Evaluation of Uncontrolled and Signalized Intersections in Brgy. Del Rosario and Brgy. Dolores in the City of San Fernando, Pampanga: A Basis for Risk Mitigation Plans

Edward Ian D. Dimabuyu [1], Lester A. De Dios [1], Nolito G. Mendeja [1], Jaeson Anthony G. Pelayo [1], Alvie B. Rivera [1], Roustom N. Tobias [1], Juanita Carmelita R. Zoleta [1], Charles G. Lim [1]

[1]Department of Civil Engineering, College of Engineering and Architecture, Don Honorio Ventura State University, Cabambangan, Villa De Bacolor, Pampanga, Philippines.

Corresponding Author: dimabuyuedwardian@gmail.com

Abstract: - Transportation infrastructure, such as roads, is essential for a country's economic growth and road users' safety. Roadways connect many locations and are crucial for the efficient transportation of people and goods. Typically, traffic congestion and accidents occur at an intersection, where two or more roads intersect. An intersection can be uncontrolled, with no signs or traffic lights, or signalized, with both. Consequently, the purpose of this study was to determine which factors, such as Mobility, Traffic Control, Road Condition, and Behavior, contribute the most to accidents in the study area. The study utilized the quantitative descriptive approach, wherein the researchers used numerical data to analyze the connection of the variables. Four hundred (400) respondents were surveyed by the researchers, including 200 drivers from the signalized intersection at Brgy. Del Rosario and 200 drivers from the uncontrolled intersection at Brgy. Dolores. The researchers gathered data via survey questionnaires. Additionally, the collected data were analyzed using Weighted Mean, Likert Scale, Standard Deviation, and Independent Sample T-Test to address the study's objectives. The respondents agreed that the four (4) factors have an impact on the safety of road users at the signalized intersection. Meanwhile, the drivers believed that Mobility partly impacts the safety at the uncontrolled intersection, while they agreed that Road Condition and Behavior affect the area. Concisely, the study discovered that Behavior is the area's most significant risk factor. Furthermore, the study found a significant difference between the Signalized Intersection (Brgy. Del Rosario) and the Uncontrolled Intersection (Brgy. Dolores) in terms of Mobility, Road Condition, and Behavior.

Key Words— ***Uncontrolled, Signalized, Mobility, Traffic Control, Road Condition, Behavior.***

I. INTRODUCTION

In the field of road transport, roadways are pivotal to people's safety and a country's economic progress. Poor planning on roads and inappropriate behaviors of motorists might lead to accidents, which will delay the movement of vehicles. Thus, it hinders the productivity of individuals and businesses in a country. De Leon et al. (2005) concluded in their analysis that traffic accidents substantially impact a country's economy. According to the study, the leading factor negatively affecting the economy is lost revenue owing to fatalities and permanent disability. Furthermore, the medical costs of severe injuries and property damage from minimal accidents impact economic growth.

Meanwhile, road traffic safety has become a severe issue due to the developing world's growing population and the rise in automobiles despite improvements in infrastructure and technology (Vedagiri & Killi, 2015). Traffic accidents occur at a rate of 40-60% in most countries (Lefevre et al., 2012). The primary reason for these concerns resides in the behavior of

Manuscript revised June 10, 2023; accepted June 11, 2023. Date of publication June 12, 2023.

This paper available online at www.ijprse.com

ISSN (Online): 2582-7898; SJIF: 5.59

motorists, such as inattentiveness, misjudgment of the situation, and poor decisions. The absence of a stop or yield sign at intersections confuses some drivers, increasing the likelihood of an accident. According to Tamayo (2009), substandard roads and the lack of road signage also contribute to the increasing rate of road accidents due to the economy's poor performance. As a result, motorists and pedestrians are unsafe in these places. Pertinent to that, the most vulnerable road users are pedestrians and bikers because they account for 26% of all fatalities from vehicle accidents worldwide (WHO, 2018; Jain & Rastogi, 2016, as cited in Kathuria & Vedagiri, 2020). Additionally, according to WHO (2013, as mentioned in Jain & Rastogi, 2016), almost 5000 pedestrians are killed weekly on the world's highways because their needs have been ignored for decades. Moreover, in the Philippines, notably in Metro Manila, the accident rate in this area reaches 72.44 % as noted by Tamayo (2009, as cited in ASEAN Development Bank, n.d).

In addition, road intersections play a massive role in road transport since it is where most vehicles pass through. Therefore, any unexpected event can occur at any time. Traffic congestion and accidents frequently occur at intersections, whether uncontrolled or signalized. According to Lefevre (2012), the intersection's population makes the environment crowded and prone to hazards. Consequently, 40% to 50% of road collisions occur at junctions. Also, the author noted that due to the frequent interaction of vehicles in intersections, the type of road network environment should be considered to reduce the frequency of road accidents. In addition, Briz-Redón et al. (2019) also proposed three goals that can be invaluable in preventing unexpected incidents: locating areas where accidents frequently occur, identifying areas where accidents are likely to happen, and identifying accidents that cause severe problems for motorists and pedestrians.

Road intersections, particularly signalized intersections, are typically located in urban areas wherein massive, heavy vehicles such as trucks extensively damage road surfaces. For instance, India has many signalized intersection problems, including casualties of road users. Numerous factors contribute to the severity of accidents at signalized crossroads, including the existence of all red-time, a restricted right-turning phase, an obstructed carriageway, non-motorized traffic, and the transparency of lane markings (Mitra & Bhowmick, 2020).

On the other hand, based on the study of Sanatizadeh (2017), three kinds of data were collected to determine how cars act when people trying to cross at uncontrolled crosswalks have the right of way.

These are the information about the location, the people who drive and walk, and how they act. Driver and pedestrian behavior are only seen when a person is trying to cross at a crosswalk and when a car is approaching the intersection. The vehicle must decide to yield to the pedestrian who is waiting to cross. Pedestrians' behavioral characteristics include assertiveness, standing posture, and waiting time at the crosswalk to find a gap in the flow of traffic (Sanatizadeh, 2017).

Moreover, in the Philippines, the continual traffic incidents have become a serious concern in terms of people's safety and the growth of the country. The estimated number of serious injuries from road accidents in 2016 was 190,350, with 10,012 fatalities (Global Road Safety Facility, n.d). Furthermore, the recorded cases cost 4.1% of the country's Gross Domestic Product (GDP).

In relation to that, according to the data from the Philippine National Police - City of San Fernando, Pampanga, there were 2,586 traffic accidents, including 22 deaths reported in the uncontrolled intersection of Brgy. Dolores, City of San Fernando, Pampanga (CSFP), from January 2016 to February 2023. This intersection is a four-legged type of intersection, wherein there are no road markings or traffic signs to restrict vehicle flow, which is classified as uncontrolled. Meanwhile, the signalized and four-legged type of intersection at Brgy. Del Rosario, City of San Fernando, Pampanga (CSFP) has reported cases of accidents in the same year with 364 cases, including five fatalities. Consequently, the status of uncontrolled and signalized intersections in the City of San Fernando, Pampanga (CSFP) requires improvement and prompt action to support the demands of all individuals who cross through the intersections. Furthermore, the goal of this research was to provide risk-reduction recommendations that will help in reducing and eliminating possible risks in the study area. This study will benefit the drivers, pedestrians, and the local government unit in determining the factor that highly contributes to the hazards in the intersections of Brgy. Dolores and Brgy. Del Rosario, CSFP.

II. METHODOLOGY

This chapter presents the processes used to achieve the goal of the study.

2.1 Research Design

This study used a quantitative-descriptive research design wherein the researchers analyzed the connection between two variables using numerical data.

2.2 Respondents of the Study

The researchers utilized the simple random sampling technique and adapted Yamane's Formula to determine the sample size who will answer the survey questionnaires. By employing this sampling technique, the researchers identified the respondents based on the condition that they must pass through the intersection of Brgy. Del Rosario and Brgy. Dolores in the City of San Fernando, Pampanga. To calculate the sample size of the respondents, Yamane's Formula is

$$n = \frac{N}{1 + Ne^2}$$

Where n is the number of samples, N is the total population, and e is the error tolerance (0.05).

The respondents of the study were drivers who crossed the intersection of Brgy. Del Rosario and Brgy. Dolores, CSFP. The researchers gathered the Annual Average Daily Traffic (AADT) data to determine the population in the study area.

Table.1. Annual Average Daily Traffic in Year 2021

Location	AADT (Road Name)			
Brgy. Del Rosario	41,475 *(Manila North Road)*	41,475 *(Manila North Road)*	45,895 *(Manila North Road)*	45,895 *(Manila North Road)*
Brgy. Dolores	45,895 *(Manila North Road)*	35,817 *(Jose Abad Santos Avenue)*	27,148 *(Manila North Road)*	41,816 *(Jose Abad Santos Avenue)*

The table above indicates the AADT of the roads of the intersections. The total population passing through these intersections is 325,416 motorists. Thus, by using Yamane's formula, the sample size for this study is

$$n = \frac{N}{1 + Ne^2} = \frac{325{,}416}{1 + (325{,}416)(0.05)^2}$$

$$n = 399.509 \approx 400 \text{ respondents}$$

The researchers calculated the recommended sample size of four hundred (400) respondents based on the abovementioned formula. Consequently, out of the total respondents, the researchers divided the respondents into two groups, wherein two hundred (200) participants answered the questionnaire on the "Signalized Intersection" category while, two hundred (200) respondents responded to the questionnaire in the "Uncontrolled Intersection" category.

2.3 Research Instrument

The research instrument used for this study was a survey questionnaire checklist for the drivers passing from the intersections of Brgy. Del Rosario and Brgy. Dolores, City of San Fernando, Pampanga. The accumulation of data from the Department of Public Works and Highways (DPWH) and the PNP–CSFP was carried out. The researchers constructed the questions in the questionnaire checklist based on the contributing factors that cause hazards in the intersections. The questionnaire contains five statements based on the four (4) factors contributing to intersection hazards. The researchers utilized the Likert Scale in the survey questionnaire to answer questions. Wu and Leung (2017) stated that the Likert Scale, which is generally designed with four to seven points, is extensively used in social work research. Usually considered an interval scale, it is an ordinal scale where mathematical operations cannot be performed. The researchers made use of the 4-point Likert that forces the respondents to make a view on the questions provided in the survey questionnaire.

Furthermore, the survey questions were designed to explore the potential consequences and dangers of uncontrolled intersections and signalized intersections in the city.

2.4 Statistical Treatment

This study utilized different statistical tools in interpreting the collected data. The data interpreted helped to achieve the purpose of the study. The researchers used the following statistical tools.

Weighted Mean. The weighted mean is calculated by multiplying each data point in a set by a value given by some aspect of whatever contributed to the data point.

$$W = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i}$$

Where w_i is the weights applied to x-values, X_i is the data values to be averaged, and n is the number of terms to be averaged.

Likert Scale. A psychometric scale is applied as a fundamental and frequently used tool in educational and social sciences research (Joshi et al., 2015). It is a widely used approach to scaling with the use of questionnaires.

Table.2. Verbal Interpretation of Mean of Levels of Agreement

Ratings	Interval	Interpretation
4	3.26 – 4.00	Agree
3	2.51 – 3.25	Somewhat Agree
2	1.76 – 2.50	Somewhat Disagree
1	1.00 – 1.75	Disagree

Standard Deviation. Is a measure of the data's dispersion in relation to the mean. A low standard deviation suggests that data is grouped around the mean, whereas a significant standard deviation shows that data is more spread out. A standard deviation near 0 suggests that data points are closed to the mean, whereas a high or low standard deviation indicates that data points are above or below the mean, respectively.

$$\sigma = \sqrt{\frac{\sum(x - \bar{x})^2 f}{n - 1}}$$

Where x is the data point, $\bar{x}$ is the mean, f is the frequency, and n is the total sample size.

Independent Sample T-Test. Is a parametric test where it compares the means of two independent groups in order to determine whether there is statistical evidence that the associated population means are significantly different.

$$t = \frac{\bar{x}_1 - \bar{x}_2 - \Delta}{s_p \cdot \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where:

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_1^2}{n_1 + n_2}}$$

Where n_1 is the 1st sample size, $\bar{x}_1$ is the 1st sample mean, s_1 is the 1st sample standard deviation, n_2 is the 2nd sample size, $\bar{x}_2$ is the 2nd sample mean, s_2 is the 2nd sample standard deviation, and Δ is the hypothesis mean difference.

Moreover, the Statistical Package for the Social Sciences (SPSS) was utilized to ensure the correct analysis of the gathered data. The SPSS is a software program created for the statistical analysis of social science data. Also, this program is primarily used by many researchers for complicated data analysis.

III. RESULTS AND DISCUSSION

This section presents the results obtained from the survey questionnaires and the discussion of every part. The results were based on the responses of the respondents regarding the contributing factors to the intersections. The researchers used tables, followed by an explanation for a better understanding.

3.1 Drivers' Responses on the Category of Signalized Intersection at Brgy. Del Rosario in City of San Fernando, Pampanga

In the category of "Signalized Intersection", the researchers selected a total of two hundred (200) drivers who travel through the intersection of Brgy. Del Rosario, CSFP. The respondents answered four (4) parts of the questionnaire: Mobility, Traffic Control, Road Condition, and Behavior.

Table.3. Summary of Responses of Drivers in Signalized Intersection in Mobility

Statement	Mean	SD	Interpretation
1. The abundance of private vehicles traveling in an intersection significantly impacts other vehicle's movements.	3.67	0.66	Agree
2. The Public Utility Jeepneys (PUJ), which load and unload passengers near the intersection, influence the slow movement of other vehicles.	3.50	0.82	Somewhat Agree
3. Due to the no-coding policy in Pampanga, many vehicles move freely every day, clogging roads, particularly intersections.	3.68	0.69	Agree
4. Due to the unexpected actions of every individual crossing the pedestrian, drivers will suddenly stop, which can cause danger to both the driver and the pedestrians.	3.77	0.61	Agree
5. Crossing the intersections during rush hours is difficult due to the high number of vehicles.	3.79	0.56	Agree
Overall Mean	**3.68**	**0.67**	**Agree**

Table 3 shows that *"5. Crossing the intersections during rush hours is difficult due to the high number of vehicles."* has the

highest mean score of 3.79 with a standard deviation of 0.56 or interpreted as Agree, while *"2. The Public Utility Jeepneys (PUJ), which load and unload passengers near the intersection, influence the slow movement of other vehicles."* has the lowest mean score of 3.50 with the standard deviation of 0.82 or interpreted as Somewhat Agree. In summary, the respondent's perception of "Mobility" has an overall mean of 3.68 with a standard deviation of 0.67 or interpreted as Agree.

Table.4. Summary of Responses of Drivers in Signalized Intersection in Traffic Control

Statement	Mean	SD	Interpretation
1. The lack of signage at pedestrian crossings near intersections raises the risk of an accident.	3.86	0.38	Agree
2. The absence of lighting at pedestrian crossings near intersections raises the risk of an accident.	3.77	0.50	Agree
3. The time allotted to traffic lights is sufficient to accommodate all vehicles crossing intersections.	3.56	0.71	Agree
4. Different sizes of each mode of transportation must be controlled to lessen the risk/harm that might happen.	3.59	0.67	Agree
5. The traffic enforcers help to decrease traffic congestion and improve the flow of vehicles through an intersection.	3.74	0.65	Agree
Overall Mean	**3.70**	**0.58**	**Agree**

Table 4 shows that *"1. The lack of signage at pedestrian crossings near intersections raises the risk of an accident."* has the highest mean score of 3.86 with a standard deviation of 0.38 or interpreted as Agree, while *"3. The time allotted to traffic lights is sufficient to accommodate all vehicles crossing intersections."* has the lowest mean score of 3.56 with the standard deviation of 0.71 or interpreted as Agree.

In summary, the respondent's perception on "Traffic Control" has an overall mean of 3.70 with a standard deviation of 0.58 or interpreted as Agree.

Table.5. Summary of Responses of Drivers in Signalized Intersection in Road Condition

Statement	Mean	SD	Interpretation
1. The uneven road surface affects the speed of the vehicles crossing the intersection.	3.90	0.35	Agree
2. Slippery roads caused by natural phenomena, man's action, unexpected spills, etc., can lead to uncontrolled movement of vehicular wheels, especially motorcycles.	3.66	0.57	Agree
3. Road lines at intersections that are not visible at night affect the speed, causing traffic delays.	3.75	0.55	Agree
4. The improper position of barricades limiting the space of roads and drivers is dangerous.	3.72	0.63	Agree
5. The road space available for right-turning vehicles is limited, resulting in a slow traffic flow.	3.71	0.63	Agree
Overall Mean	**3.75**	**0.54**	**Agree**

Table 5 shows that *"1. The uneven road surface affects the speed of the vehicles crossing the intersection."* has the highest mean score of 3.90 with a standard deviation of 0.35 or interpreted as Agree, while *"2. Slippery roads caused by natural phenomena, man's action, unexpected spills, etc., can lead to uncontrolled movement of vehicular wheels, especially motorcycles."* has the lowest mean score of 3.66 with the standard deviation of 0.57 or interpreted as Agree.

In summary, the respondent's perception on "Road Condition" has an overall mean of 3.75 with a standard deviation of 0.54 or interpreted as Agree.

Table.6. Summary of Responses of Drivers in Signalized Intersection in Behavior

Statement	Mean	SD	Interpretation
1. The conflicts with other motorists can cause misunderstanding which may lead to accident.	3.89	0.35	Agree
2. The inattentiveness of motorists to traffic lights and when crossing intersections affects the movement of vehicles.	3.87	0.36	Agree
3. The inability to decide quickly of motorists on when to give way or stop in an intersection can create confusions that lead to an accident.	3.85	0.38	Agree
4. A motorist who lacks knowledge of traffic rules increases the risk of an accident.	3.92	0.30	Agree
5. A person under the influence of alcohol and drugs creates problems with their co-drivers, leading to misunderstandings and accidents.	3.96	0.20	Agree
Overall Mean	**3.90**	**0.32**	**Agree**

Table 6 shows the respondents' answers on "Behavior". Based on the results, *"5. A person under the influence of alcohol and drugs creates problems with their co-drivers, leading to misunderstandings and accidents."* has the highest mean score of 3.96 with a standard deviation of 0.20 or interpreted as Agree, while *"3. The inability to decide quickly of motorists on when to give way or stop in an intersection can create confusions that lead to an accident."* has the lowest mean score of 3.85 with the standard deviation of 0.38 or interpreted as Agree. In summary, the respondent's perception on "Road Condition" has an overall mean of 3.90 with a standard deviation of 0.32 or interpreted as Agree.

3.2 Drivers' Responses on the Category of Uncontrolled Intersection at Brgy. Dolores in City of San Fernando, Pampanga

In the category of "Uncontrolled Intersection", the researchers selected a total of two hundred (200) drivers who travel through the intersection of Brgy. Dolores, CSFP. The respondents answered three (3) parts of the questionnaire: Mobility, Road Condition, and Behavior.

Table.7. Summary of Responses of Drivers in Uncontrolled Intersection in Mobility

Statement	Mean	SD	Interpretation
1. The abundance of private vehicles traveling in an intersection significantly impacts other vehicle's movements.	3.50	0.83	Somewhat Agree
2. The Public Utility Jeepneys (PUJ), which load and unload passengers near the intersection, influence the slow movement of other vehicles.	3.48	0.92	Somewhat Agree
3. Due to the no-coding policy in Pampanga, many vehicles move freely every day, clogging roads, particularly intersections.	3.53	0.83	Agree
4. Due to the unexpected actions of every individual crossing the pedestrian, drivers will suddenly stop, which can cause danger to both the driver and the pedestrians.	3.27	0.92	Somewhat Agree
5. Crossing the intersections during rush hours is difficult due to the high number of vehicles.	3.49	0.82	Somewhat Agree
Overall Mean	**3.45**	**0.86**	**Somewhat Agree**

Table 7 shows that *"3. Due to the no-coding policy in Pampanga, many vehicles move freely every day, clogging roads, particularly intersections."* has the highest mean score of 3.53 with a standard deviation of 0.83 or interpreted as Agree, while *"4. Due to the unexpected actions of every individual crossing the pedestrian, drivers will suddenly stop, which can cause danger to both the driver and the pedestrians."* has the lowest mean score of 3.27 with the standard deviation of 0.92 or interpreted as Somewhat Agree. In summary, the respondent's perception on "Mobility" has an overall mean of 3.45 with a standard deviation of 0.86 or interpreted as Somewhat Agree.

Table.8. Summary of Responses of Drivers in Uncontrolled Intersection in Road Condition

Statement	Mean	SD	Interpretation
1. The uneven road surface affects the speed of the vehicles crossing the intersection.	3.75	0.54	Agree
2. Slippery roads caused by natural phenomena, man's action, unexpected spills, etc., can lead to uncontrolled movement of vehicular wheels, especially motorcycles.	3.52	0.82	Agree
3. Road lines at intersections that are not visible at night affect the speed, causing traffic delays.	3.55	0.79	Agree
4. The improper position of barricades limiting the space of roads and drivers is dangerous.	3.34	0.86	Somewhat Agree
5. The road space available for right-turning vehicles is limited, resulting in a slow traffic flow.	3.36	0.90	Somewhat Agree
Overall Mean	**3.50**	**0.78**	**Agree**

Table 8 shows that *"1. The uneven road surface affects the speed of the vehicles crossing the intersection."* has the highest mean score of 3.75 with a standard deviation of 0.54 or interpreted as Agree, while *"4. The improper position of barricades limiting the space of roads and drivers is dangerous."* has the lowest mean score of 3.34 with the standard deviation of 0.86 or interpreted as Somewhat Agree. In summary, the respondent's perception on "Road Condition" has an overall mean of 3.50 with a standard deviation of 0.78 or interpreted as Agree.

Table.9. Summary of Responses of Drivers in Uncontrolled Intersection in Behavior

Statement	Mean	SD	Interpretation
1. The conflicts with other motorists can cause misunderstanding which may lead to accident.	3.57	0.72	Agree
2. The inattentiveness of motorists to traffic lights and when crossing intersections affects the movement of vehicles.	3.63	0.60	Agree
3. The inability to decide quickly of motorists on when to give way or stop in an intersection can create confusions that lead to an accident.	3.55	0.71	Agree
4. A motorist who lacks knowledge of traffic rules increases the risk of an accident.	3.74	0.56	Agree
5. A person under the influence of alcohol and drugs creates problems with their co-drivers, leading to misunderstandings and accidents.	3.84	0.46	Agree
Overall Mean	**3.66**	**0.61**	**Agree**

Table 9 shows that *"5. A person under the influence of alcohol and drugs creates problems with their co-drivers, leading to misunderstandings and accidents."* has the highest mean score of 3.84 with a standard deviation of 0.46 or interpreted as Agree, while *"3. The inability to decide quickly of motorists on when to give way or stop in an intersection can create confusions that lead to an accident."* has the lowest mean score of 3.55 with the standard deviation of 0.71 or interpreted as Agree. In summary, the respondent's perception of "Behavior" has an overall mean of 3.66 with a standard deviation of 0.61 or interpreted as Agree.

Table.10. Calculated t-value and p-value

Factors	t-value	p-value	Remarks
Mobility	2.980	0.003	Significant
Road Condition	3.720	0.000	Significant
Behavior	4.920	0.000	Significant

Table 10 shows the results of differentiating the Signalized Intersection at Brgy. Del Rosario and Uncontrolled Intersection at Brgy. Dolores, CSFP in terms of Mobility, Road Condition, and Behavior by using independent t-test at 0.05 level of significance.

The study's findings showed a significant difference between the uncontrolled intersection at Brgy. Dolores and the signalized intersection at Brgy. Del Rosario to the factors that contribute to hazards in terms of Mobility ($t = 2.980$, $p = 0.003$), Road Condition ($t = 3.720$, $p = 0.000$), and Behavior ($t = 4.920$, $p = 0.000$) at 0.05 level of significance. Thus, it can be concluded that Signalized Intersection (Brgy. Del Rosario) has a higher mean score than Uncontrolled Intersection (Brgy. Dolores) regarding Mobility, Road condition, and Behavior.

Meanwhile, the "Traffic Control" factor is not included in the analysis of data in the abovementioned table since it is only relevant to the "Signalized Intersection" category.

IV. Conclusion

In this study, the signalized and uncontrolled intersection of Brgy. Del Rosario and Brgy. Dolores was evaluated. The uncontrolled intersection is described as a road junction that lacks signs and traffic lights, whereas signalized intersections feature both. The researchers identified the contributing factors leading to accidents: Mobility, Traffic Control, Road Condition, and Behavior.

As per the results, drivers agreed that Mobility, Traffic Control, Road Condition, and Behavior are risk-leading variables to accidents at signalized intersections, with "Behavior" having the highest mean score out of the four, which suggests that behavior is the most probable cause of an accident in the area. Meanwhile, the researchers discovered that the drivers somewhat agreed that mobility significantly impacts road users' safety in the uncontrolled intersection. Nonetheless, the researchers determined that respondents agreed that road condition and behavior are crucial to road safety, with "behavior" being the most likely cause of an accident in the area.

In addition, the study concluded that the Signalized Intersection (Brgy. Del Rosario) has a higher mean score than Uncontrolled Intersection (Brgy. Dolores) regarding Mobility, Road Condition, and Behavior.

Consequently, the status of the uncontrolled intersection at Brgy. Dolores and signalized intersections at Brgy. Del Rosario in the City of San Fernando, Pampanga (CSFP) requires improvement and immediate action to meet the needs of all people who use the intersections. Thus, the researchers used the collected data to develop a strategy to reduce accidents and provide more reliable transportation for road users.

V. RECOMMENDATIONS

The researchers came up with risk-reduction strategies after a systematic analysis of the necessary data. The following solutions were made:

1. Considering the risk-causing factors, specifically Traffic Control and Road Condition, the researchers recommend repairing and having regular maintenance of the following:
    - Traffic Signages
    - Street Lights
    - Roads
    - Road markings

    It is also vital that these are correctly and adequately maintained. Drivers should have a clear view of the road intersection to improve their alertness. Every traffic sign near an intersection should have clear and visible signs indicating the right-of-way, speed limits, and other traffic restrictions, as well as equipping a reflective sticker so that cars can see it easily at night. Furthermore, deteriorated roads increase the likelihood of an accident; hence, road maintenance and adequate construction must be considered.
2. Given that behavior was identified as the most likely cause of accidents in both the area scope, measures such as promoting positive driving behavior must be taken. A transportation safety education program should be provided in which road users, students, and pedestrians who travel daily should participate. The people who abide by the regulations on the road help in preventing the risk of accidents, which benefits the country's economic success.
3. The researchers recommend having a proper promotion of using public transport. The use of public transport helps to reduce road congestion, resulting in the efficient movement of people and goods. Also, public transit is significantly less expensive than driving a private vehicle.
4. Since the study focused on a specific location such as Brgy. Dolores and Brgy. Del Rosario in the City of San Fernando, Pampanga, future researchers could consider investigating intersections in different locations with varying levels of urbanization, infrastructure, and traffic patterns, to understand how contextual factors may influence the contributing factors at intersections. Also, instead of the sole perspective of drivers, future researchers could consider other perspectives of such pedestrians, cyclists, traffic enforcers, and local residents to obtain a more comprehensive understanding of the intersections and their contributing factors.

REFERENCES

[1]. Abdel-Aty, M., & Radwan, A. E. (2000). Modeling traffic accident occurrence and involvement. Accident Analysis & Prevention, 32(5), 633–642.

[2]. Abdullah, P., & Sipos, T. (2022). Drivers' Behavior and Traffic Accident Analysis Using Decision Tree Method. Sustainability, 14(18), 11339.

[3]. Aguilar, M. (2022, April 5). Philippines among top 10 countries with worst road quality, study says. philkotse.com.

[4]. Ateneo de Manila University. (2022, July 1). The Urgent Call for Sustainable Mobility in Our Cities.

[5]. Bathan, A., de Ocampo, J., Ong, J., Gutierrez, A. M. J., Seva, R., & Mariano, R. (2018, March). A predictive model of motorcycle accident involvement using structural equation modeling considering driver personality and riding behavior in Metro Manila. In Proceedings of the International Conference on Industrial Engineering and Operations Management (pp. 1783-1804).

[6]. Briz-Redón, L., Martínez-Ruiz, F., & Montes, F. (2019). Spatial analysis of traffic accidents near and between road

intersections in a directed linear network. Accident Analysis &Amp; Prevention, 132, 105252.
[7]. Bui, Q.T., Rahman, M.T., & Al Mamun, M. (2019). Evaluating the impact of no-coding policy on urban mobility: a case study of Ho Chi Minh City, Vietnam. Transportation Research Procedia, 40, 697-703.
[8]. Burch, T. (2020). Road Conditions and Hazards. Burch Law Firm.
[9]. Chand, A., Jayesh, S., & Bhasi, A. (2021). Road traffic accidents: An overview of data sources, analysis techniques and contributing factors. Materials Today: Proceedings, 47, 5135–5141.
[10]. Chandler, B. E., Myers, M. C., Atkinson, J. E., Bryer, T. E., Retting, R., Smithline, J., Trim, J., Wojkiewicz, P., Thomas, G. B., Venglar, S. P., Sunkari, S., Malone, B. J., & Izadpanah, P. (2013). Signalized Intersections Informational Guide (2nd ed.). US Department of Transportation.
[11]. Chen, H., Chen, Q., Chen, L., & Zhang, G. (2016). Analysis of risk factors affecting driver injury and crash injury with drivers under the influence of alcohol (DUI) and non-DUI. Traffic Injury Prevention, 17(8), 796–802.
[12]. Datta, S., Rokade, S., & Rajput, S. P. S. (2020). Classification of Uncontrolled Intersections Using Hierarchical Clustering. Arabian Journal for Science and Engineering, 45(10), 8591–8606.
[13]. De Leon, M. R. M., Cal, P. C., & Sigua, R. G. (2005). Estimation Of Socio-Economic Cost Of Road Accidents In Metro Manila. Journal of the Eastern Asia Society for Transportation Studies, 6, 3183–3198.
[14]. Duda, K., & Sierpiński, G. (2019). Traffic Organisation Problems At Non-Signalised Intersections –Case Studies Of Visibility Distance And 'Give Way' And 'Stop' Road Signs. Scientific Journal of Silesian University of Technology. Series Transport.
[15]. Editage Insights. (2019, May 30). What is the importance of research ethics?
[16]. EPermitTest (2020, October 22). T Intersections: Right of Way Rules and Road Signs.
[17]. Fernandez, J. J., Paringit, M. C., Salvador, J. R., Lucero, P. I., & Galupino, J. G. (2020). Understanding of traffic signs by drivers in the city of Manila, Philippines. Transportation Research Procedia, 48, 3037–3048.
[18]. Global Road Safety Facility. (n.d.). Road Safety Country Profile: Philippines.
[19]. Government of Canada, Statistics Canada. (2021, June 15). Percent Distribution for RTRA.
[20]. Gutierrez, M. (2021, September 16). Road Transport: the advantages and disadvantages | Noatum Logistics. Global.
[21]. Guo, G., & Zhang, Z. (2022). Road damage detection algorithm for improved YOLOv5. Scientific Reports, 12(1).
[22]. Hosseinian, S. H., & Gilani, V. N. M. (2020). Analysis of Factors Affecting Urban Road Accidents in Rasht Metropolis. ENG Transactions, 1, 1–4.
[23]. Jain, U., & Rastogi, R. (2016). Pedestrian crossing warrants – a review of global practices on JSTOR.
[24]. Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert Scale: Explored and Explained. British Journal of Applied Science &Amp; Technology, 7(4), 396–403.
[25]. Kim, C. (2019, September 19). Car Accidents in The Philippines: Causes, Facts & Latest Statistics. philkotse.com.
[26]. Kumar, S. V., Gulati, H., & Arora, S. (2017). Design of a rotary for an uncontrolled multi-leg intersection in Chennai, India. IOP Conference Series: Materials Science and Engineering, 263, 032030.
[27]. Lefevre, S., Laugier, C., & Ibanez-Guzman, J. (2012). Risk assessment at road intersections: Comparing intention and expectation. 2012 IEEE Intelligent Vehicles Symposium.
[28]. Martin, T. L., Solbeck, P., Mayers, D. J., Langille, R. M., Buczek, Y., & Pelletier, M. P. (2013). A Review of Alcohol-Impaired Driving: The Role of Blood Alcohol Concentration and Complexity of the Driving Task. Journal of Forensic Sciences, 58(5), 1238–1250.
[29]. Mihlfeld & Associates. (2018). The 6 Modes of Transportation.
[30]. Mitra, S., & Bhowmick, D. (2020). Status of signalized intersection safety-A case study of Kolkata. Accident Analysis &Amp; Prevention, 141, 105525.
[31]. Norwalk: Transportation Management Plan. (n.d.). Intersection Design (Section I, Chapter 1-4).
[32]. Planning Tank. (2016). Intersection Control - Active & Passive control. Transportation.
[33]. Politics of Urban Manila. (n.d.). An Introduction to Manila's Traffic Congestion Issue.
[34]. Resnik, D. B. (2020, December 23). What Is Ethics in Research & Why Is It Important? - by David B. Resnik, J.D., Ph.D. National Institute of Environmental Health Sciences.
[35]. Rifaat, S.M. (2020). Traffic signal timings optimization for congested intersections during peak hours. Ain Shams Engineering Journal, 11(3), 745-755.
[36]. Saharuddin, I. N. A., & Ing, D. S. (2019). Factors Influencing Road Damage in Developing Countries. Int. J. Eng. Res. Manag, 6.
[37]. Sanatizadeh, A. (2017). Contributing Factors on Drivers Yielding Behaviors at Uncontrolled Intersections [Thesis]. University of Wisconsin-Milwaukee.
[38]. Siedlecki, S. L. (2020). Understanding Descriptive Research Designs and Methods. Clinical Nurse Specialist, 34(1), 8–12.
[39]. Sunio, V., Gaspay, S. M., Guillen, M. D., Mariano, P., & Mora, R. (2019). Analysis of the public transport modernization via system reconfiguration: The ongoing case

in the Philippines. Transportation Research Part A-policy and Practice, 130, 1–19.

[40]. Tamayo, A. (2009). Occurrence of Traffic Accidents in the Philippines: An Application of Poisson Regression Analysis. Social Science Research Network.

[41]. Toledo, M. (2022, November 14). Fixing traffic with Smart Urban Mobility. Philstar.com.

[42]. Tomar, I., Sreedevi, I., & Pandey, N. (2022). State-of-Art Review of Traffic Light Synchronization for Intelligent Vehicles: Current Status, Challenges, and Emerging Trends. Electronics, 11(3), 465.

[43]. Touya, G. (2010). A Road Network Selection Process Based on Data Enrichment and Structure Detection. Transactions in GIS, 14(5), 595–614.

[44]. Transportation Engineering Agency. (n.d.). Intersection Design Types of Intersections.

[45]. Tsuboi, T. (2021). Visualization and Analysis of Traffic Flow and Congestion in India. Infrastructures, 6(3), 38.

[46]. Vedagiri, P., & Killi, D. V. (2015). Traffic Safety Evaluation of Uncontrolled Intersections using Surrogate Safety Measures under Mixed Traffic Conditions. Transportation Research Record, 2512(1), 81–89.

[47]. Wang, Y., Yao, Z., Wang, C., Ren, J., & Chen, Q. (2020). The impact of intelligent transportation points system based on Elo rating on emergence of cooperation at Y intersection. Applied Mathematics and Computation, 370, 124923.

[48]. Wu, H., & Leung, S. O. (2017). Can Likert Scales be Treated as Interval Scales? —A Simulation Study. Journal of Social Service Research, 43(4), 527–532.

[49]. World Health Organization (WHO) (2023, February 10). Ensuring ethical standards and procedures for research with human beings.

[50]. Yan, X., Radwan, E., & Abdel-Aty, M. (2005). Characteristics of rear-end accidents at signalized intersections using multiple logistic regression model. Accident Analysis & Prevention, 37(6), 983–995.