entries and exits. Similarly, Station 3 (termed "KFC") was found to suffer from traffic delays primarily attributable to parallel parking activities near the municipal office of Guagua. Station 4 (referred to as "Pandayan") exhibited inefficiencies in traffic flow due to factors such as jeepney drop-off points and parallel parking arrangements. Conversely, Station 5 ("Gleemart") was observed as approaching optimal traffic flow conditions relative to other stations. Station 6 (identified as "Feeder Road") was characterized by fluctuating traffic patterns predominantly influenced by grocery shopping activities.

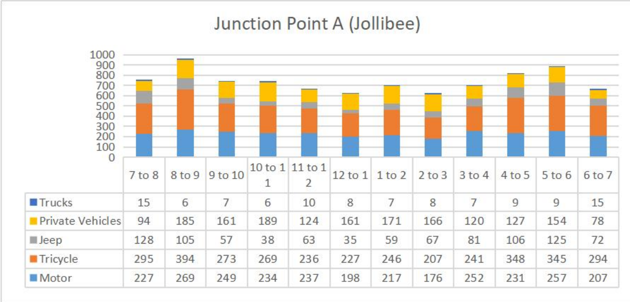
B. ***LOS Based on VCR of Plaza Burgos***

Plaza Burgos was divided into 4 entry points namely A (From San Fernando / Bacolor), B (From Lubao), C (From Sasmuan), and D (From GNC) and 1 exit point E (To Feeder Road). Each junction point bears a different LOS based on the computed VCR Rating.

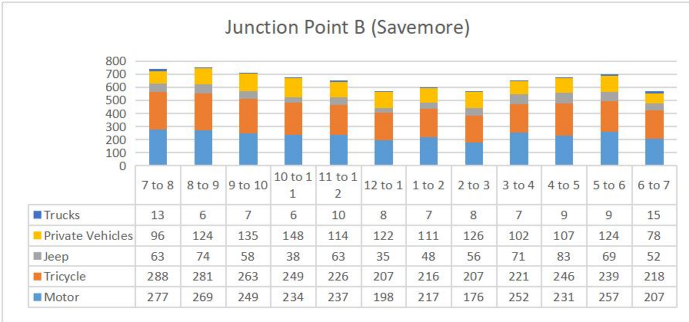
Vehicular Traffic Pattern (Hourly Period)

Distribution of vehicles for entry point A within an hourly interval interpreted in bar graph form.

A. Junction point from San Fernando/Bacolor



Junction A (Jollibee)



Junction A is located near Jollibee Guagua and directly in front of Pima Drug, a critical intersection. This junction is the primary entry point for vehicles arriving from San Fernando and Santa Rita. Additionally, it is an essential exit for vehicles departing from Plaza Burgos, heading towards San Fernando, or continuing straight to Jose Abad Santos Avenue. According to the figure above, the period between 8 am and 9 am experiences the highest concentration of vehicles passing through this junction, highlighting its importance in the daily commute of residents and visitors alike.

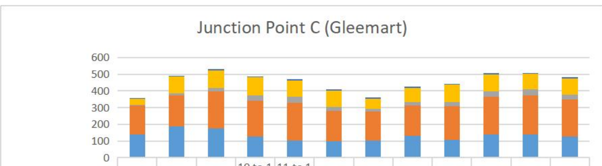
In terms of vehicle composition, tricycles represent the largest portion of traffic volume at

Junction A, reflecting their popularity and widespread use in the area. This is followed closely by motorcycles, contributing significantly to the overall traffic. The predominance of these smaller, more maneuverable vehicles suggests a high degree of local, short-distance travel, as tricycles and motorcycles are commonly used for quick trips and navigating through congested areas. The data on vehicle types not only provides insights into traffic patterns but also indicates the need for tailored traffic management strategies to accommodate the specific characteristics of Junction A. Effective traffic control measures are essential to maintain order and safety at this busy intersection, particularly during the peak morning hour when the influx of vehicles is at its highest.

B. Junction point from Lubao

Junction B is situated at the front of Savemore grocery mall. The junction serves as an entry point for vehicles mainly from Lubao and nearby barangays such as Santo Cristo. Furthermore, the junction also sets out as an exit road for vehicles westbound from Plaza Burgos. The collected data represents the volume of vehicles going through the intersection to the plaza. During the hours of 7 am to 9 am, the peak vehicle volume occurs. This period witnesses the heaviest traffic, with the largest number of vehicles passing through. Consequently, this timeframe experiences the highest traffic concentration, making vehicular movement the busiest part of the day. Tricycles and motorcycles have the highest volume counted during this hour period on Junction B, representing the common usage of this type of vehicle.

C. Junction point From Sasmuan

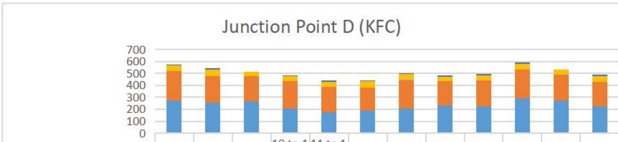


	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7
Trucks	1	6	3	5	4	3	4	5	6	6	6	3
Private Vehicles	38	99	108	105	97	97	61	85	103	101	93	97
Jeep	1	14	18	35	33	25	17	23	26	34	38	29
Tricycle	175	182	222	214	226	183	173	180	201	228	231	219
Motor	139	189	176	126	104	98	102	131	107	137	140	128

Junction C (Gleemart)

The location of Junction C is on the right side of the municipal hall of Guagua. This junction only caters to vehicles going to the plaza and westbound, as it is a one-way road. This junction is the main pathway for public vehicles, whose terminals are at the plaza. Periods of 9 am to 10 am record the busiest time for the junction in the morning. While 4 pm up to 6 pm is the highest volume of vehicles going through the junction in the afternoon. It is the main pathway for public vehicles going to the plaza. Tricycles and motorcycles still have the highest count in the junction. The road condition on the junction also is a little bit narrower than the other junction because of vehicles parking on the roadside, making it difficult to maneuver and posing another problem in managing the traffic congestion.

D. Junction point located from GNC and at KFC

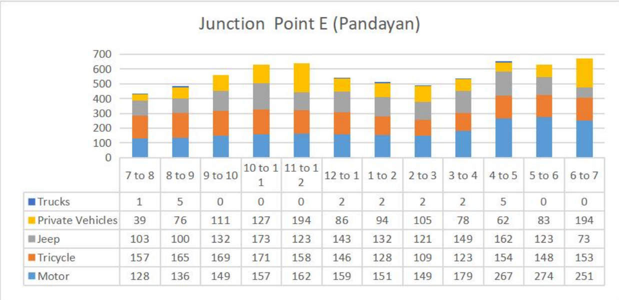


	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7
Trucks	7	5	0	1	6	3	5	5	4	2	0	6
Private Vehicles	51	55	38	44	41	54	49	38	44	50	40	49
Jeep	0	1	0	2	1	0	1	2	0	1	0	0
Tricycle	246	225	210	229	214	194	241	205	214	239	221	203
Motor	273	253	266	204	175	186	203	229	227	293	272	224

Junction D (KFC)

Junction D is the main vehicle pathway to Guagua National Colleges (GNC). Located right beside KFC and the municipal hall (left side). Vehicles that exit the plaza and go eastbound mainly use this junction, and vehicles from Sasmuan and nearby barangays usually come through this junction. Peak hours of 7 am to 8 am and 4 pm to 5 pm are the busiest times of the junction. Vehicles going to and from GNC mainly account for the volume of vehicles in the junction. Tricycles and motorcycles also comprise the majority of the traffic volume in the area.

E. Junction point to Feeder Road located at Pandayan



Junction E (Pandayan)

Junction E can be found in front of Pandayan, a few distance from the municipal hall. This junction is the main drop-off of public vehicles coming from nearby municipalities. It heavily impacts the flow of traffic around the junction. Intervals of 11 am to 12 pm suggest the highest traffic count in the morning going through lunchtime, and 6 pm to 7 pm states the highest volume of traffic in the afternoon to evening. The number of tricycles and motorcycles passing through the junction has the highest volume, followed by public transports.

C. *Initial simulation Utilizing the Software PTV Vissim*

Utilizing the PTV Vissim software to conduct simulations with the gathered data to improve understanding in a simulated setting. Additionally, PTV Vissim was used to model the proposed solutions and produce theoretical results. The aim is to replicate the present road network system at the research site precisely. Building the roads with precise measures, consulting the Local Government Unit of Guagua's Comprehensive Land Use Plan (CLUP) as a guide. Utilizing a network of roads totaling about 3,500 meters, varying in length on specific routes.

Node Location	Delay (s/veh)	LOS Rating
A	36.3	E
B	27.27	D
C	15.33	C
D	34.2	D

PTV Vissim produced the results, clearly illustrating the extent of traffic congestion on Plaza Burgos and confirming the existing problem. This situation underscores the urgent need for a solution. An evaluation of the Level of Service (LOS) for all intersections shows that Locations A, B, and D have LOS ratings indicating heavy traffic, necessitating immediate intervention. Conversely, Node C, with the lowest LOS rating, experiences moderate traffic.

PTV VISSIM EVALUATION RESULT SUMMARY		
Node Location	**Delay (s/veh)**	**LOS Rating**
A	10.73	B
B	10.23	B
C	8.3	A
D	10.35	B

The running simulation with the terminals on Plaza Burgos, Guagua Pampanga, shows a noticeable difference in the results, indicating better traffic conditions. It has been stated that the re-routing plans and designs are effective where it is mentioned that the old routes are not good and cause traffic congestion. Based on these results, it can be identified and concluded that all of the new routes for node locations have been improved.

The vehicular delay comparison between the current road state and the newly designed roads used. The chart demonstrates that adopting specific routes can reduce travel time by up to 25.57 seconds, with a minimum reduction of 7.03 seconds. The chart displays the corresponding level of service (LOS) for the current and suggested solutions. Alternative routes may enhance the traffic situation at the major intersection for all entrance points.

The researchers chose to implement a modification of the pathways in Plaza Burgos, Guagua, and Pampanga as the answer. After analyzing the data, the researchers used PTV Vissim to assess the efficacy of the solutions. This chapter demonstrated the effectiveness of rerouting the majority of entry points, resulting in an improvement in their quality of service.

IV. CONCLUSIONS

The research findings suggest that Plaza Burgos, located in Guagua, Philippines, suffers from traffic congestion due to ineffective traffic management. In order to conduct a more thorough investigation, researchers collected data from the Municipality of Guagua by administering surveys and performing manual traffic counts. After analyzing, simulating, and projecting this data, it became clear that traffic congestion is a significant issue, particularly at the San Roque intersection. Traffic congestion considerably influences areas such as Rosario Memorial Hospital, Santo Nino, Plaza Burgos, and Senator Gil Puyat Avenue. Enhancing transportation networks is important to provide advantages to various stakeholders, including government officials, residents, commuters, and drivers. According to the experts' research, rerouting is proposed to reduce traffic congestion and improve traffic control in the region.

ACKNOWLEDGMENT

This study would not have been possible without the guidance and help of several individuals who, in one way or another, contributed and extended their valuable assistance in preparing and completing it. The researchers would like to extend their deepest gratitude and appreciation to the following individuals:

Firstly, they wholeheartedly acknowledge the Almighty God for His unwavering presence. Despite challenges, His blessings have sustained them, enabling them to remain resilient and reach great heights. They are grateful and humbled by His continuous presence.

The researchers are immensely grateful to their thesis coordinator, Engr. Aaron S. Malonzo. His unwavering support, invaluable guidance, and insightful feedback have been instrumental in shaping this thesis. His commitment to excellence and passion for the field has been a constant source of inspiration.

The researchers would like to extend their heartfelt appreciation to the faculty members of the Civil Engineering Department. Their expertise, encouragement, and scholarly advice have significantly enriched the quality of this thesis. Their dedication to fostering academic growth and intellectual curiosity has broadened the researchers' perspectives and enhanced their learning experience.

Nevertheless, it is important to recognize the invaluable contribution of their thesis adviser, Engr. Rolando M. Tanig Jr., from the Civil Engineering Department, for his time and support during the data collection. His professionalism and expertise were instrumental in ensuring the success of the current project.

In addition to the support and opportunities received, they would like to thank their fellow researchers for their camaraderie, collaboration, and insightful discussions, which greatly enriched and defined this thesis as a high-quality document.

Hence, they sincerely thank their families for their unwavering support, patience, and encouragement. Their loved ones' presence during joyous and challenging times and unwavering belief in their abilities have been a tremendous source of motivation. They are deeply appreciative and hold their families in the highest regard.

REFERENCES

[1] A. Abadi, T. Rajabioun, and P. A. Ioannou, “Traffic Flow Prediction for Road Transportation Networks With Limited Traffic Data,” IEEE Transactions on Intelligent Transportation Systems, pp. 1–10, 2014, doi: https://doi.org/10.1109/tits.2014.2337238.

[2] M. Q. Nguyen, T. T. X. Pham, and T. T. H. Phan, “Traffic Congestion,” European Journal of Engineering and Technology Research, vol. 4, no. 9, pp. 112–116, Sep. 2019, doi: https://doi.org/10.24018/ejeng.2019.4.9.1524.

[3] B. Priambodo and A. Ahmad, “TRAFFIC FLOW PREDICTION MODEL BASED ON NEIGHBOURING ROADS USING NEURAL NETWORK AND MULTIPLE REGRESSION,” Journal of Information and Communication Technology, Oct. 2018, doi: https://doi.org/10.32890/jict2018.17.4.8269.

[4] J. J. Aydinan, “TRAFFIC CONGESTION SITUATION IN THE TRICYCLE CAPITAL OF THE PHILIPPINES: ITS CAUSES AND EFFECTS,” www.academia.edu, Dec. 2020, Accessed: Nov. 26, 2020.

[Online]. Available: https://www.academia.edu/44717688/TRAFFIC_CONGESTION_SITUATION_IN_THE_TRICYCLE_CAPITAL_OF_THE_PHILIPPINES_ITS_CAUSES_AND_EFFECTS

[5] S. Munuhwa, E. Govere, B. Mojewa, and A. Lusenge, "Alleviating Urban Traffic Congestion: Case of Gaborone City," ResearchGate, Apr. 30, 2020. https://www.researchgate.net/publication/353739308_Alleviating_Urban_Traffic_Congestion_Case_of_Gaborone_City

[6] J. Gao, L. Dai, and X. Gan, "Traffic flow and safety analysis," Theoretical and Applied Mechanics Letters, vol. 8, no. 5, pp. 304–314, Sep. 2018, doi: https://doi.org/10.1016/j.taml.2018.05.005.

[7] C. T. Calafate, D. Soler, J.-C. Cano, and P. Manzoni, "Traffic Management as a Service: The Traffic Flow Pattern Classification Problem," Mathematical Problems in Engineering, vol. 2015, pp. 1–14, 2015, doi: https://doi.org/10.1155/2015/716598.

[8] R. Żochowska and G. Karoń, "ITS Services Packages as a Tool for Managing Traffic Congestion in Cities," Studies in Systems, Decision and Control, pp. 81–103, Jun. 2015, doi: https://doi.org/10.1007/978-3-319-19150-8_3.

[9] M. Roşca, C. Oprea, A. Ilie, S. Olteanu, and O. Dinu, "Solutions for Improving Transit through Intermodal Passenger Terminals," Procedia Manufacturing, vol. 46, pp. 225–232, 2020, doi: https://doi.org/10.1016/j.promfg.2020.03.033.

[10] Ma. E. A. Bayona, S. Cano, M. M. Dagdagan, and C. C. Valeda, "Design considerations for a major terminal facility in Metro Manila," Bachelor's Theses, Jan. 2016, Available: https://animorepository.dlsu.edu.ph/etd_bachelors/9290/

[11] R. F. Jabal, "Towards a more sustainable transportation sector in the Philippines," BusinessWorld Online, Apr. 25, 2023. https://www.bworldonline.com/opinion/2023/04/25/519050/towards-a-more-sustainable-transportation-sector-in-the-philippines/

[12] R. Guevara, "The Public Transport System Dilemma of the Philippines," M2.0 Communications, Nov. 15, 2022. https://m2comms.com/2022/11/15/the-public-transport-system-dilemma-of-the-philippines/#:~:text=The%20entire%20system%20of%20the

[13] J. Mahona, C. Mihlu, J. Kihedu, and H. Bwire, "FACTORS CONTRIBUTING TO TRAFFIC FLOW CONGESTION IN HETEROGENEOUS TRAFFIC CONDITIONS," INTERNATIONAL JOURNAL FOR TRAFFIC AND TRANSPORT ENGINEERING, vol. 9, no. 2, pp. 238–254, 2019, doi: https://doi.org/10.7708/ijtte.2019.9(2).09.

[14] A. Bull, "Gracias por su interés en esta publicación de la CEPAL," Jan. 2004. Available: https://repositorio.cepal.org/server/api/core/bitstreams/d0851342-86b1-4aee-a262-0bedb95193cc/content

[15] S. Chowdhury, K. Zhai, and A. Khan, "The Effects of Access and Accessibility on Public Transport Users' Attitudes," Journal of Public Transportation, vol. 19, no. 1, pp. 97–113, Mar. 2016, doi: https://doi.org/10.5038/2375-0901.19.1.7.

[16] E. D. Agustin, "Assessment of inter-municipal PUV Services in Southern Iloilo, Philippines," Civil Engineering Master's Theses, Jun. 2022, Accessed: Jan. 05, 2024. [Online]. Available: https://animorepository.dlsu.edu.ph/etdm_civ/23

[17] F. Harrou, A. Zeroual, M. M. Hittawe, and Y. Sun, "Chapter 5 - Traffic congestion detection: data-based techniques," ScienceDirect, Jan. 01, 2022. https://www.sciencedirect.com/science/article/abs/pii/B9780128234327000100

[18] T. Okamura, Y. Kaneko, F. Nakamura, and R. Wang, "Passengers' Attitudes to the Service items of Jeepneys in Metro Manila by Different Lifestyles," Journal of the Eastern Asia Society for Transportation Studies, vol. 10, pp. 1384–1395, 2013, doi: https://doi.org/10.11175/easts.10.1384.

[19] P. M. Manila, "Modernizing Public Transport in the Philippines," Changing Transport, Aug. 11, 2020. https://changing-transport.org/modernizing-public-transport-in-the-philippines/?fbclid=IwAR1YakKk9X7dHlbpMC8HxrNTdAF49zyFAsh7lEAHgzDaRNt1oN6Erw8fmK8 (accessed Jan. 05, 2024).

[20] "Philippine Traffic Crisis: Reflection and Suggestion - Free Essay Example," Edubirdie. https://edubirdie.com/examples/philippine-traffic-crisis-reflection-and-suggestion/?fbclid=IwAR1-hebwmQmvdpT3B7hACXkyBr5NUWrF87W29wZb1zJZCyHTfZWVF76emsg (accessed Jan. 05, 2024).

[21] Z. Cao, S. Jiang, J. Zhang, and H. Guo, "A Unified Framework for Vehicle Rerouting and Traffic Light Control to Reduce Traffic Congestion," IEEE Transactions on Intelligent Transportation Systems, vol. 18, no. 7, pp. 1958–1973, Jul. 2017, doi: https://doi.org/10.1109/TITS.2016.2613997.

[22] "The Project for Capacity Development on Transportation Planning and Database Management in the Republic of the Philippines MMUTIS Update and Enhancement Project (MUCEP) Urban Transportation Planning," 2015. Available: https://openjicareport.jica.go.jp/pdf/12247656_01.pdf

[23] I. Daniel, R. Paolo, and A. M. Fillone, "Proximity Indexing of Public Transport Terminals in Metro Manila," Sustainability, vol. 13, no. 8, pp. 4216–4216, Apr. 2021, doi: https://doi.org/10.3390/su13084216. Available: https://www.mdpi.com/2071-1050/13/8/4216. [Accessed: Jan. 16, 2024]

[24] "Next Road Rerouting: A Multiagent System for Mitigating Unexpected Urban Traffic Congestion | IEEE Journals & Magazine | IEEE Xplore," ieeexplore.ieee.org, Oct. 2016. https://ieeexplore.ieee.org/abstract/document/7433412 (accessed Jan. 16, 2024).

[25] A. M. de Souza et al., "Better Safe Than sorry: A vehicular traffic re-routing based on traffic conditions and public safety issues - journal of internet services and applications," SpringerOpen, https://jisajournal.springeropen.com/articles/10.1186/s13174-019-0116-9 (accessed Jan. 17, 2024).

[26] I. Appelqvist and S. Örngren, "Rerouting of road traffic: A comparison of different rerouting alternatives at unplanned disruptions in road traffic." Accessed: Jan. 16, 2024. [Online]. Available: https://odr.chalmers.se/server/api/core/bitstreams/44a6311a-c257-4927-8bb1-63b4bf1de8be/conte