Suitability Assessment and Microscopic Simulation of Pedestrianization on Segments of I. Delos Reyes Street, Sampaloc, Manila

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Abstract: The I. Delos Reyes St. (IDR) in Sampaloc, Manila, thrives with diverse establishments, bustling pedestrian activity, and a vibrant atmosphere, particularly evenings. Recognizing its potential as a hub for street food hawking and the need for enhanced safety, the researchers aimed to assess the potential of pedestrianization. This study focused on segments of IDR, specifically from P. Noval St. to P. Campa St. The assessment included the suitability of IDR, through Public Need and Infrastructure Sufficiency, and potential traffic impact, evaluated through a microscopic simulation using PTV Vissim. The model was calibrated and validated using the GEH statistic with traffic volume as basis. Results indicated a somewhat-needed demand (score of 2.778) and insufficient infrastructure (score of 0.5). However, the microscopic simulation revealed a consistent aggregated LoS B for all intersections before and after pedestrianization scenarios, indicating sustained free-flowing traffic. Moreover, statistical analysis indicated no significant adverse traffic impact in IDR.

Keywords: Pedestrianization, PTV Vissim, Suitability, Simulation, Level of Service, Manila

1. INTRODUCTION

The Philippines, particularly in Metro Manila, continues to grapple with persistent urban challenges. The heavy reliance on cars for transportation exacerbates issues like traffic congestion, pollution, and insufficient walkable infrastructure (Soni & Soni, 2016). This scenario necessitates a shift towards sustainable transportation development, where walking is not just a neglected mode of movement but a central focus in urban planning efforts (World Wide Fund, 2019). In the context of the Philippines, the lack of well-developed sidewalks and footpaths, coupled with high vehicular traffic volume, impedes walkability (Amini & Shankar, 2017). This deficiency is further exacerbated by factors such as political challenges, rapid population growth, and insufficient green spaces (Saloma & Akpedonu, 2022). Consequently, newer indoor areas like malls have gained popularity, leading to a decline in traditional city centers' appeal (Diaz & Koh, 2022). However, the significance of pedestrian-friendly environments transcends mere convenience; they serve as vital spaces for physical activity, social interaction, and community engagement, essential for physical and mental well-being (Halecki *et al.,* 2022). The COVID-19 pandemic underscored the importance of such spaces, highlighting the need for investments in green areas to enhance urban livability (Noszczyk *et al.*, 2021).

Therefore, pedestrianization appears as a holistic approach to address these challenges, offering a multitude of benefits across transportation, social, environmental, economic, and health-related aspects (Soni and Soni, 2016). By reducing car usage and promoting alternative forms of mobility, pedestrianization alleviates traffic congestion and enhances public transit utilization (Holmgren, 2020). Moreover, it encourages safer and more sociable urban environments, improves air quality, and encourages physical activity, thereby promoting public health (Maizlish *et al.*, 2013).

However, the implementation of pedestrianization faces various criticisms and barriers, including opposition from motorists and local merchants and concerns about enforcement and institutional support (Parajuli and Pojani, 2017). Furthermore, in a landscape where walkability remains largely unfamiliar to both the public and local policymakers, and where traditional car-centric ideologies persist, the integration of pedestrian-friendly environments into urban planning is a critical yet contentious issue. Moreover, the success of pedestrianization initiatives depends on factors like public acceptance, economic viability, and effective management of alternative transport and parking (Yassin, 2019). Despite these challenges, successful examples of pedestrianization initiatives worldwide provide valuable lessons for implementation. From Strøget in Denmark to the Old Chinatown District in Kuala Lumpur, pedestrianized areas have demonstrated significant improvements in economic activity, public health, and urban livability (Initiative and Officials, 2016). In the Philippines, cities like Vigan and Valenzuela have pioneered pedestrianization efforts, albeit with varying degrees of success (Amistad, 2008; Laurel, 2020). Despite its geographical, economic, and cultural significance, the capital city of Manila also faces challenges in balancing vehicular traffic with pedestrian welfare.

Therefore, this study focuses on I. Delos Reyes Street, located within the vibrant University Belt of Sampaloc, Manila. Renowned for its bustling local businesses and vibrant student activity, this area is an ideal candidate for pedestrian-centered development due to its dense foot traffic, relevance, and commercial vitality. Figure 1 exhibits the vicinity map of the study area, along with the segments considered for the simulation.

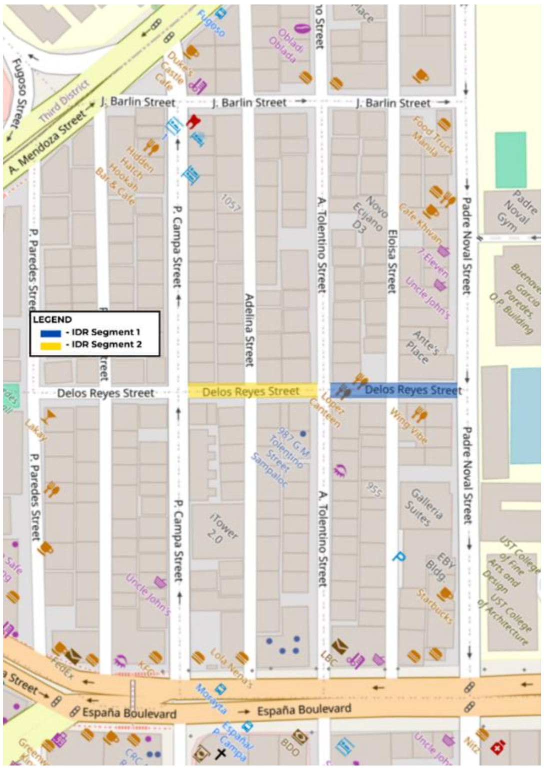

Figure 1. Vicinity Map of I. Delos Reyes Street

The main objective of this study is to assess the pedestrianization of the segments of I. Delos Reyes Street between P. Noval Street and P. Campa Street. Furthermore, the study aims to determine whether the area is suitable for pedestrianization in terms of public need and infrastructure sufficiency and to analyze the traffic impact of the proposed pedestrianization through simulation.

In light of the multifaceted benefits offered by pedestrianization, from encouraging community engagement to promoting environmental sustainability, the study's findings are expected to benefit pedestrians, residents, businesses, the environment, and local government units, aligning with sustainable development goals. Moreover, this study delimits detailed economic analyses, stakeholder opinions, and surrounding street evaluations or implementation designs. Also, this study assumes data validity and simulation accuracy which include the reliability of traffic counts, representativeness of peak hour data, and accuracy of onsite audits and simulations.

The remainder of this paper is organized as follows. Section 2 describes the methods used in the suitability assessment and microsimulation of pedestrianization. Section 3 outlines the results of the data gathering process and the discussion of its interpretation and implications. Lastly, Section 5 shows that pedestrianization is a viable pedestrian initiative in the area.

2. RESEARCH METHODOLOGY

2.1 Research Design

The study employed a descriptive research design to evaluate the area's suitability, simulate the existing and experimental scenarios, and describe the differences through scenario comparative analysis.

2.2 Data Gathering and Evaluation of Suitability

This study adopts the evaluation methodology from the Planning and Development Research Foundation, Inc. [PLANADES] (2019), to assess road suitability for pedestrianization. This methodology was selected for its comprehensive approach, relevance to the local context, and credibility as a local resource for evaluating pedestrianization suitability.

The framework assesses road suitability based on two primary criteria: 'Public Need' and 'Sufficient Infrastructure.' 'Public Need' evaluates factors such as the need for pedestrian facilities, complementary land use, and the area's heritage or tourism character. Furthermore, the 'Sufficient Infrastructure' criterion examines supportive road geometry and the impact on existing traffic flows. Each criterion is detailed through specific indicators, with a grading system that averages these indicators to derive an overall suitability score. A balanced assessment is met, as both 'Public Need' and 'Sufficient Infrastructure' must be adequately met for an area to be considered suitable for the corresponding effects of pedestrianization.

2.2.1 Road Network Geometry

The road geometry of the entire network was conducted through on-site inspections. Data for carriageway width, instances of double parking, number of lanes, lane directions, and car widths were measured and recorded to create a model in PTV Vissim.

The measurement of carriageway widths adopted a comprehensive approach, extending from curb to curb. The researchers measured each segment per road by referencing the left and right sides to the visible markings along the center of each segment. The instances of double parking, number of lanes, and lane directions were personally observed by the researchers and cross-verified using the DPWH Road and Bridge Inventory and Google Maps. The car width was only measured once by taking the width of a parked firetruck along P. Noval St.

2.2.2 Pedestrian and Traffic Volume

Pedestrian volume data was collected on August 1, 2023 (Tuesday) and August 30,2023 (Wednesday), both core weekdays—defined as any regular day from Tuesday to Thursday when traffic is more consistent, standard, and predictable (Chand, 2021; Rakha & Van Aerde, 1995). In contrast, weekends typically see lower and more variable traffic flows (Rakha & Van Aerde, 1995). The method was done by manual tally on-site wherein counters were strategically located in the middle of each segment (mid-block method). Additionally, during these two days, a comprehensive initial counting effort was taken place for a duration of 16 hours, commencing from 6 am up until 10 pm to determine the peak hours of the core weekdays for the traffic volume count.

Once the peak hours had been identified during the initial counting, these were used to collect traffic volume data for the entire network. This data collection took place on two additional core weekdays, October 24, 2023 (Tuesday) and October 25, 2023 (Wednesday). This method was done through an on-site manual tally in the intersections of the surrounding road network area, which includes the following streets: España Blvd, P. Noval St., G. Tolentino St., P. Campa St., Barlin St., Adelina St., and Eloisa St.

2.2.3 Study Area Audit of Public Needs

The Public Needs criteria signify the level of demand that the community has towards the available amenities that contribute to the authorities' planning for improvement in the area, and it includes the following sub-criterions: a) Urgent Need for Pedestrian Facilities, b) Complementary Land Use, and c) Tourism Character.

Under the Urgent Need criterion, the effective sidewalk width and sidewalk condition were determined. The sidewalk width was measured every five meters per segment starting from the P. Noval Street – IDR junction until the P.Campa – IDR intersection Street. On the other hand, the sidewalk condition was assessed through a manual and onsite audit of IDR using the modified PASER by Pohlar (2022) and Sidewalk Cleanliness Guidelines by Krambeck (2016).

The score for Complementary Land Use has been identified by analyzing the residential and commercial shares of the buildings along the length of IDR, and identifying the school's population nearest to the study area. The residential and commercial shares were assessed through an onsite audit of each building in the study area. The number of floors and usage of each were considered. The floor areas of each building were estimated using Google Earth's satellite images and measuring tool. The number of floors based on residential or commercial use was multiplied by the floor area for each building. The school population of the University of Santo Tomas (UST) was determined through the X account of The Flame, in which the account announced on August 16, 2023, the final total number of enrolled students.

The score for Tourism Character was evaluated by identifying the combined area of parks and open spaces adjacent to IDR, and examining the existing architectural features of the buildings along the study area. The sub-criterion Combined Area of Parks and Open Spaces was primarily scored through satellite imagery and an ocular visit to the study area. The assessment of the ‘interesting architectural features’ of buildings along IDR was conducted using the adapted Birkhoff's Aesthetic Measure, as introduced by Megahed and Gabr (2010) and Meddahi and Boussora (2021). This approach, based on Birkhoff's (1934) original measure, and refined by Eysenck (1941), provides an objective evaluation of architectural appeal through quantifiable metrics such as symmetry, repetition, and color harmony for order, and form complexity and color contrast for complexity.

2.2.4 Study Area Audit of Sufficient Infrastructure

The Sufficient Infrastructure criterion helps evaluate whether an area can adequately support and accommodate the shift toward a pedestrian-friendly zone, or not. The sub-criteria falling under Sufficient Infrastructure, both Supportive Road Geometry and Minimal Traffic Impact, were determined through on-site inspections and satellite imagery analysis along IDR.

The score for Supportive Road Geometry was assessed through ocular visits to the study area, wherein the street’s number of lanes and off-street parking facilities were counted on-site. The presence of parallel streets, however, had been observed through satellite images of the area via Google Maps.

2.2.5 Factored PCU, VCR, and PCEF

Regarding the data collection of values for the simulation, the peak hour traffic volume was used as an input for the simulation. This input variable was obtained through the manual counting method at selected points. Subsequently, the collected traffic volume data during peak hour traffic counting were plotted in MS Excel to determine the factored Passenger Car Units (PCU) and its total value and determine the most critical hour within the peak hours window.

Moreover, the PCU values obtained were multiplied by the Passenger Car Equivalent Factor (PCEF) to account for the space occupied by each vehicle type.

$$PCU = \sum(Volume_{Veh\,Type} \times PCEF_{Veh\,Type}) \tag{1}$$

where,

PCU: Passenger Car Units (veh/hr)

Furthermore, the Volume Capacity Ratio (VCR) was calculated using Equation 2. In this study, the LoS was determined based on the computed VCR.

$$VCR = \frac{PCU}{Capacity} \tag{2}$$

where,

PCU: Passenger Car Units (veh/hr)

2.3 Model Simulation

This study utilized PTV Vissim to simulate the effects of the different pedestrianization schemes on I. Delos Reyes Street by conducting multiple scenario simulations, namely: Baseline, Segment 1 and 2 Closed, Segment 1 Closed, and Segment 2 Closed.

2.3.1 Model Creation

To simulate the study area, the researchers created a model using the PTV Vissim software to replicate the entire study network. This network includes various road segments, such as P. Noval St., P. Campa St., Tolentino St., Barlin St., España Blvd corner P. Noval St. and P. Campa St., and I. Delos Reyes St corner P. Campa St. to P. Noval St. A combination of links and connectors was then traced along the specified routes. Furthermore, the model creation process was initiated by placing vehicle inputs at network entrances.

Data collection points were established on links near intersections and junctions to capture turning movements. This data was used to validate the model by comparing the simulated turning movements with the actual observed behavior and volume at these intersections.

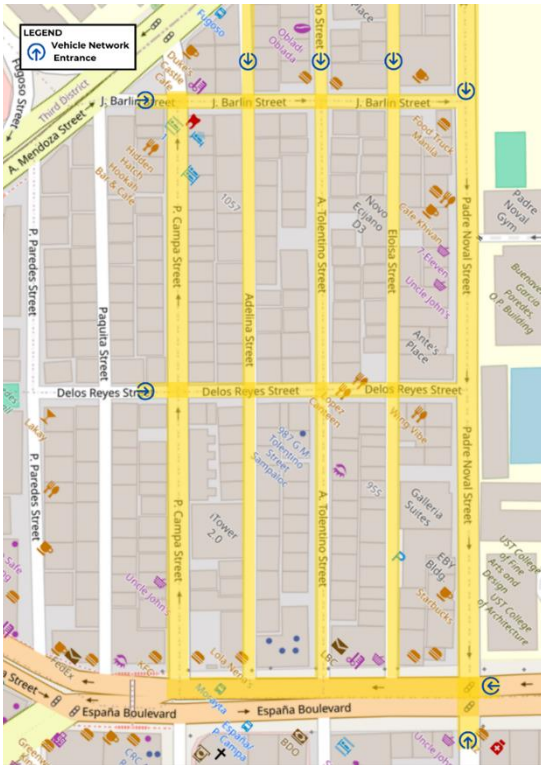

Figure 2. Network Map of Study Area

2.3.2 Data Calibration and Validation

The simulations in PTV Vissim required calibration and adjustments of the parameters under the Base Data tab. Wiedemann 74 model was used for the car-following model. Starting from their default values, these parameters need to be modified in an iterative manner: Distribution, Driving Behavior, and Vehicle Types and Classes.

After the calibration process, the parameters needed to undergo validation to ensure their accuracy and achieve results that closely match the obtained data. In this study, the GEH statistic was utilized as the validation method for the calibrated parameters, using Equation 3.

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}} \tag{3}$$

where,

M : Output Traffic Volume from the simulation (veh/hr)
C : Input/Observed Traffic Volume (veh/hr)

To be considered valid, the GEH statistic below 5 signifies validity and a minimum of 85% of validations for individual link flows must meet this criterion. Furthermore, the whole road network must also achieve a GEH statistic of less than 4% for the validation of the recreated model.

2.3.3 Scenario Simulations

The study involves a comprehensive exploration of road closure simulation strategies aimed at simulating pedestrianization, particularly focusing on IDR. Various scenarios were simulated, as seen in Table 1, each with a unique approach to traffic closure pedestrianization.

Table 1. Matrix of All Simulations Scenarios

Name	Description
Baseline	Model simulation of the Baseline Condition. The entire span of IDR. is open to traffic.
Segment 1 and 2 Closed	Both segments of IDR, from corner P. Noval St. to Tolentino St. and Tolentino St. to P. Campa St., are closed to traffic.
Segment 1 Closed	Only Segment 1 of IDR, from corner P. Noval St. to Tolentino St, is closed to traffic.
Segment 2 Closed	Only Segment 2 of IDR, from the corner of Tolentino St. to P. Campa St., is closed off to traffic.

To replicate the road closure, the study manipulated the Relative Flows (RelFlow) parameter, strategically redirecting static vehicle routing decisions whose destination link is IDR towards immediate alternative directions. Results were determined through Data Collection Points known as DCMs, or Data Collection Measurements, that were strategically placed on the network.

2.4 Data Analysis

Statistical data analysis is warranted in making conclusive results regarding the comparisons of the different scenario simulations. In the statistical analysis, the primary variable analyzed is the Volume/Capacity (V/C) ratio for each simulation scenario. It is important to note that this V/C ratio is distinct from the V/C ratio discussed prior based on Passenger Car Units (PCU), which was used to determine the peak hour. The V/C ratios in the statistical analysis were derived from the traffic volumes collected during the simulation scenario testing. Subsequently, these V/C ratios from the proposed pedestrianization schemes (experimental scenarios) were subjected to statistical analysis to assess deviations from the V/C ratio of the Baseline Scenario.

However, to ensure the accuracy of the results, the datesets from conditions prior to road closure (Baseline) and from various segment closure schemes (e.g., Segment 1 and 2 Closed, Segment 1 Closed, Segment 2 Closed) were adjusted to exclude data from simulation points where traffic volume results were zero. These points corresponded to segments where no traffic could pass due to the experimental scenario closure, and their inclusion would distort the analysis. This exclusion was necessary because the statistical analysis aimed to quantify significant changes in traffic volumes on the streets surrounding the closed segments, rather than within the closed segments themselves. To achieve these comparisons, the following statistical tests were employed: Paired T-Test, Wilcoxon Signed-Rank Test, and Shapiro-Wilk Test.

2.4.1 Paired T-test

The Baseline scenario is the existing traffic scenario observed in I. Delos Reyes Street is the initial and reference scenario for comparison with each data set of proposed pedestrianization schemes produced. The Paired T-Test was employed to compare datasets representing before and after scenarios using Equation 4.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(s^2(\frac{1}{n_1} + \frac{1}{n_2})}} \quad (4)$$

where,

t	: t-value
x	: groups being compared
s_2	: pooled standard error of the group
n	: number of observations per group

2.4.2 Wilcoxon Signed Rank Test

It is crucial to note that the Paired T-Test assumes a normal distribution of the data. An alternative approach, the Wilcoxon Signed Rank test, was also applied to address situations where normality might not be met. The Wilcoxon Signed Rank test is a nonparametric test, making it suitable for assessing statistical differences between datasets without the requirement of a specific distribution using Equation 5.

$$\mathrm{T} = \min(\sum_{\mathrm{i=1}}^{\mathrm{n}} \mathrm{sgn}(X_i - Y_i)) \times \mathrm{R_i},\ \sum_{\mathrm{i=1}}^{\mathrm{n}} \mathrm{sgn}(Y_i - X_i) \times \mathrm{R_i}) \quad (5)$$

where,

T	: Test Statistic
X_i & Y_i	: Paired Observations
n	: Number of paired observations,
$sgn()$	: Sign function (returns -1 if u < 0, 0 if u = 0, and 1 if u > 0)
R_i	: The rank of the absolute difference between Xi and Yi

2.4.3 Shapiro-Wilk Test

The Shapiro-Wilk Test examined the data distribution's normality. This test aids in determining whether the assumption of normality holds for the datasets under consideration using Equation 6. The combined application of these tests contributes to a reliable statistical evaluation.

$$[W = \frac{(\sum_{i=1}^{n} a_i \cdot x_{(i)})^2}{\sum_{i=1}^{n} (x_i - \bar{x})^2}] \quad (6)$$

where,

W	: Test Statistic

n : Sample size
x_i: : i-th ordered observation
$\bar{x}$: : Sample mean
a_i: : Constants are given by the test

2.4.4 Aggregation of V/C Ratios

For descriptive purposes, the Volume/Capacity (V/C) Ratios from all Data Collection Points (DCMs) were aggregated for each scenario using two distinct methods: the normal mean: and weighted mean. The normal mean calculates the average V/C Ratio across all DCMs, providing a straightforward representation of the overall traffic conditions. On the other hand, the weighted mean approach adjusts the average V/C Ratio to account for the relative significance of different traffic volumes, under the assumption that segments with higher traffic volumes are more sensitive to changes in Level of Service (LoS).Aggregated V/C Ratios, calculated using both normal and weighted means, were used only to describe the overall V/C Ratio and Level of Service (LoS) conditions for each scenario.

3. RESULTS AND DISCUSSION

3.1 Suitability Analysis

a) Public Need

A multi-faceted assessment determined the Need for Pedestrian Facilities and sidewalk characteristics within I. Delos Reyes Street. Pedestrian counts on Eloisa and Adelina Streets in August 2023 yielded a score of 3 based on the grading scale of PLANADES (2019). Effective sidewalk width had an average of 2.465 meters on both sides of IDR and scored 4. Finally, a manual audit on October 18, 2023, resulted in an average sidewalk condition score of 3, indicating an average quality.

Complementary Land Use was determined based on Residential and Commercial land use along with the school population nearby. Residential share resulted in an area of 6552.57 square meters which is around 72% of the total land area, garnering it a score of 4. In comparison, the Commercial area resulted in 2534.2 square meters which is the remaining 28% of the total land area, garnering a score of 3. The school population of the enrolled students in the University of Santo Tomas was 41,554 on August 16, 2023, earning this sub-criterion a score of 5.

The Tourism Character was determined by computing the area of parks and open spaces and observing the presence of architectural features. There was no observed park or open spaces within IDR, earning it a score of 0. The resulting computed Aesthetic Measure was 24.291 using Birkhoff's Aesthetic Measure, corresponding to a score of 2.

Public Need earned an overall average of 2.778, Need for Pedestrian Facilities had an average of 3.333, Complementary Land Use had an average of 4, and Tourism Character had an average of 1. This translates to a somewhat need for pedestrianization based on the grading scale of PLANADES (2019)

b) Sufficient Infrastructure

The Supportive Road Geometry was assessed through ocular observation and satellite imagery. IDR had been identified as a two-way lane road with 1 lane for each direction, and this earned it a score of -2. The presence of off-street parking facilities was tallied to a total of 255 parking spaces, earning it a score of 4. The presence of parallel streets was assessed through satellite imagery, and it showed that there are 2 streets parallel to IDR, garnering a score of 4.

Minimal Traffic Impact was determined through the identification of the street's road classification and two 16-hour traffic volume counts. The classification for IDR is a city road and based on the grading criteria, it earned a score of 2. The traffic volume counts identified each vehicle passing through and multiplied it with its corresponding PCEF. On the first day of counting, the PCU of Eloisa Street was 7451.1and Adelina Street had a PCU of 5497.8. On the second day of counting, Eloisa Street had a PCU of 9288.4, and Adelina Street had 6264.5, and with the average PCU of each street being more than 5000, this sub-criterion earned a score of -4.

Sufficient Infrastructure earned an overall average of 0.5, Supportive Road Geometry scored an average of 2, and Minimal Traffic Impact earned an average score of -1. This means that the existing infrastructure in IDR is insufficient for pedestrianization.

Table 2. Computation of Evaluation of Suitability

Public Need [PN]			Sufficient Infrastructure [SI]	
Need for Pedestrian Facilities	Complementary Land Use	Tourism Character	Supportive Road Geometry	Minimal Traffic Impact
Pedestrian Volume	Residential Share	Combined Area of Parks and Open Spaces	Number of Road Lanes	Road Classification
3	4	0	-2	2
Sidewalk Width	Commercial Share	Presence of Architectural Features	Presence of Parallel Streets	Daily Average Volume
4	3	2	4	-4
Sidewalk Condition	School Population		Off-street Parking Facilities	
3	5		4	
Score	Score	Score	Score	Score
3.333	4	1	2	-1
	Score of PN		Score of SI	
	2.778		0.5	

3.2 PTV Vissim Calibration and Simulation Analysis

a) Baseline Scenario Model Calibration

The simulation model was developed in PTV Vissim utilizing the road geometry values derived from a comprehensive road geometry audit. Subsequently, the model was calibrated and validated iteratively, employing the GEH statistic as the primary metric. It is noteworthy that literature suggests that a GEH statistic below 5 signifies validity and a minimum of 85% of validations for individual link flows must meet this criterion. Furthermore, the whole road network must also achieve a GEH statistic of less than 4% for the validation of the recreated model. This study adhered to these standards, as depicted in Table 3, highlighting the iterative calibrations and their corresponding percentage of validated Data Collection points. Notably, Simulation Run No. 21 exhibited a validation rate of 97.14286% for individual link flows and 3.37902% for all link counts. For this reason, the model corresponding to the 21st run was adopted as the Baseline scenario.

Table 3. Calibration and Validation Sequence of the Simulation Model

Run	Calibration Measure	Percentage of GEH Valid DCMs (%) for Individual Link Flows		Percentage of GEH Valid DCMs (%) for All Link Counts	
1	Adjust Average Standstill Distance: From 2 m to 0.2 m	20	FAIL	37.98183	FAIL
2	Adjust Reduced Speed Area in Eloisa St. and Adelina St: From 20 kph to 5 kph for Motorcycles and Tricycles	22.85714	FAIL	34.86068	FAIL
3	Adjust Additive Part of Safety Distance: From 2 to 1 Adjust Multiplicative Part of Safety Distance: From 3 to 2	22.85714	FAIL	43.14850	FAIL
4	Adjust DesSpeedDistr of all vehicle classes at Reduced Speed Area in Eloisa St. and Adelina St.: From 20 kph to 5 kph	22.85714	FAIL	44.50250	FAIL
5	Corrected Static Vehicle Route (4-1) from NOVAL UJ bound ESP-UST to NOVAL UJ bound ESP-CHOWKING	22.85714	FAIL	57.99224	FAIL
6	Adjust DesLatPos: From Middle of Lane to Any Free Lane Selection	22.85714	FAIL	59.40252	FAIL
7	Cleared Static Vehicle Route in Adelina and Eloisa St.	17.14286	FAIL	66.72540	FAIL
8	Set RelFlow to all Static Vehicle Route	74.28571	FAIL	17.94781	FAIL
9	Adjusted the Conflict Area at España-Tolentino Intersection; Priority Flow for España, waiting for in and out Tolentino	71.42857	FAIL	17.22011	FAIL
10	Added Conflict Area at España-Adelina & España-Eloisa junctions Enable Lateral Behavior: Consider Next Turning	71.42857	FAIL	17.89937	FAIL

Table 3. Calibration and Validation Sequence of the Simulation Model (Cont.)

11	Adjust Signal Heads at España	71.42857	FAIL	17.09860	FAIL
12	Blocked VehTypes such as HGV, Bus, [E]-Jeeps, Truck, L300, and PUV in entrances (connectors) of Adelina and Eloisa St.	74.28571	FAIL	17.36583	FAIL
13	Set all Static Vehicle Routes with the value of 0 or 1 when the link is unidirectional or with the exact volumes when multidirectional	82.85714	FAIL	2.39841	PASS
14	Set Reduced Speed Area in AS1	82.85714	FAIL	2.39841	PASS
15	Fixed Conflict Areas in all Intersections and Links	82.85714	FAIL	3.61819	PASS
16	Adjust Lane Change Distance: From 200 m to 250 m Adjust Emergency Stop Position: From 5 m to 7 m	82.85714	FAIL	3.60046	PASS
17	Adjust LatDistStandDef: From 0.20 m to 0.30 m Adjust LatDistDrivDef: From 1 m to 0.50 m	82.85714	FAIL	3.82212	PASS
18	Adjusted positions of all Desired Speed Decisions in AS1-IDR/ESP and ELS1-IDR/ESP of all VehTypes right after the position of all Static Vehicle Routes on said links	88.57143	PASS	7.97565	FAIL
19	Adjusted link alignment on Adelina and Eloisa St.	88.57143	PASS	7.87630	FAIL
20	Enabled Overtake Left and Overtake Right Adjusted España Link and Corresponding Signal Heads Set Vehicle Input Interval to respective 900s	88.57143	PASS	5.54952	FAIL
21	Fixed Static Vehicle Route RelFlow from 318 to 543 at Tolentino Link Set VehInput VolType to Stochastic Adjust VehComp DesSpeedDistr according to PCEF	97.14286	PASS	3.37902	PASS

b) Scenario Simulations

The simulation results were gathered from groups of Data Collection Points known as DCMs, or Data Collection Measurements. These features within PTV Vissim enabled the researchers to assess and measure the fluctuations and changes in traffic volume. The DCMs were assigned unique numerical codes, ranging from DCM-1 to DCM-35, with each corresponding location detailed in Table 4. Figure 3 illustrates the positions of DCMs along the network map of the study area.

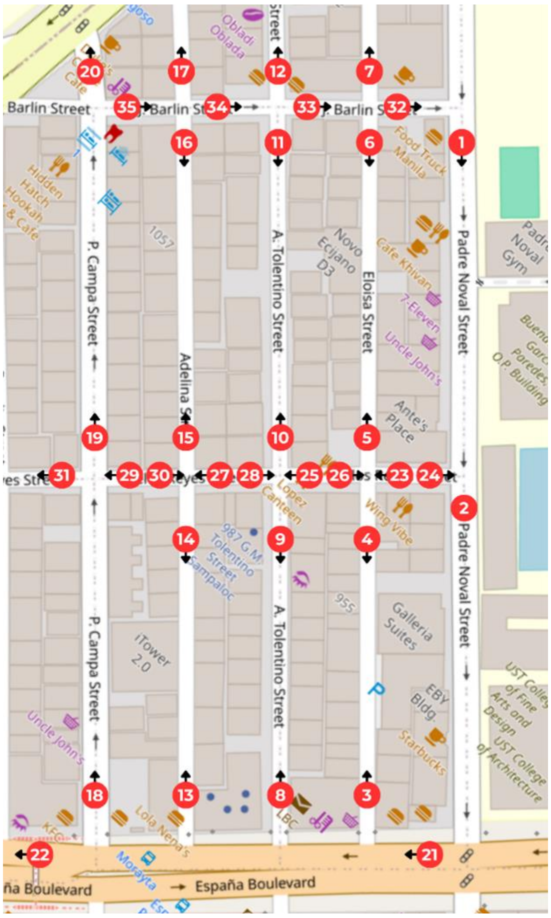

Figure 3. Network Map of Study Area and the corresponding DCM markers

After gathering the traffic volumes, the Volume Capacity Ratio (V/C) and LOS per DCM was calculated in each of the simulated scenarios, It is evident in Table 4 that the LOS remains relatively consistent across various scenarios, suggesting that fluctuations in Traffic Volume within DCMs might not be substantial enough to impact the continuous flow of vehicles in accordance with the Level of Service criteria established by the DPWH.

Table 4. Comparison of Scenarios in terms of V/C Ratio & LOS

DCM No.	DCM Name	Baseline		Segment 1 and 2 Closed		Segment 1 Closed		Segment 2 Closed	
		V/C	LOS	V/C	LOS	V/C	LOS	V/C	LOS
1	NS2	0.55000	C	0.57813	C	0.57125	C	0.55375	C
2	NS1	0.83750	D	0.76917	D	0.76250	D	0.79167	D

Table 4. Comparison of Scenarios in terms of V/C Ratio & LOS (Cont.)

3	ELS1-IDR	0.05167	A	0.00000	A	0.00000	A	0.05333	A
4	ELS1-ESP	0.04833	A	0.00000	A	0.00000	A	0.04500	A
5	ELS2-BAR	0.04333	A	0.00000	A	0.00000	A	0.04333	A
6	ELS2-IDR	0.04667	A	0.00000	A	0.00000	A	0.04833	A
7	ELS3-MEN	0.05000	A	0.00833	A	0.00833	A	0.05167	A
8	TS1-IDR	0.89167	E	0.86500	E	0.85833	E	0.89333	E
9	TS1-ESP	0.43000	B	0.46833	B	0.59333	C	0.48833	B
10	TS2-BAR	0.65667	C	0.86333	E	0.75500	D	0.76167	D
11	TS2-IDR	0.48333	B	0.47167	B	0.48333	B	0.47167	B
12	TS3-MEN	0.57667	C	0.74167	D	0.64333	C	0.66500	C
13	AS1-IDR	0.18667	A	0.00000	A	0.22500	B	0.00000	A
14	AS1-ESP	0.01667	A	0.00000	A	0.01667	A	0.00000	A
15	AS2-BAR	0.03000	A	0.00000	A	0.03000	A	0.00000	A
16	AS2-IDR	0.00333	A	0.00000	A	0.00333	A	0.00000	A
17	AS3-MEN	0.00333	A	0.00167	A	0.00333	A	0.00167	A
18	CS1	0.25083	B	0.35500	B	0.25500	B	0.35250	B
19	CS2	0.35417	B	0.39917	B	0.33667	B	0.39583	B
20	CS3	0.41667	B	0.45750	B	0.40250	B	0.45750	B
21	ESP1	0.42493	B	0.42433	B	0.42448	B	0.42403	B
22	ESP2	0.32164	B	0.32328	B	0.33239	B	0.32194	B
23	IDRS1-ELS	0.30500	B	0.00000	A	0.00000	A	0.30833	B
24	IDRS1-NOV	0.52167	C	0.00000	A	0.00000	A	0.41833	B
25	IDRS2-TOL	0.29333	B	0.00000	A	0.00000	A	0.29500	B
26	IDRS2-ELS	0.51167	C	0.00000	A	0.00000	A	0.40167	B
27	IDRS3-ADL	0.25833	B	0.00000	A	0.19833	A	0.00000	A
28	IDRS3-TOL	0.20167	B	0.00000	A	0.22333	B	0.00000	A
29	IDRS4-CAM	0.32000	B	0.00000	A	0.27333	B	0.00000	A
30	IDRS4-ADL	0.12667	A	0.00000	A	0.12667	A	0.00000	A

Table 4. Comparison of Scenarios in terms of V/C Ratio & LOS (Cont.)

31	IDRS5-PAR	0.10167	A	0.02833	A	0.09667	A	0.03000	A
32	BS1	0.26750	B	0.30500	B	0.29750	B	0.27250	B
33	BS2	0.28083	B	0.29250	B	0.28583	B	0.28667	B
34	BS3	0.12833	A	0.11833	A	0.12667	A	0.11833	A
35	BS4	0.11333	A	0.11500	A	0.11167	A	0.11500	A

As depicted in Table 5, the simulation of the Baseline Scenario and proposed pedestrianization schemes all resulted in a LOS B, and according to DPWH standards, relatively smooth traffic flow is observed for such scenarios.

Table 5. Simulation Scenarios and Aggregated V/C with LOS

Designation	Mean V/C Ratio		Weighted Mean V/C Ratio	
	V/C Ratio	LOS	V/C Ratio	LOS
Baseline	0.28869	B	0.44396	B
Segment 1 and 2 Closed	0.21674	B	0.41088	B
Segment 1 Closed	0.24128	B	0.41281	B
Segment 2 Closed	0.25904	B	0.43487	B

c) Statistical Treatment of Data

The resulting V/C Ratio gathered during the simulation of the Baseline scenario and the proposed pedestrianization scheme were subjected to statistical analysis to compare their statistical differences. Each dataset underwent a comprehensive statistical analysis using multiple tests, including the Paired T-Test, Wilcoxon Signed-Rank Test, and Shapiro-Wilk Test.

Table 6. Statistical Datasets

DCM No.	Baseline	Segment 1 and 2 Closed	Baseline	Segment 1 Closed	Baseline	Segment 2 Closed
1	0.550	0.578	0.550	0.571	0.550	0.554
2	0.838	0.769	0.838	0.763	0.838	0.792
3	0	0	0	0	0.052	0.053
4	0	0	0	0	0.048	0.045
5	0	0	0	0	0.043	0.043
6	0	0	0	0	0.047	0.048
7	0.050	0.008	0.050	0.008	0.050	0.052
8	0.892	0.865	0.892	0.858	0.892	0.893
9	0.430	0.468	0.430	0.593	0.430	0.488
10	0.657	0.863	0.657	0.755	0.657	0.762
11	0.483	0.472	0.483	0.483	0.483	0.472
12	0.577	0.742	0.577	0.643	0.577	0.665
13	0	0	0.187	0.225	0	0
14	0	0	0.017	0.017	0	0
15	0	0	0.030	0.030	0	0

Table 6. Statistical Datasets (Cont.)

16	0	0	0.003	0.003	0	0
17	0.003	0.002	0.003	0.003	0.003	0.002
18	0.251	0.355	0.251	0.255	0.251	0.353
19	0.354	0.399	0.354	0.337	0.354	0.396
20	0.417	0.458	0.417	0.403	0.417	0.458
21	0.425	0.424	0.425	0.424	0.425	0.424
22	0.322	0.323	0.322	0.332	0.322	0.322
23	0	0	0	0	0.305	0.308
24	0	0	0	0	0.522	0.418
25	0	0	0	0	0.293	0.295
26	0	0	0	0	0.512	0.402
27	0	0	0.258	0.198	0	0
28	0	0	0.202	0.223	0	0
29	0	0	0.320	0.273	0	0
30	0	0	0.127	0.127	0	0
31	0.102	0.028	0.102	0.097	0.102	0.030
32	0.268	0.305	0.268	0.298	0.268	0.273
33	0.281	0.293	0.281	0.286	0.281	0.287
34	0.128	0.118	0.128	0.127	0.128	0.118
35	0.113	0.115	0.113	0.112	0.113	0.115

The statistical analysis resulted in no significant difference at a 5% level of significance among all the proposed scenarios. These statistical results indicate that pedestrianization schemes on I. Delos Reyes Street will not significantly impact its corresponding adjacent roads, suggesting that the road closure for pedestrianization is feasible given the street's existing traffic scenario.

Table 7. Results and Interpretation of the Paired T-Test, Shapiro Wilk Test, and Wilcoxon Signed-Rank Test

Statistical Dataset	**α**	**Paired T-Test**		**Shapiro-Wilk Test for differences**		**Wilcoxon Signed-Rank Test**	
		p-value	Remarks	Normality p-value	Remarks	p-value	Remarks
Comparison between Baseline and Segment 1 and 2 Closed	0.05	0.168	No Significant Difference between	0.02457	Not Normally Distributed	0.2598	No Significant Difference between
Comparison between Baseline and Segment 1 Closed	0.05	0.5221	No Significant Difference between	0.001543	Not Normally Distributed	0.8348	No Significant Difference between
Comparison between Baseline and Segment 2 Closed	0.05	0.6919	No Significant Difference between	0.002497	Not Normally Distributed	0.3743	No Significant Difference between

4. SUMMARY AND CONCLUSION

In summary, the implementation of pedestrianization on I. Delos Reyes St., a two-way, two-lane infrastructure, appears to be somewhat necessary, but insufficiently suitable in the area with no significant impact on the surrounding traffic flow. Employing the Suitability Analysis approach from PLANADES (2019), the evaluation of the study area yielded a 2.778 score for the Public Needs Criteria and a 0.5 score for the Sufficient Infrastructure Criteria. This suggests a need for facilities for pedestrians and underscores the difficulties that the layout of the roads presents for vehicular traffic. While the need for pedestrianization is somewhat evident, the existing infrastructure is found to be inadequate to accommodate the implementation of pedestrianization. Meanwhile, through PTV Vissim and the statistical analysis of the data obtained, it was found that closing I. Delos Reyes Street, including both Segment 1 and Segment 2, during peak hours had negligible effects on traffic flow. The (V/C) ratio and the overall LoS remained stable when compared to the baseline scenarios, showing that traffic movement was not significantly hindered by the closures. These findings are also relevant outside of peak traffic times, especially for planners and policymakers, in assessing the effectiveness of pedestrianization in balancing traffic management and pedestrian needs.

5. RECOMMENDATIONS

The study investigated making I. Delos Reyes Street pedestrian-only by conducting a road audit and using PTV Vissim software to analyze traffic flow. Challenges like limited time and bad weather affected data collection, making comparing traffic during peak and off-peak times difficult. Future studies should examine traffic patterns across different seasons, especially during school holidays, to better understand the traffic flow.

Additionally, to improve traffic behavior predictions, future research should lengthen traffic count times, especially in peak hours, and gather data on both traffic and pedestrian activity in the rainy season to allow for examination of how different weather conditions and unusual events impact traffic and pedestrian numbers.

Future studies should consider investigating partial pedestrianization, to maintain a balance between pedestrian convenience and vehicle needs. Effective planning, including traffic rerouting and venue capacity assessment, is key to managing both pedestrian and vehicle flows efficiently, thereby enhancing the success of pedestrianization initiatives

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