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Simulation Study: Effectiveness of Unified Vehicular Volume Reduction Program (UVVRP) at Dolores Junction, San Fernando, Pampanga using PTV Vissim Software

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ABSTRACT

Traffic Congestion is considered one of the main problems that people around the world have to deal with. This problem can not only affect a certain individual life, but it can also lead to an economic crisis when not treated. Many have tried a lot of methods or strategies to redSuce traffic congestion, some are effective, and some are not. In the city of Manila, a number coding scheme known as Unified Volume Vehicular Reduction Program (UVVRP), is a very popular used method to alleviate traffic congestion in the area. Dolores Intersection at San Fernando, Pampanga is an intersection between MacArthur Highway and Olongapo-Gapan Road, and it is known to be the most used intersection in Pampanga. Therefore, at a certain hour, traffic congestion exists in the locale. This study about a simulation study of the effectiveness of UVVRP using PTV Vissim, helped the researchers as it identified the impact of having a volume reduction scheme on a certain time at Dolores Intersection. In this study, the researchers gathered data that are important to make the simulation work and produce precise

results about the influence of the volume reduction at the research locale. The volume reduction that was simulated on the software PTV Vissim significantly impacted the traffic flow and reduced the traffic congestion happening during the peak hour at Dolores Intersection. Unfortunately, the researchers failed to gather data about the list of plate numbers of the vehicles passing through the intersection from the Land Transportation Office and decided to just used percentage reduction as a basis for not allowing a certain digit on the road. The researchers recommend to further improve the study by collecting all the necessary data needed.

Keywords: *Traffic Flow, Level of Service, Peak Hour Factor, Geometric Layout*

1. THE PROBLEM AND REVIEW OF RELATED LITERATURE AND STUDIES

1.1 Introduction

Transportation plays a big role in the lives of many people in the world. Having a good transportation can promote such things as economic growth, efficiency, and speed for people to travel to their respective destinations, and improves fuel efficiency. Alongside transportation, there is also traffic congestion. Traffic congestion is when roads are filled with cars, trucks, and buses and can cause an increase in travel time and many more. It is usually caused by a demand-supply imbalance in the transportation network like large numbers of pedestrians holding up vehicles, road works, accidents, and etc. In the Philippines, traffic congestion is well known and it commonly happens in every part of the country. Average Filipino wastes about 188 hours per year stuck in traffic during rush hour and finding a solution is becoming a priority for some people in the transportation field.

Nowadays, most people choose to travel by car. In metropolitan regions, traffic delays are accelerating due to an increased number of homes and the number of cars each household possess (US Department of Transportation, 2013). In addition, this implies that the issue is escalating and needs to be continuously dealt with to avoid its unfavorable effects. Traffic congestion reduces mobility, adds to air pollution, wastes fuel, and slows down economic expansion. High traffic demand in Metro Manila has been a result of rapid motorization, high-density urban growth, population concentration, and concentration of economic activity. It caused congestion on major arterials, particularly in significant conflict areas like signalized intersections.

Traffic volume is defined as the number of vehicles passing at a point on a road segment or in a lane during a specific time interval (Musa et al., 2022). As for Zhan et al. (2016), Traffic volume estimation at the city scale is an important problem useful to many transportation operations and urban applications. In addition, Mathew (2019) stated that Traffic volume studies are conducted to determine the number, movements, and classifications of roadway vehicles at a given location. These data help to identify critical flow time periods, determining the influence of large vehicles or pedestrians on vehicular traffic flow.

1.2 Review of Related Literature

Traffic congestion has been one of the major issues that most metropolises are facing and thus, many measures have been taken to mitigate congestion has concluded that the results clearly show that the traffic congestion wastes time and energy, causes pollution and stress, decreases productivity, and imposes costs on society (Rao, 2013).

When there is a traffic congestion, the car moves slowly, and the rapid braking technique causes insufficient fuel oil combustion and produces a lot of hazardous exhaust gas, which raises air pollution. Additionally, there are more accidents on the road. Therefore, finding practical ways to reduce traffic congestion is a pressing issue in many communities (Xin liu et al., 2020). In accordance with this, Qing Tang et al., (2019) stated that, the transportation network's demand-supply imbalance leads to traffic congestion. When there are more cars on the road or the capacity of the road is reduced for a variety of reasons, traffic flow slows down. Also, it causes several problems including longer travels times for the drivers and passengers, higher fuel consumption and greenhouse gas emissions, and a higher rate of vehicle crashes, among others.

According to Emo et al., (2016), in Metropolitan area, particularly those in developing countries, struggle with traffic congestion. Queues, slower speeds, and longer travel times caused by traffic congestion make commuters tired and stressed, which lowers productivity and raises intangible societal costs. As for Begatim (2016), each driver pays both a private and a public expense each time they drive. In comparison to the public cost, which includes the "cost imposed to the community in the form of noise, accident risk, fumes, etc.," while the private cost includes travel time and fuel spent. Also, if there is a traffic jam, drivers lose more time and gasoline. "Time that could be utilized effectively and has an economic cost linked to it that, while difficult to define, can be large," is what it meant by wasted time.

Metro Manila Development Authority (MMDA) has introduced the UVVRP, also known as the Number Coding

Scheme, which places restrictions on the movement of both private and public utility vehicles based on the final digit of the license plate. During the week, this program is in effect Monday to Friday (Zulueta, 2022). In fact, subjective feelings of safety have shown themselves to be an important factor affecting users' choice of a car mode and encouraging them to shift to public transport. Individuals who can afford a private vehicle feel safer using private motorized transport rather than using public or active transport (Maia et al., (2020).

In Metro Manila the most recent number coding is put into place from Monday through Friday during the morning rush hour (7 a.m. to 10 a.m.) and the afternoon/evening rush hour (5 p.m. to 8 p.m.). Weekends and holidays are however exempt from the number coding system. The number coding system mostly applies to personal automobiles. The day of the week on which you are not permitted to drive is determined by the final digit of your vehicle's license plate (Zoleta, 2022). Additionally, In the 1990s, with ongoing transportation infrastructure upgrades in Metro Manila, the UVVRP, sometimes known as the "number coding" scheme, was initially created as a short-term travel demand management strategy. The UVVRP facing is still in place along with major roadways in Metro Manila even though it was never intended to be a long-term policy, albeit with certain tweaks like the mid-day window. Various transportation stakeholders, especially those who are severely hampered by the UVVRP, are critical of its continued implementation now that those significant infrastructure projects have been completed, especially now that the authorities are imposing the program on public transportation vehicles as well.

The past decades have seen a massive development of contemporary civilization accompanied by a rising need for mobility in metropolises, accounting for the conflict between the limits of road capacity and the amplification of traffic demand shown by serious traffic congestion. Induced of such a problem, residents suffer from the decline in travel efficiency and the growth of both fuel consumption and air pollution connected with pollution problems (Boquet, 2019).

City of San Fernando traffic congestion has worsened in this bustling city, especially during the holiday season. Traffic buildup along major thoroughfares like the McArthur Highway, Jose Abad Santos Avenue, and Capital Boulevard is experienced especially during rush hours. Mayor Vilma Caluag said several measures have already been implemented by the city government to address the problem. "Marami na po tayong binuksan na mga daanan para po mabawasan ang traffic sa San Fernando. Sa tulong po ng mga homeowners, nabuksan po as alternate routes ang mga subdivisions," she said (Peña, 2022). Therefore, the researchers plan to propose UVVRP as an alternative solution in the problem along the highway.

Based on the study of Regidor (2013), to assess traffic performance for changes to the schemes, several scenarios were created. At the time, it was determined that UVVRP was sufficient to reduce traffic congestion. The UVVRP needs to be reviewed to see if it is still effective in reducing traffic congestion given the current experience of daylong traffic jams on major highways. This study revisits the UVVRP and outlines a plan for reducing traffic in the city.

The transportation system is a complex system with multiple transportation elements. Therefore, how to simulate a complex transportation system is a difficult point in transportation research. To study this type of complex traffic flow and associated vehicular interactions, simulation is considered as an effective tool. The benefits of the proposed modelling and simulation are for monitoring and predicting congestion at intersections, as well as possible solutions that can be taken to solve the congestion problems at each of intersection path. The simulation is built by computer application, where at the current time, there are many computer application systems in various fields (E Harahap et al., 2019).

The analysis, planning, and development of traffic networks and systems frequently employ the traffic simulation approach. A range of traffic simulation models were discovered in trials and applications from the literature study with the intention of simulating real traffic operations. In the research by Yuniawan et al., (2018), a simulation method was implemented in order to manage the traffic queue. As the tool to modelling the traffic queue line Arena Simulation software was used. Traffic simulation models have become an important and popular tool in modelling transport systems, in particular, owing to advent of fast and powerful computers. According to Aghabayk (2013), one of the supreme advantages of using such tools is to assess different alternates and scenarios prior to their implementations. The traffic simulation models can be categorized into three namely, microscopic modelling, macroscopic modelling and mesoscopic modelling. This report is aimed to overview these traffic simulation models, in term of its function, limitation and application (Azlan et al., 2017).

The performance of both infrastructures was assessed using the VISSIM traffic micro-simulation model in terms of parameters at intersections, such as average vehicle delay and queue length, and network performance assessment parameters, including trip time. VISSIM is a small, behavior-based simulation model with a 1-second time step that was created to simulate urban traffic and public transit operations. It may be used as a tool for assessing multiple options in line with performance metrics used in transportation engineering and planning, such as various infrastructure types, junction controls, and so forth. Fabianova et al., (2020), stated that there is a wide choice of simulation tools, but one of the most widespread software used for micro-simulation modelling in transport is VISSIM. This is also due to its very good performance and outputs quality. As a stochastic, microscopic, time-step, behavior-based model with capabilities to provide application of programming interface (API) and simulation, VISSIM has become one of the most useful and reliable programs utilized by contemporary engineers and researchers in the processes of evaluation of control operations and strategies of transportation

(Rrecaj, 2015).

Everyone can achieve the desired level of mobility with a balanced use of cars and public transportation. Thus, the goal of this study is to find out the potential of Unified Vehicle Volume Reduction Program (UVVRP) on lessening the traffic congestion in the City of San Fernando, Pampanga.

1.3 Background of the Study

Traffic congestion can cause a lot of negative impact not only to the people who travels, but also to the economy of the society. Numerous cities throughout developing countries, particularly in Asia, struggle the joint harms of rising population, high density and increasing use of private vehicles, motorbikes or cars, resulting to unpleasant levels of air pollution and severe traffic congestion. These changes are not new to the Philippines. Since the 1990's, the Philippines are dealing with an explosive increase (Boquet, 2019).

Many parts of the Philippines are affected by this problem, and it is becoming a nuisance for locals and government because of its effect. A good example of this is San Fernando in the province of Pampanga. As per the interview in (Balita Pampanga), Vice Governor, Nanay "Baby" Lilia Pineda stated that, she also experiences the massive traffic in San Fernando, the main reasons of this massive traffic are Rapid Increase of Vehicular users (G. Rutao, personal communication, November 25, 2022). There are lots of methods used to aid traffic congestion from around the world which can increasingly improve the flow of the traffic and also the economy, which can be beneficial to the community. However, the researchers will focus on the effectiveness of UVVRP when applied in Dolores, Intersection at San Fernando, Pampanga. The study will determine if UVVRP can act as an effective remedy to reduce traffic congestion in Dolores Intersection at San Fernando, Pampanga by using Vissim to simulate the current traffic flow and when the method scheme is applied. Therefore, the researchers came up with the research title "A simulation study based on the effectiveness of Unified Vehicular Volume Reduction Program (UVVRP) at Dolores, Intersection at City of San Fernando, Pampanga using PTV Vissim software".

1.4 Objectives of the Study

1.4.1 General Objective

The general objective of this study was to implement a study that would prove if UVVRP is an effective method to reduce traffic congestion at Dolores, Intersection by proposing " Simulation Study: Effectiveness of Unified Vehicular Volume Reduction Program (UVVRP) at Dolores Intersection, San Fernando, Pampanga using PTV Vissim software" that utilizes the software to simulate the traffic flow with or without the number coding method.

1.4.2 Specific Objectives

The researchers wanted to meet the following objectives:

a. To determine the Peak Hour Volume at Dolores, Intersection.
b. To develop a simulation model using PTV Vissim software to visualize the traffic conditions at the Dolores, Intersection.
c. To assess the effectiveness of UVVRP in reducing traffic congestion at the Dolores Intersection through determining the Level of Service of the road.

1.5 Statement of the Problem

The study aimed to evaluate the effectiveness of the Unified Vehicular Volume Reduction Program in reducing traffic congestion at Dolores Intersection, City of San Fernando, Pampanga. The following benefited from the study:

ENVIRONMENT. Reduction of traffic congestion which is a product of the UVRRP resulted to decrease in air pollution leading to better human health and environment.

COMMUTERS AND MOTORIST. The UVRRP reduced traffic congestion leading to less travel time and fuel cost reducing stress to commuters and motorists.

LOCAL GOVERNMENT. The findings of this study provided valuable insights for the local government of the City of San Fernando, Pampanga, and other areas facing similar traffic challenges. They can use the results to develop evidence-based policies and strategies to manage traffic congestion and improve transportation efficiency.

FUTURE RESEARCHERS. This study may serve as a reference for future researchers who will explore the effectiveness of UVVRP in other areas or using different methods.

1.6 Scope and Limitations

This study aimed to evaluate the effectiveness of the Unified Vehicular Volume Reduction Program (UVVRP) in reducing traffic congestion at the Dolores Intersection in the City of San Fernando, Pampanga using the PTV Vissim software.

The proposed volume reduction focused on private vehicles such as trucks, personal 4-wheel vehicles, and etc. passing through the area and did not include public utility vehicles to avoid disruption to commuters and drivers.

The software that was used in the simulation is a student version of PTV Vissim. The researchers were only limited into using a student version of the software because of the lack of resources into using a full version of PTV Vissim. Therefore, the researchers were limited into gathering data for the study to be thoroughly conducted.

The limitations of this study included the simulation's dependence on the accuracy and completeness of the data gathered from Manual Counting Method. The PTV Vissim needed an accurate data to obtain precise result from the software. The study was also limited to Dolores Intersection, which is composed of two roads classified as MacArthur Highway and Jose Abad Santos Ave (JASA) located at City of San Fernando, Pampanga and may not be applicable to other intersections or areas with different traffic patterns. It is also known that MacArthur Highway and Jose Abad Santos Ave (JASA) which are considered as main roads in Luzon and occupies a large amount of traffic daily at Dolores Intersection. Additionally, the study did not take into account other factors that may affect traffic congestion, such as road construction or accidents.

The study was limited into only applying a certain percentage reduction in traffic volume from Manual Counting Method since it is only a visual representation on what reducing the traffic volume will exhibit when applying volume reduction scheme. According to Grace et al. (2013), the survey asked respondents which day of the week their car is not allowed to run on the streets of Metro Manila due to NCS. According to the results, around 22% of participants reported that their car is banned on Mondays, 17% on Tuesdays, 28% on Wednesdays, and 16% on both Thursdays and Fridays, with an overall average of 20%. Therefore, the researchers used 20% reduction from the peak hour volume to use in PTV Vissim on reducing the traffic congestion at Dolores Intersection.

1.7 Conceptual Framework

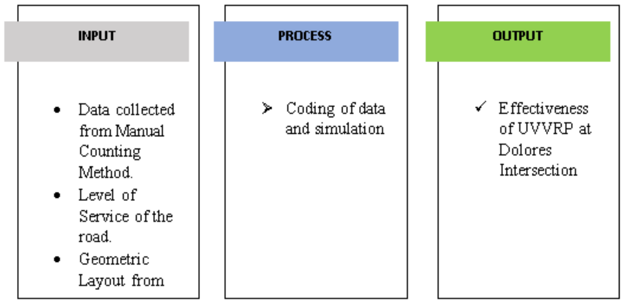

Figure 1.1 Conceptual Framework of the Study

The figure above shows the framework for the conceptual basis of the proposed study. The framework utilizes the IPO format, which separates the objectives and the process to identify the results that are needed for the research study. In the figure, the first is the input which involves the collection of data on the number of vehicles passing through Dolores, Intersection at City of San Fernando Pampanga by manual counting method. Also, the level of service of the road was used to identify if a traffic congestion exists. The second phase is where the researchers used the data collected from the input to further conduct the study. The simulator will then process the data coded by the researchers. Last phase is the output where the researchers will gather the data from the simulator. Summary and conclusion will be constructed in this phase.

1.8 Definition of Terms

The following are terminologies that were beneficial for the research progress:

Unified Vehicular Volume Reduction Program (UVVRP) - commonly called number coding or color coding, is a road space rationing program in the Philippines that aims to reduce traffic congestion, in particular during peak hours, by restricting the types of vehicles that can use major public roads based on the final digit of the vehicle's license plate.

Traffic congestion - a condition in transport that is characterized by slower speeds, longer trip times, and increased vehicular queueing.

Commuters - a person who travels some distance to work on a regular basis.

Private utility vehicles (PUV) - Any motor vehicle owned by individuals and juridical persons for private use.

DPWH (Department of Public Works and Highways) - responsible for the planning, design, construction, and maintenance of national highways, major flood control systems, and other public works.

Traffic volume – A traffic count is a count of vehicular or pedestrian traffic, which is conducted along a particular road, path, or intersection. A traffic count is commonly undertaken either automatically, or manually by observers who visually count and record traffic on a hand-held electronic device or tally sheet.

2. METHODOLOGY

2.1 Methodological Framework

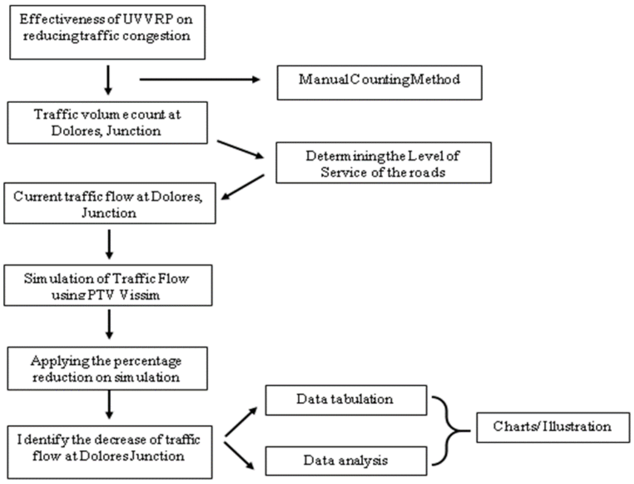

Figure 2.1 Methodological Framework

The figure above is the Methodological Framework of the study. It involved the definite structure on how the research study progressed along the way. The goal of the study was to assess the potency of the coding scheme UVVRP at Dolores, Intersection. The researchers made use of the simulator called PTV Vissim, using the data needed that was gathered from the Manual Counting Method. Also, the researchers needed to determine the Level of Service of the road to analyze whether a traffic volume reduction method was needed in the first place. Using the data collected, the researchers now had the opportunity to analyze the traffic flow at the research locale. Then, the researchers applied the 20% reduction on the number of vehicles gathered from the manual counting method to compare whether the volume reduction is effective or not. The statistics were shown on Charts or Illustration to exhibit the results from the conducted simulation.

2.1.1 Research Locale

In this study, the research design that was used is quasi-experimental research method. According to "Quasi-Experimental Design: Types, Examples, Pros, and Cons" (2022), quasi-experimental design is a form of research technique similar to an experimental research design, with the main distinction being that in a quasi-experimental design, the researchers do not randomly choose certain aspects. The selection in this experiment is subjective. For a traffic simulation study, a quasi-experimental research design could be used, as it allows for the testing of an intervention or simulation on one group, while comparing the results to a control group that did not receive the intervention or simulation. A common quasi-experimental design used in traffic simulation studies is the before-and-after study design, where traffic conditions are observed and measured before and after the implementation of a traffic intervention or simulation. This design allowed the researchers for the comparison of traffic conditions with and without the intervention or simulation and can help determine its effectiveness.

2.1.2 Research Locale

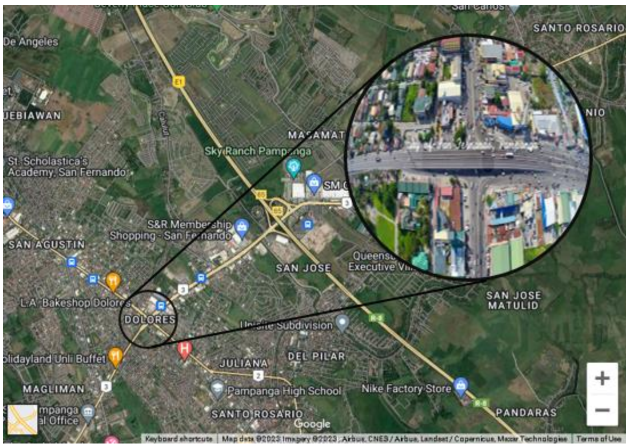

Figure 2.2 Satellite view of Dolores, Intersection

The research locale of this study is shown in the Figure below. The researcher's study took place at Dolores Intersection, that intersects MacArthur Highway and Jose Abad Santos Ave (JASA) Road. The study took place at this location for the reason that its mostly where the vehicles pass through in the province of Pampanga. Therefore, it is the busiest and congested road, which is a good research locale to test the effectiveness of UVVRP at reducing traffic congestion using the software PTV Vissim to simulate. The figure shown above is the satellite view of Dolores, Intersection City of San Fernando Pampanga. It also presents in the figure the actual photo of the said Intersection. This is the intersection between OG Road and McArthur Highway that consists of 12 lanes and 6 lanes on the other side. Also, Dolores Intersection flyover serves as a pathway for those who are going to Zambales and Bataan.

2.1.3 Research Instrument

The research instruments that were used in conducting this study is PTV Vissim Software (Student Version). Fabianova et al., (2020), stated that there is a wide choice of simulation tools, but one of the most widespread software used for micro-simulation modelling in transport is Vissim. It is a traffic simulation software used for modeling and simulating traffic operations of roads, highways, and urban areas. Vissim uses microscopic traffic simulation to model individual vehicles and their interactions with each other and the surrounding infrastructure, allowing for the testing of different traffic scenarios, signal timings, and roadway configurations. The software is commonly used in transportation planning and engineering to evaluate the performance of existing or proposed roadway designs, signal timings, and other traffic management strategies.

2.2 Data Analysis and Evaluation

The collected 7-year traffic population data requested from the Department of Public Works and Highways was helpful for the researchers to identify the changes in traffic population every year at Dolores Intersection at San Fernando, Pampanga. With this data, the researchers showed that there is a consistent increase in vehicle population every year by checking the Annual Average Daily Traffic at Dolores Intersection, hence, a new traffic reduction method is needed to resolve this concern. The geometric layout on the other hand was used to layout the Intersection on the software PTV Vissim, to produce accurate results.

The data gathered by Manual Counting Method regarding the number of vehicles were used to determine the Peak Hour Volume per lane within a day, needed for the simulation to identify the traffic flow at Dolores Intersection. Also, this is an important data to collect due to its significance on identifying the total number of vehicles during the peak hour at the research locale.

The researchers used formula based for determining the Level of Service of roads at Dolores Intersection. Level of Service (LOS) refers to a measure that evaluates the effectiveness of a pavement in meeting the needs of its users. In the design methodology for pavement structures developed by the American Association of State Highway and Transportation Officials (AASHTO), there is a concept called "pavement serviceability" which quantifies the extent to which roads and streets cater to the requirements of motor vehicle users (Solminihac et.al, 2003). There are several data needed for the level of service to be determined. First is the peak hour factor, this was to identify the actual flow rate happening at Dolores Intersection. Next is the actual flow rate, the peak hour volume that was gathered by manual counting method over the peak hour factor. Road capacity was computed by identifying the number of vehicles multiplied by their corresponding PCU factor, which the researchers accumulated from DPWH (Regional Office III). The researchers then used all the needed data to solve for the level of service by dividing the actual traffic flow over road capacity. The result served as a basis to know whether a road is congested or not.

$$Peak\ Hour\ Factor\ (PHF) = \frac{Peak\ Hour\ Volume}{(4\ x\ peak\ 15\text{-}minute\ interval)}$$

$$Actual\ Flow\ Rate\ (AFR) = \frac{Peak\ Hour\ Volume}{PHF}$$

$$Road\ Capacity\ = \Sigma(No.\ of\ vehicles\ x\ PCU\ factor)$$

$$Level\ Of\ Service\ = \frac{traffic\ flow}{road\ capacity}$$

Table 2.1: Level of Service Criteria

Level of Service	Traffic Situation	Volume-Capacity Ratio
Level A	free flowing traffic	< 0.20
Level B	relatively free flowing traffic	0.21 and 0.50
Level C	moderate traffic	0.51 and 0.70
Level D	moderate/heavy traffic	0.71 and 0.85
Level E	heavy traffic	0.86 and 1.00
Level F	Saturation traffic volumes	> 1.0

Figure 2.3 Level of Service Criteria

The collecting of data for the numbers of lanes per direction was done by observation of the road at Dolores Intersection. These were important to identify the width of the road per lane, which are needed to layout the size of the road for the vehicles to pass through. As per "Urban Street Design Guide" (2013), in cities, it's a good idea to have lanes that are 3-meter-wide because it makes streets safer without causing problems for traffic flow. On roads where trucks or buses are allowed, it's okay to have one lane in each direction that's 3.35 meter wide. The researchers multiplied 3.35 meter, which is the measurement for road where trucks or buses are allowed, to the gathered number of lanes per direction to determine the width of the roads at Dolores Intersection.

The data from the software PTV Vissim was the most important among the rest because it helped the researchers to know if the Volume Reduction will be effective at reducing traffic flow. The researchers simulated a situation where UVVRP will take place by reducing 20% percent of the total number of vehicles and compare it to the current state of flow at Dolores, Intersection during peak hour of traffic. Therefore, the effectiveness of UVVRP depend on the result from the software that the researchers used.

3. RESULTS AND DISCUSSIONS

3.1 Annual Average Daily Traffic

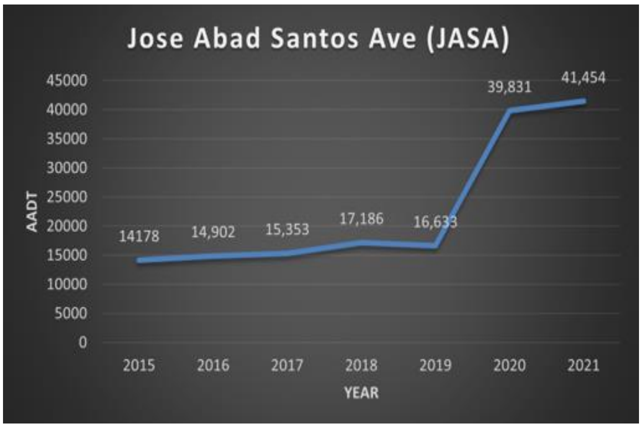

Figure 3.1 Jose Abad Santos Ave (JASA) AADT Graph

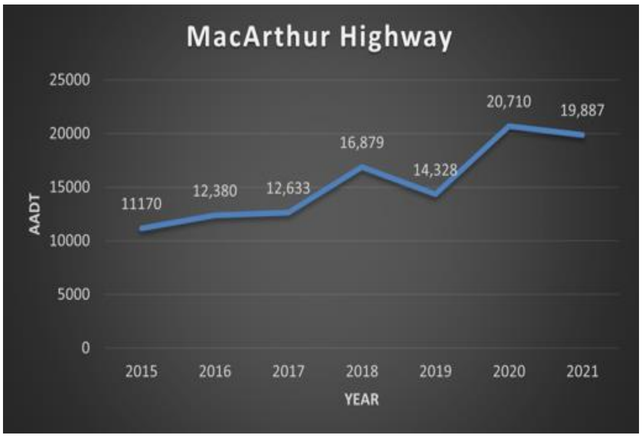

Figure 3.2 **MacArthur Highway AADT Graph**

These data were gathered at the Department of Public Works and Highways (Regional Office III), San Fernando, Pampanga, as a reference for the traffic count data the researchers will conduct.

Figure 3.1 is a line graph that shows the Annual Average Daily Traffic at Jose Abad Santos Ave (JASA) gathered from DPWH (Regional Office III). This graph shows the total number of the daily average vehicles passing through Dolores Intersection at JASA. The graph also conveys the increase of the AADT every year until the year of 2021, which concludes that there is a growth at the population of vehicles at the span of 7 years, that can lead into traffic congestion if not taken care of.

Figure 3.2 is also a line graph that shows the Annual Average Daily Traffic at MacArthur Highway gathered from DPWH (Regional Office III). This graph indicates that there is also an increase in traffic population in some years, and a slight decrease on 2019 and 2021, at MacArthur Highway passing through Dolores Intersection. Despite the slight decrease on other years, there is still some growth at the traffic population, when ignored it can lead into some problem at the locale.

3.2 Geometric Layout

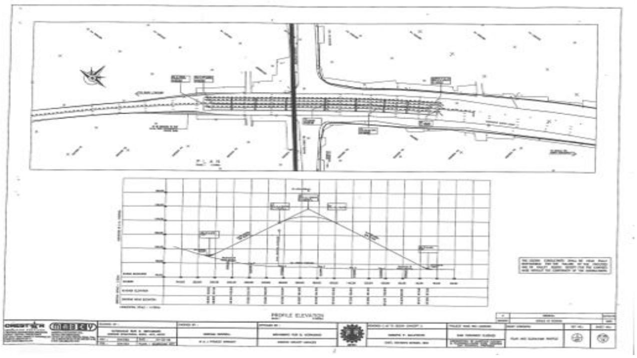

Figure 3.3 Geometric Layout of Dolores Intersection

The layout of Dolores Intersection was gathered from the Department of Public Works and Highways, as a reference for creating the layout for Dolores Intersection on PTV Vissim.

Figure 3.3 shows the Geometric Layout of Dolores Intersection. This figure shows the layout of the flyover and every road of the intersection. The layout of the road was needed for the simulation to be more precise at gathering data and showing the traffic flow.

3.3 Manual Counting Method

Table 3.1: Manual Counting on Monday

Road name	Time	Motorcycle	Tricycle	PUV	Truck	Bus	Private Vehicle	Total
OG Road	Morning	1396	432	612	712	96	4032	7280
	Afternoon	1730	488	671	786	118	4435	8228
McArthur Highway	Morning	748	344	472	208	4	1336	3112
	Afternoon	1047	417	520	231	12	1792	4019

Table 3.2: Manual Counting on Tuesday

Road name	Time	Motorcycle	Tricycle	PUV	Truck	Bus	Private Vehicle	Total
OG Road	Morning	1228	371	591	689	83	3981	6943
	Afternoon	1409	423	630	727	97	4188	7474
McArthur Highway	Morning	712	309	453	187	1	1268	2930
	Afternoon	856	378	486	212	8	1456	3396

Figure 3.4 Manual Counting

Table 3.3: Manual Counting on Wednesday

Road name	Time	Motorcycle	Tricycle	PUV	Truck	Bus	Private Vehicle	Total
OG Road	Morning	1338	365	572	651	68	3929	6923
	Afternoon	1424	401	625	756	87	4171	7464
McArthur Highway	Morning	665	238	441	187	0	1301	2832
	Afternoon	868	353	471	197	9	1429	3327

Table 3.4: Manual Counting on Thursday

Road name	Time	Motorcycle	Tricycle	PUV	Truck	Bus	Private Vehicle	Total
OG Road	Morning	1387	378	581	669	61	3976	7052
	Afternoon	1501	419	649	713	91	4239	7612
McArthur Highway	Morning	683	221	417	195	6	1349	2871
	Afternoon	901	399	571	205	11	1512	3599

Table 3.5: Manual Counting on Friday

Road name	Time	Motorcycle	Tricycle	PUV	Truck	Bus	Private Vehicle	Total
OG Road	Morning	1435	476	626	709	87	4123	7456
	Afternoon	1909	521	725	749	131	4529	8564
McArthur Highway	Morning	801	331	491	191	5	1443	3262
	Afternoon	1112	427	570	261	14	1854	4238

Figure 3.5 Manual Counting

The researchers conducted manual counting of the vehicles passing through the road of Jose Abad Santos Ave and MacArthur Highway at Dolores Intersection. The data gathering by manual counting started from8 am until 9am in the morning and 5pm until 6pm in the evening that lasted from Monday to Friday, to determine what time of the day does the Peak Hour Volume occur. The volume of vehicles increased the highest in the evening compared to data gathered from the morning. Therefore, if the volume reduction is to be applied, the best time to utilize it is from 5pm to 6pm where traffic volume count is higher. Also, the Peak Hour Volume gathered from the manual counting is needed for the simulation to show the exact number of vehicles at Dolores Intersection in that same time of the day, where traffic congestion exists.

3.4 Peak Hour Factor and Actual Flow Rate

To determine the number of vehicles passing through each road, manual observations were conducted over a period of five days, with two different hour intervals each day. The hour interval that had the highest vehicle count in both directions of traffic was identified as the Peak Hour Interval. The volume of traffic during this peak hour was calculated by summing up the highest number of vehicles recorded in a 15-minute interval and multiplying it by four. The calculated values for hourly traffic flow represent the actual flow rate through the Peak Hour Factor (PHF). PHF converts the hourly traffic volume into the actual flow rate, specifically representing the busiest 15 minutes of the peak hour or rush hour.

Table 3.6: Peak Hour Factor & Actual Flow Rate of OG Road

Road Name	Peak Hour Interval (Afternoon)	(veh/hr)	Peak Hour Factor & Actual Flow Rate (veh/hr)	
OG Road	5:00-5:15	1991	Peak Hour Factor (PHF)	0.87
	5:15-5:30	2046		
	5:30-5:45	2073	Actual Flow Rate (veh/hr)	9843
	5:45-6:00	2454		
	Peak Hour. Volume	8564		
Hourly Traffic Flow		9843		

Figure 3.6 Peak Hour Factor & Actual Flow Rate of OG Road

Manual counting was conducted between 8:00 to 9:00 in the morning and 5:00 to 6:00 in the afternoon for the Olongapo-Gapan Road (OG Road) and McArthur Highway. Based on the collected data, the busiest hour for both roads were found to be between 5:00 to 6:00 in the afternoon. Further calculations revealed that in OG Road the hourly traffic flow during this time period was 9843 vehicles per hour. To assess the consistency of vehicle volume on the route and the variation in flow, the peak hour factor and actual flow rate were computed. Both directions of OG Road exhibited a peak hour factor of 0.87, indicating periodic changes in traffic flow.

Table 3.7: Peak Hour Factor & Actual Flow Rate of McArthur Highway

Road Name	Peak Hour Interval (Afternoon)	(veh/hr)	Peak Hour Factor & Actual Flow Rate (veh/hr)	
McArthur Highway	5:00-5:15	939	Peak Hour Factor (PHF)	.81
	5:15-5:30	984		
	5:30-5:45	1011	Actual Flow Rate (veh/hr)	5232
	5:45-6:00	1304		
	Peak Hour. Volume	4238		
Hourly Traffic Flow		5232		

Figure 3.7 Peak Hour Factor & Actual Flow Rate of McArthur Highway

Observations were carried out manually between 8:00 to 9:00 in the morning and 5:00 to 6:00 in the afternoon for the Olongapo-Gapan Road (OG Road) and McArthur Highway. Based on the data collected, it was determined that the busiest hour for both roads was between 5:00 to 6:00 in the afternoon. Further calculations showed that during this time period, McArthur Highway had an hourly traffic flow of 5232 vehicles. To assess the consistency of vehicle volume on the route and the variation in flow, the peak hour factor and actual flow rate were calculated. Both directions of McArthur Highway had a peak hour factor of 0.81.

3.5 PCU Factor

Most intersection roads tend to have a lot of different variation of vehicles. Dolores Intersection is mostly occupied by vehicles that can trigger a congestion on the road. Trucks, buses, and many private and public utility vehicles on the road can really affect the traffic flow. Also, each vehicle comes with different PCU factor.

For 2-wheeler and 3-wheeler vehicles, they have 2.5 pcu factor on the road. Car, Van, and Jeepney on the other hand have 1 pcu factor along the road. Bus and Truck have 2. Minibus has 1.5 pcu factor. These are all the vehicles that the researchers monitored passing through Dolores Inteserction.

Table 3.8: Vehicle types with Passenger Car Unit (PCU) factors

Vehicle Type	PCU factors
2-wheeler	2.5
3-wheeler	2.5
Car/Van/Jeepney	1
Bus/Truck	2
Minibus	1.5
2-3 Axle	3
Multi-axle	4.5
Auto Rickshaw	2.5
Tractor	1.5
Tractor with trailer	4.5
Long Combination Vehicle (LCV)	1.5
Mini-LCV	1

Figure 3.8 Vehicle types with Passenger Car Unit (PCU) factors

The largest number of cars recorded using the manual counting approach was multiplied by the corresponding PCU

(Passenger Car Unit) factors to establish the road capacity for each road. The overall capabilities were then calculated by adding these individual capacities. For each road, the capacity with the greatest observed value was chosen as the final road capacity.

Table 3.9: Road Capacity

	PCU						
	Motorcycle	Tricycle	PUV	Truck	Bus	Private	Total
OG Road	4773	1303	725	1498	262	4529	13089
McArthur Highway	2780	1068	570	522	28	1854	6822

Figure 3.9 Road Capacity

3.6 Data for PTV Vissim

Table 3.1.1: Data for PTV Vissim

Road Name	Width of road (m)	No. of Lanes	No. of Cars During Traffic	No. of Cars with Applied UVVRP (20%)
OG Road	40.2	12	8564	6851
McArthur Highway	20.1	6	4238	3390

Figure 3.1.1 Data for PTV Vissim

Table 3.1.1 which is shown above, shows all the data that the researchers need to encode on the software for the simulation to run and produce precise results for the study. These are the data gathered from manual counting and observing the Dolores Intersection. The width of the roads is gathered by multiplying 3.35 meter, which is the standard width per lane, to the number of lanes observed at Dolores Intersection. The results are 40.2 meters for OG Road consisting a 12 number of lanes and 20.1 meters for McArthur Highway which having a number of lanes.

Lastly, for the quantity of cars with applied Volume Reduction, these are the data with 20% reduction from the original total volume of vehicles. The researchers decided to deduct some percentage from the total population of vehicles from the manual counting as a basis to replicate when UVVRP is applied.

3.7 Results from the Simulation

- **Without volume reduction**

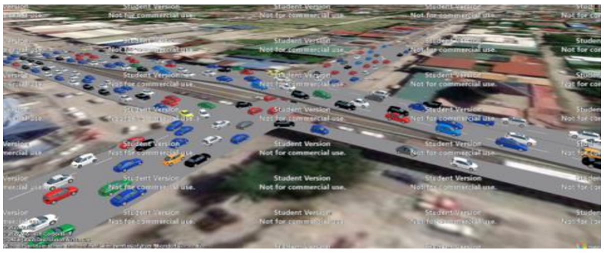

Figure 3.1.2 Simulation of Traffic Flow without volume reduction

The figures shown above are the results from the simulation that the researchers conducted using the data that were illustrated shown on Table 3.5. As shown in the results, there is traffic congestion happening at the research locale from Monday to Friday at exactly the identified Peak Hour, where volume of vehicles is at the highest point within a day.

- **With volume reduction applied**

Figure 3.1.2 Simulation of Traffic Flow with Volume Reduction Applied

The figure shown above are the results from the software PTV Vissim using the gathered data needed for the simulation to run and give precise results. The data that were encoded in the results are the number of vehicles that were gathered with 20% reduction to recreate when UVVRP is applied to the traffic flow at Dolores Intersection. As shown in the figures below, there is a significance change in the traffic flow, the number of vehicles plummeted and the traffic congestion lessen compared to the figure above.

3.8 Peak Hour Factor and Actual Flow Rate After Volume Reduction

Table 3.1.2: Peak Hour Factor & Actual Flow Rate of OG Road After Volume Reduction

Road Name	Peak Hour Interval (Afternoon)	(veh/hr)	Peak Hour Factor & Actual Flow Rate (veh/hr)	
OG Road	5:00-5:15 5:15-5:30 5:30-5:45 5:45-6:00	1593 1637 1658 1963	Peak Hour Factor (PHF)	.87
	Peak Hour. Volume	6851	Actual Flow Rate (veh/hr)	7874
Hourly Traffic Flow		7874		

Table 3.1.3: Peak Hour Factor & Actual Flow Rate of McArthur After Volume Reduction

Road Name	Peak Hour Interval (Afternoon)	(veh/hr)	Peak Hour Factor & Actual Flow Rate (veh/hr)	
McArthur Highway	5:00-5:15 5:15-5:30 5:30-5:45 5:45-6:00	751 787 809 1043	Peak Hour Factor (PHF)	.81
	Peak Hour. Volume	3390	Actual Flow Rate (veh/hr)	4185
Hourly Traffic Flow				

Figure 3.1.3 Peak Hour Factor & Actual Flow Rate After Volume Reduction

The tables above show the Peak Hour Factor and Actual Flow Rate with applied volume reduction. The data gathered were used to determine the level of service of the road when volume reduction is applied. This is to evaluate the results and analyze if an adjustment occurred at the traffic flow of vehicles at Dolores Intersection.

3.9 Comparison Table

Table 3.1.4: Comparison Table from the Simulation Result

	WITHOUT VOLUME REDUCTION			WITH VOLUME REDUCTION		
	Traffic flow rate	Road Capacity	LOS	Traffic flow rate	Road Capacity	LOS
OG Road	9843	13089	0.75 (D)	7874	13089	0.60 (C)
McArthur Highway	5232	6822	0.77 (D)	4185	6822	0.61 (C)

Figure 3.1.4 Comparison Table from the Simulation Result

Reducing the volume of the vehicles travelling through the intersection of Dolores, San Fernando, Pampanga made the traffic flow become much more efficient. The data the researchers gathered showed a difference on the level of service of the road from D to C by just reducing 20% of the traffic volume. As per the level of service criteria table, C means a moderate traffic. The researchers concluded that from moderate/heavy traffic of level service, the current traffic flow transitioned into a moderate traffic level of service when volume reduction was applied.

4. SUMMARY, CONCLUSION, AND RECOMMENDATION

4.1 Conclusion

It is clear that no single strategy can solve the problem of traffic congestion. Instead, a combination of different approaches tailored to the specific needs of a given area is necessary. However, the only main objective of this study is to test how efficient UVVRP on reducing the traffic congestion and identify if there is really a significant change on the traffic flow at Dolores Intersection using the software PTV Vissim.

The following data shown from table 3.1 to 3.9, were the gathered data by using all the formula needed to identify or determine the level of service of the road. As shown there, the researchers concluded that level of service of OG Road and MacArthur Highway is at D, which means a moderate/heavy traffic as per the level of service criteria shown at table 2.1 above. The researchers then tried to simulate the same exact traffic flow at Dolores Intersection to provide a better view of the situation. After that, the researchers applied 20% volume reduction on all the necessary data needed for the simulation. With that said, the simulation showed the result that there was a significant difference between the traffic flow when volume reduction is applied. On the other hand, the researchers also calculated the level of service of Dolores Intersection with a 20% volume reduction and concluded that it has improved from D, moderate/heavy traffic, to C, moderate traffic level of service. These results were then used as a basis to conclude that UVVRP can reduce traffic congestion at Dolores Intersection during peak hours.

4.2 Recommendation

In light of the findings and conclusions drawn, the following are offered for recommendations:

First, future researcher should gather more accurate data to the greatest extent possible to achieve the most precise output in the simulation. It is better if the video recording method was used in vehicle counting instead of the manual counting method only. Unfortunately, the researchers failed to gather data from the Land Transportation Office (LTO) about the plate number of vehicles passing through the research locale. The researchers came up with the idea to use the 20% volume reduction as their basis to imitate how the UVVRP work in Metro Manila.

Next, future researchers should broaden the research locale to assess more areas with a problem of traffic congestion and identify if UVVRP will be any of use. Third, the researchers recommend that future researchers to try and implement the Unified Vehicular Volume Reduction Program (UVVRP) with enough data and preparedness, this study will serve as a basis for what can this program do in reducing the traffic volume in Dolores Intersection, City of San Fernando, Pampanga.

The researchers would also like to recommend to the future researchers who are willing to continue the study, to have a full access to the PTV Vissim. Using only student versions of the mentioned software, there were numerous restrictions placed on the simulations and their corresponding evaluations. The most important being the limitation placed on the simulation time considered to a maximum of 10 mins. Lastly, the researchers suggest to try other simulation software like PTV Vistro that is more often use as traffic tool analysis especially on the Intersection Highway.

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