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Research Article

Factors and Challenges in Road Crash Incidents: Basis for Enhanced Interventions

William M. Segun, Fermel V. Dela Cruz, Nathaniel S. Golla, Elizabeth B. Villa*

De La Salle University-Dasmarinas, Philippines

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**Corresponding author:*
E-mail:
ebvilla@dlsud.edu.ph

ABSTRACT

This study examined the factors that led to road crash incidents in Metro Manila, focusing on human behavior, public awareness and attitudes, road infrastructure and Mdesign, technological interventions, and the implementation of enforcement measures. The findings indicated that human error was the primary cause of road crashes, with speeding, driving under the influence of alcohol or drugs, distracted driving, failure to adhere to traffic rules, and aggressive driving behaviors identified as significant factors. We also found that road infrastructure and design, public awareness and attitudes, technological interventions, and enforcement measures significantly contribute to road crash incidents.

The study further explored the challenges encountered by the Philippine National Police Highway Patrol Group in reducing road crash incidents. The study identified significant challenges in human behavior, public awareness, road infrastructure and design, technological interventions, and enforcement measures and found strong positive relationships between these factors and road crash incidents. We deemed it crucial to address these challenges to impact road safety and reduce accidents significantly. The research highlighted the importance of addressing human behavior, public awareness, road infrastructure and design, technological interventions, and enforcement measures to enhance road safety and reduce road crash incidents in Metro Manila. By focusing on these factors and addressing the identified challenges, the PNP Highway Patrol Group could implement enhanced interventions and promote a safer transportation environment for all road users.

Keywords: *Road Crash Incidents, Human Behavior, Human Awareness, Road Infrastructure and Design, Technological Intervention, Enforcement Measures, PNP Highway Patrol Group*

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Introduction

Road traffic incidents have a significant economic impact, affecting individuals, families, and nations. Every year, approximately 1.3 million individuals lose their lives due to road crash incidents, and an additional 20 to 50 million suffer injuries globally. These incidents create significant financial burdens, including medical expenses and lost productivity for those injured and their families. According to the World Health Organization (2022), the economic impact of these incidents can represent around 3% of a country's gross domestic product.

In general, road safety depends on three main things: how people behave, what the vehicles are like, and the condition of the roads. While human error plays a significant role, road design and car characteristics can also influence road safety. That is why newer road safety plans, like the Safe System Approach, look at everything together. They aim to enhance the quality of roads, enhance the safety of cars, enforce adherence to rules, and promote caution among road users. According to Faus (2021), using a mix of different safety measures tends to work better at preventing incidents. Road safety involves everything about the roads and what is around them, as Babić (2022) emphasized. Road signs, markings, and signals are all essential parts of the road. From ancient times, people have used basic stuff like trees or stones to mark roads for a long time, mainly to help with directions.

The old way of thinking about road safety—using engineering, education, and enforcement—has dramatically affected the number of incidents worldwide. However, even though we are making more cars and using them more, the number of deadly incidents has not changed much in the last ten years (Mcllroy, 2019).

Peden (2019) noted that since the early 2000s, influential organizations like the United Nations, the World Health Organization, and the World Bank have renewed their focus on road safety. They have prioritized this issue and set ambitious targets to reduce deaths and injuries from road crash incidents by half. These efforts involved global meetings, advocating for action, raising awareness, securing funding, testing different strategies, and tracking progress. Despite some success in certain countries, the number of deaths from road crash incidents has not decreased significantly. To make a substantial impact, there is a need for more training in various countries on implementing comprehensive road safety approaches, especially in low-resource settings. Additionally, there is a call for sustainable transportation ideas and a greater focus on supporting those injured in incidents. There is still considerable work to see a tangible reduction in incidents over the next decade.

Road safety is a significant health problem worldwide, as explained by Jadaan et al. (2018). Lots of people know how severe and costly road crash incidents can be. Safe roads depend on how many cars and how rich a country is. Compared to places like the European Union, places that are still growing have many more incidents per person. The European Union wants to make their roads way safer, aiming for close to zero incidents. However, in developing countries, the number of incidents might stay high unless they take decisive actions to make incidents less severe. The money spent because of incidents is a massive problem in growing countries, making up more than 2% of the money they make from selling things and services—much more than in developed countries.

It is evident that roads, while connecting people, also come with a cost. According to Mohammed et al. (2019), traffic incidents happen when vehicles crash into pedestrians, animals, or obstacles like trees. These collisions can lead to injuries, deaths, and damage to vehicles and property. They are a big problem worldwide, causing loss of life, property damage, and resource use. Surprisingly, even in countries affected by conflicts like Afghanistan, Libya, Pakistan, and Yemen, road crash incidents cause more deaths than wars and legal conflicts combined.

Traffic congestion in urban networks may lead to solid degradation in the utilization of the network infrastructure, which can be mitigated via suitable control strategies. Based on the paper by Baldi et al. (2019) studied and analyzed the performance of an adaptive traffic-responsive strategy that controls the traffic

light parameters in an urban network to reduce traffic congestion. Simulation results obtained using a traffic simulation model of the network in Chania, Greece, an urban traffic network containing many varieties of junction staging, demonstrate the proposed approach's efficiency compared to alternative traffic strategies based on a simplified linear model of the traffic network.

Yu et al. (2023) described that inefficient traffic signals and bus headway control strategies can lead to significant problems, including traffic congestion, bus passenger delays, and bus crowding. Therefore, Yu et al. aimed to manage traffic flow at intersections within large-scale networks, solving the challenge of integrating various objectives. The study employs the Deep Q-Network (DQN) algorithm to navigate the challenges of a continuous state space, with a principal focus on achieving uniform bus traffic via traffic signal control while maintaining traffic efficiency.

The National Highway Traffic Safety Administration (2023) highlighted the significant economic repercussions of road traffic incidents in the United States. Their report in 2019 revealed that these incidents incurred a total cost of $340 billion, encompassing medical expenses, reduced productivity, legal fees, emergency services, insurance administration, traffic congestion, property damage, and workplace disruptions. Specifically, crashes related to speeding caused 10,192 fatalities, 498,000 non-fatal injuries, and an economic toll of $46 billion in 2019. Similarly, incidents involving distracted drivers led to 10,546 deaths, 1.3 million non-fatal injuries, and a financial burden of $98.2 billion that same year.

Moreover, Cooney and Conway (2023) pointed out that millions of individuals operate heavy machinery daily on American roads, making incidents inevitable. Despite a decrease in car incidents to 38,800 fatalities in 2019, the resurgence of travel post-pandemic in 2021 saw a rise in deaths to nearly 43,000. Various factors across different regions contribute to these incidents, such as weather conditions, inadequate road maintenance, malfunctioning traffic signals, and drivers being distracted or impaired.

Securing excessive cargo results from the need to immobilize it during transportation by transporting it in such a way that it remains in an unaltered state of geometry, shape, and dimension, that is, undamaged, and is moved from the source place to its destination, thus not posing any threats to people and means of transport. There are several critical mandatory rules for attaching an oversized load to a given means of transport. First, people should be aware that the load, if incorrectly attached, is a considerable threat to people dealing directly with its transport and to outsiders close to the cargo being carried. An improperly attached load may slip, causing vehicle traffic disruptions and resulting in injury or even death during maneuvers such as emergency braking or accidents. Macioszek (2020).

Kamarudin et al. (2019) highlighted that globally, around 1.17 million people die every year because of road crash incidents, with 70% of these incidents occurring in developing countries. Shockingly, 65% of these deaths involve pedestrians, with 35% being children. Between 23 and 34 million people are hurt in road crash incidents yearly. These incidents are a significant cause of death worldwide, along with chronic diseases like stroke and heart disease. In Malaysia, fatal incidents have increased by 70%, and it is clear that factors like traffic, road design, and the behavior of road users play a significant role in these incidents, especially in specific areas.

It is clear from Goutam (2023) that globally, traffic incidents claim the lives of 1.35 million people a year, with 90% of these tragedies happening in less wealthy nations. Shockingly, traffic injuries rank as a leading cause of death for young people aged 5 to 29, surpassing diseases like diarrheal illnesses or tuberculosis. Despite government efforts and global initiatives, there are still significant gaps in road safety concerning infrastructure, law enforcement, and public awareness. The goal of halving traffic incidents, as outlined in Sustainable Development Goal 3.6, falls short of what is truly needed.

In the Philippines, according to Sabenorio et al. (2023), road traffic incidents in Metro Manila followed a distinct pattern: they steadily increased until the first quarter of 2020, sharply declined to their lowest point in April

2020 during the COVID-19 lockdown, and subsequently partially recovered as restrictions eased. However, these incidents only rebounded to about half their previous levels. Similarly, incidents causing property damage also saw a partial rebound post-lockdown, while those resulting in injuries (both fatal and non-fatal) returned to pre-lockdown levels. Despite an overall decrease in total road crash incidents, the proportion of incidents resulting in injuries notably surged during the lockdown due to reckless driving behaviors.

As highlighted by Macalalag (2021), WHO's World Status Report on Global Road Safety in 2015 recorded 10,379 deaths in the Philippines, with the low-income group being the majority. The Department of Transportation Road Safety Management Group is implementing various laws related to speed limits, motorcycle helmets, drug and drunk driving, seatbelts, and mobile phone usage while driving.

Gumasing (2020), referring to WHO Philippines records, reported a total of 11,264 deaths from road crash incidents, with motorcycles involved in 53% of these cases. The number of injured motorcycle riders and passengers in 2016 reached 28,694.

Anent to it, Lu, S. (2019) found that over 50% of public utility vehicles registered in Metro Manila were buses, and more than 20% were trucks. Many drivers worked over 12 hours a day, and a concerning percentage of road crashes occurred during late hours. Human error, such as drunk driving, running red lights, and sleepiness, accounted for the overwhelming cause of road crashes.

In addition, Lu, J. (2021) conducted a study on patients admitted to the PGH Department of Surgery from 2008 to 2017 due to road crashes in Metro Manila. The majority of these patients were male, with the highest number of admissions and road crash deaths occurring in 2016. Most incidents happened at night, involving motorcycles, and a significant portion of patients were not wearing helmets, with a history of alcohol intake in the majority of cases.

In the CALABARZON Philippines, Velasco et al. (2021) emphasized that larger vehicle sizes lead to more severe incidents, while a driver's age is a significant factor in predicting incident severity. They noted that older drivers are more prone to being involved in critical incidents than younger ones. Additionally, the severity of road traffic incidents is influenced by road congestion, as highly congested roads typically lower driving speeds, thereby reducing incident fatalities.

Furthermore, Abrigo et al. (2021) highlighted weather conditions contributing to increased road traffic incidents. They suggested an intensive driving lessons program, strict implementation of driving licensure enrollment, and meticulous travel planning. Additionally, they recommended real-time monitoring and visualization of weather conditions for safer travel.

In addition, trucks and vans are often implicated in road accidents due to their size, which can lead to blind spots and challenges in navigating through urban areas (Toney-Butler, 2023). Similarly, buses and public utility jeeps (PUJs) are prone to crashes due to frequent stops, passenger loading and unloading activities, and the nature of their operation (Toney-Butler, 2023).

Likewise, according to Francisco (2023), Quezon City has the most road crash incidents in Metro Manila, showing a need for targeted safety measures. Manila and Makati also have significant incidents, reflecting varied traffic patterns and infrastructure challenges. Districts like Pasig, Taguig, and Paranaque also face considerable crash issues. Even smaller areas like Pasay and Mandaluyong are affected, emphasizing the need for specific solutions tailored to each area's dynamics. In contrast, districts like Pateros and Navotas have fewer incidents, suggesting traffic patterns or infrastructure differences. Most road crash incidents are concentrated on national, city, expressways, and barangay roads. These four categories represent vital focus areas for road safety initiatives and interventions, accounting for a significant portion of the incidents (Francisco, 2023).

Furthermore, December is the month with the highest frequency of road crash incidents. This finding suggests that the holiday season, characterized by increased traffic volume due to festivities and travel, poses a higher risk for road accidents (Villanueva, 2015). Specifically, the rush hour period represents the period of peak road activities. The period varies widely

across rural and urban regions, with the peak densities occurring between 6-9 a.m. and 3-7 p.m.

About a quarter of fatal crash injuries occur during the rush hour period (Cook et al., 2021).

Moreover, rear-end collisions are one of the most common types, often occurring due to factors like tailgating, inattention, or driving too fast for the conditions. Side-impact or T-bone collisions follow closely behind and are typically caused by running red lights or failing to yield. Parking lot crashes present another common scenario, occurring in parking lots and leading to various injuries. Single-vehicle crashes, often resulting from driver errors, distractions, or speeding, contribute significantly to accidents.

Additionally, while rare, head-on collisions pose a high level of danger, often linked to confusion or impaired driving (Christy Bieber, 2024). Fatal accidents due to road crashes were also investigated from 2005 to 2014. In all the years, there were a minimum of 204 fatalities, which in 2012 and the year 2014 registered the highest at 418 deaths. This data is only for Metro Manila, the Philippines' capital. Non-fatal accidents were the highest, too, in 2014, registering 16,665 cases. Property damage peaked in 2014 at 73,175 cases (Lu, 2016).

According to Sy (2023), I mentioned that factors such as medical issues, fatigue, and driving under the influence of alcohol contribute significantly to human errors. Besides human error, vehicle defects play a notable role in road crashes in Metro Manila. Issues like brake failures, tire blowouts, or mechanical malfunctions can lead to city road accidents. The condition of the streets also plays a part in road crash incidents. Poor road maintenance, inadequate signage, or slippery surfaces can contribute to accidents in Metro Manila. While human error, vehicle defects, and road conditions are the primary causes, other factors like weather conditions, a lack of enforcement of traffic rules, and infrastructure challenges can also influence the occurrence of road crashes in Metro Manila.

One of the leading causes of road crashes in Metro Manila is inattention while driving. Distractions such as using cell phones, daydreaming, or being preoccupied with other tasks can result in accidents due to the driver's lack of focus on the road and surrounding conditions (Marquez, 2019). By addressing these prevalent human factors through education, enforcement of road safety laws, and promoting responsible driving practices, efforts can be made to reduce road crashes and create a safer road environment in Metro Manila (Marquez, 2019).

According to Crash Science in the Classroom (2021), the time of occurrence, such as the day of the week or time of day, can impact road crash incidents due to varying traffic volumes, driver behaviors, and environmental conditions. For instance, during rush hour, there may be higher incidences of crashes due to increased congestion and driver stress levels. Moreover, the type of collision, whether it involves a motor vehicle and a fixed object, pedestrian incidents, or multiple distractions, can significantly influence the severity and outcome of road crashes.

Moreover, the causes of road crashes are identified as another significant factor contributing to crash outcomes. This suggests that addressing underlying causes such as driver behavior, road conditions, or environmental factors is essential for mitigating the severity of road crashes and improving overall safety. Travelers (2023) mentioned that various factors contribute to road crashes, including distracted driving, speeding, drunk driving, road infrastructure issues, unsafe vehicles, and inadequate law enforcement. Each of these factors plays a crucial role in the occurrence and severity of road accidents, impacting the safety of all road users.

Lee et al. (2023) stated that while the month of occurrence does not significantly affect crash outcomes, various factors that could influence this relationship must be considered. Moreover, the month of occurrence can also be indirectly linked to driver behavior, such as increased travel during holiday seasons or different road conditions during specific months.

Macalalag (2021) stressed the importance of proactive law enforcement by the Department of Transportation Road Safety Management group. This includes rigorous enforcement of speed limits, mandatory use of motorcycle helmets, strict measures against drug and

alcohol use while driving, seatbelt enforcement, and regulations on mobile phone usage. Velasco et al. (2021) also recommended driver's license renewal, pointing out the strong correlation between age and incident severity.

However, despite these efforts, there is a significant challenge in current road safety strategies—a lack of in-depth understanding regarding the factors contributing to incidents. Existing strategies struggle to uncover specific reasons behind incidents, leading to continued high incident rates. There is a clear need for a more targeted approach that delves into the intricate interplay of psychological, infrastructural, and systemic factors influencing incidents. Bridging this gap requires focused research to unravel these complexities and tailor interventions effectively for a safer road environment. Only by gaining deeper insights into these factors can interventions be finely tuned to prevent incidents effectively.

To address these concerns, this study is a tool for reviewing and revising the existing PNP Police Operational Procedures by investigating the factors contributing to road crash incidents. Moreover, the research intends to optimize the effectiveness of the solutions implemented by the PNP Highway Patrol Group and propose recommendations for enhancing road safety measures.

In response, the Philippine National Police Highway Patrol Group (PNP-HPG) operates as a dedicated unit with a clear mission: ensuring road safety. Their primary focus is enforcing highway traffic laws, which are crucial in upholding order and security for everyone using the roads. Their duties span various aspects of road safety, from enforcing traffic regulations to promptly responding to incidents. When incidents occur, the PNP-HPG takes charge, offering aid to those involved and conducting thorough investigations to understand the causes, aiming to prevent similar occurrences. In addition to their responsive actions, the PNP-HPG regularly patrols highways, actively monitoring and regulating traffic to deter violations and improve safety. Through public awareness campaigns, they educate people about traffic rules and safe driving practices.

Collaborating with other government bodies and local communities contributes to a comprehensive and practical approach to road safety. Their efforts extend beyond enforcement, encompassing education and collaboration to create safer roads for everyone.

Furthermore, this research holds significant value for the community. Its findings can address the factors underlying road crash incidents and the implementation of practical solutions, resulting in reduced injuries, fatalities, and property damage. This can contribute to safer road environments, increased public confidence, and an improved quality of life for the community, including drivers, pedestrians, and passengers. The research findings will also provide the Philippine National Police Highway Patrol Group with valuable insights into the factors contributing to road crash incidents. This knowledge will enable data-driven decision-making, developing targeted strategies, and effectively implementing solutions to prevent incidents and enhance road safety. This, in turn, will strengthen their capacity to maintain law and order on the roads.

Furthermore, this research will benefit the healthcare sector and emergency response systems. Reducing the frequency and severity of road crash incidents will decrease the burden on healthcare facilities and emergency responders. This can lead to more efficient resource allocation and improved response times, ultimately resulting in better healthcare outcomes for incident victims.

Lastly, this study will offer valuable insights to government officials and policymakers responsible for formulating road safety policies and regulations. The research findings can inform evidence-based policies and interventions by shedding light on the root causes of road crash incidents. Policymakers can craft more comprehensive and targeted road safety initiatives by optimizing solutions developed by the PNP Highway Patrol Group.

Generally, the study aimed to investigate the factors contributing to road crash incidents and optimize the solutions provided by the PNP Highway Patrol Group.

Specifically, it aimed to answer the following questions;

1. What factors are contributory to the road crash incidents in terms of the following variables;

1.1. Human behavior;
1.2. Public awareness and attitudes;
1.3. Road Infrastructure and Design;
1.4. Technological interventions; and
1.5. Enforcement measures implemented

2. What are the challenges encountered by the Philippine National Police Highway Patrol Group in the reduction of road crash incidents?

Theoretical Framework

The Systems Theory Approach, pioneered by Ludwig von Bertalanffy, provided a holistic framework for understanding and addressing complex, interconnected problems by examining the relationships between components of a system. In the dissertation "Factors Contributing to Road Crash Incidents: Basis for the PNP Highway Patrol Group Enhanced Interventions," this approach analyzes the multifaceted causes of road crash incidents —including environmental, technological, human factors, and other allied factors. By viewing road safety through the lens of Systems Theory, the research proposes comprehensive, integrated solutions that the Philippine National Police Highway Patrol Group can implement to minimize road crash incidents effectively.

The framework described in Figure 1 revolves around Road Crash Incidents, with five major contributory factors: Human Behavior, Public Awareness and Attitudes, Technological Interventions, Road Infrastructure and Design, and Enforcement Measures Implemented.

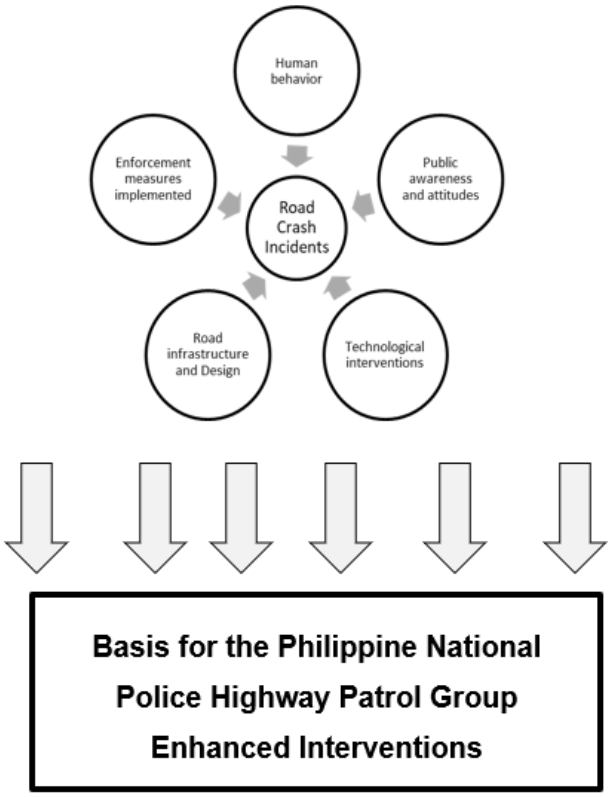

Figure 1. Research Theoretical Framework

Human Behavior: This factor includes driver error, distraction, intoxication, and fatigue. Human behavior significantly contributes to road crashes, accounting for a substantial proportion of accidents. Improving public awareness and attitudes towards road safety and enforcing traffic laws can help mitigate these risks.

Public Awareness and Attitudes: This factor involves promoting road safety education,

awareness campaigns, and fostering a culture of responsible driving. Raising awareness about the consequences of road crashes and the importance of safe driving can help change attitudes and behaviors, reducing the number of accidents.

Technological Interventions: This factor includes advancements in vehicle safety features, such as autonomous emergency braking, lane departure warnings, and electronic stability control. These technologies can help prevent accidents or reduce their severity. Technological innovations in road infrastructure, such as intelligent transportation systems and innovative traffic management, can improve road safety.

Road Infrastructure and Design: This factor encompasses roadways' design, maintenance, and condition. Road geometry, signage, lighting, and markings can significantly impact road safety. Infrastructure improvements, such as roundabouts and pedestrian-friendly designs, can help reduce accidents and their severity.

Enforcement Measures Implemented: This factor involves implementing and enforcing traffic laws, regulations, and policies. Effective enforcement can help ensure compliance with traffic laws, deter risky behavior and improve road safety. This includes sobriety checkpoints, speed cameras, and road safety campaigns.

Many of these studies have found that more accidents occur when drivers experience considerable anger, leading them to express instrumental or hostile behaviors towards others and commit core errors and traffic violations. Ergo, aggressive behaviors are positively associated with the probability of causing traffic accidents, making such behavior relevant to road safety and studying road crashes explained by human factors. In this sense, while anger and aggressive driving can help explain many global accidents, strategies such as road safety education and training, psychotherapy, and anger-management interventions may reduce crash rates and the risky behaviors preceding them. Montoro et al. (2018).

To strengthen the framework described in Figure1, particularly the road infrastructure and design and enforcement measures implemented, the Asian Development Bank released a Compendium of Best Practices in Road Asset Management (2018), which discussed thoroughly road asset management based on an analysis of road data related to inventory, condition, traffic, unit costs, and road deterioration models. The data is entered into a Road Asset Management System (RAMS) that allows the data to be analyzed and optimal budget levels and allocations to be determined.

However, road asset management is more than just the RAMS. It includes the integration of the RAMS into the broader context of structures and procedures within which it operates, complementing the economic optimization criteria of the RAMS with other policy objectives (e.g., connectivity, accessibility, road safety).

A RAMS includes any system used to collect, store, and process road and bridge inventory, condition, traffic, and related data for road planning and programming purposes. A RAMS generally involves a computerized road asset management system, encompassing data collection, data management (database), and data analysis. However, the RAMS cannot be seen separately from the context it operates in, and the term road asset management will, therefore, have a broader focus, including the integration of the RAMS into the institutional framework, road network planning, and programming systems, road sector financing and budget allocation procedures, and implementation of road repair and maintenance. Road asset management looks at developing appropriate business processes that allow the RAMS to be used effectively to execute the business needs of the entity responsible for the road network.

Given the article of Świtała & Ledwolorz (2023), which highlights the function of IT systems for the maintenance and development of the road network managed by local government units, starting in their research, the authors were operating under the assumption that nowadays, IT systems should play an essential role in solving problems related to the management of road infrastructure. The applied research method took the form of a survey, and the research sample consisted of 100

local government units acting as administrators of the road network, i.e., administrators of municipal roads (AMR), county roads (ACR) and operating within cities with independent county rights (ACCR). The research results indicate that few administrators utilize integrated information systems in practice. Their users were mainly representatives of the ACCR group, who use several different support systems daily, with different functionality and usability. The operation of IT systems is mainly used at the level of operational work related to the implementation of ongoing maintenance activities, excluding the possibility of using them in strategic management.

By addressing these five factors and their interconnections, the Philippine National Police Highway Patrol Group can initiate enhanced interventions to reduce road crash incidents, ultimately contributing to a safer and more secure transportation environment.

Methods

Research methodology constituted the procedural framework governing the execution of a research study. It encompassed a set of tools and techniques to undertake a specific investigation or inquiry. Research methods included a diverse array of instruments employed for various types of research endeavors. Therefore, the selection of an appropriate method that aligned with the research objectives became paramount. Within this segment, the researcher outlined the elements into two categories: the data collection approach and the data analysis method.

Population and Sampling Technique

The study's respondents were the graduating police trainees of PSBRC of NPTI at the National Capital Region Training Center (NCRTC) located at Camp Bagong Diwa Bicutan Taguig City. The study was participated in by 218 trainees, who represented the population of 503 students from 11 classes of PSBRC for CY 2022. A valid sample size was generated using the Qualtrics online sample generator, and a stratified simple random sampling technique was applied to choose respondents to ensure a proportional distribution between Criminology and non-criminology graduates and police trainees. Everyone has an equal chance to participate in the study.

Research Design

The research design served as a blueprint for the planned and carried out study. It covered four key aspects: the plan, the framework, who and what to study, and the methods for collecting and analyzing information. The study used a quantitative research design to identify the factors contributing to road crash incidents in the Philippines and to propose interventions that could help minimize or eliminate these incidents. The study used quantitative data collection methods, including surveys, interviews, and data analysis. These quantitative data collection methods provided numerical data that could be analyzed statistically, offering in-depth insights into the experiences, behaviors, and perspectives of individuals or groups related to road crash incidents.

Research Locale

The research took place in the National Capital Region (NCR), also known as Metro Manila, which served as the vibrant and bustling epicenter of the Philippines. This region, located on Luzon Island, included Manila, the capital city, along with sixteen (16) nearby cities and towns. It spanned about 619 square kilometers and was home to more than 13 million people, making it the most densely populated area in the Philippines (Philippine et al.). This high number of people living in a relatively small space led to many urban and transportation issues, such as traffic jams and road safety problems.

Research Instrument

A self-made questionnaire was used as an instrument to assess the level of satisfaction of police trainees. The respondents rated their satisfaction in the four domains of the PSBRC police training program: (1) Training Management, (2) Program of Instruction, (3) Faculty Members, (4) Facilities, Equipment, and Supplies. 5 Point Likert Scale was used to rate the level of satisfaction with one as the lowest with verbal interpretation of very dissatisfied and five as the highest with verbal interpretation of highly satisfied.

The researcher adapted and customized materials from existing related studies and information from the Police Operational Procedures 2021 and relevant policies implemented by the Philippine National Police and other law enforcement agencies. This helped create the survey questionnaire for the study.

The research instrument comprised three main sections tailored to capture demographic information, assess various factors influencing road crash incidents, and identify challenges faced by the PNP-HPG in mitigating these incidents.

The first section focused on demographic details such as age, gender, address, marital status, education level, job position/rank, and length of service. This information provided context and allowed for subgroup analysis to identify potential demographic patterns in respondents' perceptions and experiences.

The second section delved into the factors contributing to road crash incidents: human behavior, public awareness and attitudes, road infrastructure and design, technological interventions, and enforcement measures. Utilizing a combination of Likert scale questions and open-ended inquiries, this section aimed to gauge respondents' opinions, beliefs, and observations regarding each factor. Likert scale questions assessed the level of agreement or disagreement with statements related to each variable.

The third section addresses the Challenges the PNP-HPG encounters in reducing road crash incidents. Similar to the second section, it employs Likert scale questions. Below are the equivalents.

5- Strongly Agree (SA): This rating suggests that you firmly believe that the particular challenge mentioned is a critical and significant issue that the PNP Highway Patrol Group faces in reducing road crash incidents. You strongly agree that it has a substantial impact on their efforts.

4- Agree (A): This rating indicates that you believe the challenge mentioned is a significant factor that affects the PNP Highway Patrol Group's ability to reduce road crash incidents. You agree that it is a critical issue to address.

3- Neutral (N): A neutral rating implies that you are undecided or have no strong opinion about the mentioned challenge. You neither agree nor disagree with its impact on reducing road crash incidents.

2- Disagree (D): This rating suggests that you believe the challenge mentioned has some relevance but is not a significant obstacle in reducing road crash incidents based on your perspective. You do not entirely agree with the statement.

1- Strongly Disagree (SD): This rating indicates that you strongly believe the specific challenge mentioned is not a significant factor in reducing road crash incidents. You completely disagree with the statement or challenge mentioned.

Population and Sampling Technique

The stratified random sampling technique was employed, a method used in research to ensure that the sample drawn from a population is representative of the population's various subgroups or strata. Key stakeholders, including law enforcement officers, local officials, drivers, and community representatives, were chosen for their expertise and insights on the research topic. The goal was to include four groups: HPG Uniformed Personnel, LTO-NCR, and MMDA Personnel, and select community members as road users. Their demographic information, such as age, sex, marital status, education, position, and length of service, was gathered. Participants were randomly chosen from each group. Analyzing data from these groups separately provided unique insights into road crash incidents. Comparing findings across these groups revealed commonalities and differences, offering a complete understanding of factors contributing to incidents. This comprehensive approach ensured that the Philippine National Police Highway Patrol Group's interventions were well-informed by diverse stakeholder perspectives. Slovin's formula was then applied to calculate sample sizes for each group, ensuring adequate representation and minimizing bias.

Table 1 offers valuable insights into the age distribution of selected respondents across different agencies and community representatives. Among the HPG personnel, the majority are 26 to 30 years old, comprising 63.64% of the total respondents. MMDA personnel also show a similar pattern, with the largest proportion falling within the same age range at 61.49%. On the other hand, LTO personnel have a smaller sample size but still exhibit a higher percentage of respondents aged 26 to 30, at 75%.

The community representatives display a more diverse age distribution. The largest percentage of respondents falls within the 26- —to 30-year-old category, at 48%, followed by 31- —to 35-year-olds, at 20%. However, it is worth noting that there is a significant representation of respondents across various age groups, indicating a broad range of perspectives and experiences within the community.

Table 1. Profile of the selected respondents in terms of age

AGE	HPG-Personnel		MMDA Personnel		LTO Personnel		Community Representative	
	N	%	N	%	N	%	N	%
21 to 25 years old	6	27.27%	34	19.54%	1	25.00%	43	10.75%
26 to 30 years old	14	63.64%	107	61.49%	3	75.00%	192	48.00%
31 to 35 years old	2	9.09%	18	10.34%	0	0.00%	80	20.00%
36 to 40 years old	0	0.00%	3	1.72%	0	0.00%	11	2.75%
41 to 45 years old	0	0.00%	7	4.02%	0	0.00%	42	10.50%
46 to 50 years old	0	0.00%	5	2.87%	0	0.00%	32	8.00%
TOTAL	**22**	**100.00%**	**174**	**100.00%**	**4**	**100.00%**	**400**	**100.00%**

Table 2 provides a comprehensive overview of the selected respondents categorized by sex across different groups. In terms of male respondents, the majority are from the HPG-Personnel group, comprising 86.36% of the total respondents from that group. Similarly, male respondents dominate the MMDA Personnel group, constituting 88.51% of the total respondents. Interestingly, all respondents from the LTO Personnel group are male, making up 100% of the total. Among Community Representatives, males comprise the majority, comprising 88.75% of the total respondents.

Conversely, female representation across the groups is notably lower. In the HPG-Personnel group, female respondents make up 13.64% of the total, while in the MMDA Personnel group, they constitute 11.49%. However, there are no female respondents in the LTO Personnel group, representing 0% of the total. Among Community Representatives, females account for 11.25% of the total respondents.

Table 2. Profile of the selected respondents in terms of sex

SEX	HPG-Personnel		MMDA Personnel		LTO Personnel		Community Representative	
	N	%	N	%	N	%	N	%
Male	19	86.36%	154	88.51%	4	100.00%	355	88.75%
Female	3	13.64%	20	11.49%	0	0.00%	45	11.25%
TOTAL	**22**	**100.00%**	**174**	**100.00%**	**4**	**100.00%**	**400**	**100.00%**

Table 3 presented a breakdown of the selected respondents categorized by civil status across different groups. The majority of respondents across all groups are single, with varying percentages. In the HPG-Personnel group, single individuals make up 86.36% of the total respondents, while in the MMDA Personnel group, they constitute 71.26%.

Similarly, in the LTO Personnel group, the majority are single, comprising 75.00% of the total. Among Community Representatives, the percentage of single respondents is 71.50%.

In terms of married respondents, they form a smaller portion compared to single individuals in each group. In the HPG-Personnel group, married individuals constitute 13.64% of the total respondents, while in the MMDA Personnel group, they make up 26.44%. In the LTO Personnel group, only 25.00% of respondents are married, and among Community Representatives, the percentage of married respondents is 26.75%.

Table 3. Profile of the selected respondents in terms of civil status

CIVIL STATUS	HPG-Personnel		MMDA Personnel		LTO Personnel		Community Representative	
	N	%	N	%	N	%	N	%
Single	19	86.36%	124	71.26%	3	75.00%	286	71.50%
Married	3	13.64%	46	26.44%	1	25.00%	107	26.75%
Legally Separated	0	0.00%	4	2.30%	0	0.00%	7	1.75%
Widow/widower	0	0.00%	0	0.00%	0	0.00%	0	0.00%
TOTAL	**22**	**100.00%**	**174**	**100.00%**	**4**	**100.00%**	**400**	**100.00%**

Legally separated individuals are present in the MMDA Personnel and Community Representative groups, though they represent a tiny proportion of the total respondents in each group: 2.30% and 1.75%, respectively. Lastly, no respondents in any group identify as widowed.

Table 4 provides a breakdown of the selected respondents categorized by educational attainment across different groups. Among the Community Representatives, the highest % of respondents have completed high school, constituting 23.00% of the total. Following this, individuals with a vocational course background represent 20.00% of the respondents. Those with some college education but without a degree or only possessing college undergraduate/BS degree units account for 11.75% of the total. Furthermore, respondents who have completed college and hold a bachelor's degree make up 35.50% of the total.

Table 4. Profile of the selected respondents in terms of educational attainment

EDUCATIONAL ATTAINMENT	HPG Personnel		MMDA Personnel		LTO Personnel		Community Representative	
	N	%	N	%	N	%	N	%
Highschool Graduate	0	0.00%	0	0.00%	0	0.00%	92	23.00%
Vocational Course	0	0.00%	36	20.69%	0	0.00%	80	20.00%
College undergraduate/ BS degree Units	0	0.00%	14	8.05%	0	0.00%	47	11.75%
College graduate/BS degree	22	100.00%	124	71.26%	4	100.00%	142	35.50%
Master's Degree Unit	0	0.00%	0	0.00%	0	0.00%	39	9.75%
Master's degree	0	0.00%	0	0.00%	0	0.00%	0	0.00%
TOTAL	**22**	**100.00%**	**174**	**100.00%**	**4**	**100.00%**	**400**	**100.00%**

In contrast, within the HPG Personnel group, all respondents have completed their college education, with 100.00% holding a bachelor's degree. Similarly, all respondents in the LTO Personnel group hold bachelor's degrees, representing 100.00% of the total.

Interestingly, within the MMDA Personnel group, there is more diversity in educational attainment. While the majority have completed college and hold a bachelor's degree (71.26%), a significant portion have completed vocational courses (20.69%), and a smaller proportion

have completed some college education without a degree (8.05%). Notably, no respondents in any group have completed master's degrees or possess master's degree units.

Table 5 outlined the distribution of selected respondents based on their length of service across different groups. In the HPG-Personnel group, most respondents have served in their positions for 1-5 years, constituting 90.91% of the total. A small percentage of respondents have less than a year of service (4.55%), while a minority have served for 6-10 years (4.55%). Notably, respondents in this group had service lengths of at most ten years.

Table 5. Profile of the selected respondents in terms of length of service

LENGTH OF SERVICE	HPG-Personnel		MMDA Personnel		LTO Personnel	
	N	%	N	%	N	%
Less than a year	1	4.55%	4	2.30%	0	0.00%
1-5 years	20	90.91%	107	61.49%	4	100.00%
6-10 years	1	4.55%	52	29.89%	0	0.00%
11-15 years	0	0.00%	6	3.45%	0	0.00%
More than 15 years	0	0.00%	5	2.87%	0	0.00%
TOTAL	**22**	**100.00%**	**174**	**100.00%**	**4**	**100.00%**

The distribution of length of service is more varied for the MMDA Personnel group. The most significant proportion falls within the 1-5 years category, comprising 61.49% of the total respondents. Additionally, a substantial percentage of respondents have served for 6-10 years (29.89%), while smaller percentages have served for less than a year (2.30%), 11-15 years (3.45%), and more than 15 years (2.87%).

Conversely, in the LTO Personnel group, all respondents have served for either 1-5 years or 6-10 years, with no representation in the other categories. Specifically, 100.00% of respondents in this group fall within the 1-5 years and 6-10 years brackets.

Table 6 presents the profile of selected respondents categorized by designation across different groups. In the HPG-Personnel group, all respondents hold the designation of PNP Officer, constituting 100.00% of the total. This indicates uniformity in the designation within this group, reflecting the specific organizational structure or requirements of the Highway Patrol Group.

Table 6. Profile of the selected respondents in terms of designation

DESIGNATION	HPG-Personnel		MMDA Personnel		LTO Personnel	
	N	%	N	%	N	%
PNP Officer	22	100.00%	0	0.00%	0	0.00%
Traffic Operation Officer	0	0.00%	96	55.17%	0	0.00%
Traffic Aide	0	0.00%	78	44.83%	0	0.00%
Transportation Regulation Officer	0	0.00%	0	0.00%	4	100.00%
TOTAL	**22**	**100.00%**	**174**	**100.00%**	**4**	**100.00%**

Conversely, within the MMDA Personnel group, respondents hold varying designations related to traffic management. The majority, comprising 55.17% of the total, are Traffic Operation Officers, while 44.83% are Traffic Aides. This distribution suggests a division of roles within the MMDA focused on traffic control and management, with different personnel responsible for operational and supportive functions.

Similarly, in the LTO Personnel group, all respondents hold the designation of Transportation Regulation Officer, representing 100.00% of the total. This uniformity in

designation reflects a specific role within the Land Transportation Office related to transportation regulation and enforcement.

Result and Discussion

Investigating the factors contributory to road crash incidents

A. Human Behavior

Table 7 comprehensively assesses various human behavior factors contributing to road incidents in the Philippines.

In the results, speeding emerges as a significant factor contributing to road crash incidents, with a mean score of 4.55 and a relatively low standard deviation of 0.61. This indicates a strong consensus among respondents who strongly agree with this statement. This suggests a widespread acknowledgment of the role of speeding in road accidents within the surveyed population.

McCarty and Kim (2024) mentioned that speeding, aggressive overtaking, tailgating, and failure to follow traffic rules are forms of reckless driving behavior that significantly elevate the chances of collisions.

Similarly, driving under the influence of alcohol or drugs is identified as a significant risk factor, as evidenced by the high mean score of 4.78 and a narrow standard deviation of 0.42, indicating a strong consensus among respondents who strongly agree with this assertion. This underscores the pervasive understanding of the dangers associated with impaired driving due to substance use. McCarty & Kim (2024), operating a vehicle while under the influence of alcohol or drugs impairs judgment, coordination, and reaction times, posing a serious hazard on the road.

Table 7. Assessment on human behavior factors that contributory to the road incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Speeding is a major factor contributing to road crash incidents in the Philippines due to human behavior.	4.55	0.61	Strongly Agree
2. Driving under the influence of alcohol or drugs significantly increases the likelihood of road crashes.	4.78	0.42	Strongly Agree
3. Distracted driving, such as texting or talking on the phone while driving, is a common human behavior that leads to road incidents	4.42	0.72	Strongly Agree
4. Failure to follow traffic rules and regulations, such as running red lights or disregarding stop signs, contributes to road crash incidents.	4.72	0.45	Strongly Agree
5. Aggressive driving behaviors, like tailgating and road rage, escalate the risk of incidents on Philippine roads due to human behavior.	4.71	0.45	Strongly Agree
OVERALL	**4.64**	**0.41**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Distracted driving, mainly from texting or talking on the phone while driving, is also recognized as a typical human behavior contributing to road incidents, as indicated by the mean score of 4.42 and a relatively high standard deviation of 0.72. While the mean score suggests a strong agreement, the wider standard deviation implies some variability in

perceptions among respondents, reflecting differing attitudes towards distracted driving. McCarty & Kim (2024), distractions such as smartphone use, daydreaming, or engaging in activities unrelated to driving can lead to inattentiveness on the road, increasing the risk of accidents.

Moreover, failure to adhere to traffic rules and regulations, such as running red lights or disregarding stop signs, emerges as a significant contributing factor to road crash incidents, with a mean score of 4.72 and a narrow standard deviation of 0.45. This indicated a high consensus among respondents who strongly agreed with the importance of compliance with traffic laws to prevent accidents. Ignoring traffic signals, not yielding the right of way, and other violations of traffic laws contribute to road crashes by creating unsafe conditions for all road users. Miran (2023), ignoring traffic signals, not yielding the right of way, and other violations of traffic laws contribute to road crashes by creating unsafe conditions for all road users.

Additionally, aggressive driving behaviors, including tailgating and road rage, are identified as escalating the risk of incidents on Philippine roads due to human behavior, as reflected by the mean score of 4.71 and a narrow standard deviation of 0.45. This suggests a widespread recognition of the negative impact of aggressive driving tendencies on road safety. McCarty and Kim (2024) mentioned that aggressive driving is a form of reckless driving behavior that significantly elevates the chances of collisions.

Overall, the assessment highlighted a strong consensus among respondents regarding the significant role of human behavior factors in contributing to road incidents in the Philippines, as evidenced by the high overall mean score of 4.64 and a relatively low standard deviation of 0.41. Miran (2023) states that human behavior plays a significant role in road crash incidents, with various factors contributing to accidents.

B. Public awareness and attitudes

Table 8 comprehensively assesses public awareness and attitude factors contributing to road incidents in the Philippines. Firstly, the public's lack of awareness about road safety guidelines and practices emerges as a significant factor contributing to road crash incidents, with a mean score of 4.50 and a relatively moderate standard deviation of 0.55. This suggests a strong consensus among respondents who strongly agree that insufficient awareness plays a role in road accidents. Gopalakrishnan (2012) states that education and awareness campaigns are crucial in educating individuals about responsible driving behaviors, traffic law adherence, and the risks associated with reckless driving. By promoting a culture of safety, these initiatives aim to instill a sense of responsibility among road users.

Table 8. Assessment on public awareness and attitudes factors that contributory to the road incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Lack of awareness about road safety guidelines and practices among the public is a significant factor contributing to road crash incidents in the Philippines	4.50	0.55	Strongly Agree
2. A prevailing attitude of complacency towards traffic rules and regulations increases the likelihood of road incidents.	4.48	0.55	Strongly Agree
3. Inadequate education and campaigns regarding road safety lead to misconceptions and ignorance among the public, contributing to road crash incidents.	4.65	0.56	Strongly Agree
4. Public attitudes that prioritize convenience over safety, such as double parking or illegal U-turns, contribute to road incidents in the Philippines	4.48	0.55	Strongly Agree

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
5. Insufficient awareness about the importance of wearing seat belts and helmets further escalates the risk of injuries and fatalities in road crashes.	4.49	0.55	Strongly Agree
OVERALL	**4.52**	**0.50**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Similarly, a prevailing attitude of complacency towards traffic rules and regulations is identified as a contributing factor to road incidents, supported by a mean score of 4.48 and a moderate standard deviation of 0.55. This indicated a widespread acknowledgment among respondents of the impact of complacency on road safety, although there may be some variability in perceptions.

Gopalakrishnan (2012) also mentioned that public attitudes toward road safety, including risk perceptions, compliance with regulations, and consideration for others on the road, can significantly impact driving habits.

Moreover, inadequate education and campaigns regarding road safety are recognized as leading to misconceptions and ignorance among the public, contributing to road crash incidents, as reflected by the mean score of 4.65 and a moderate standard deviation of 0.56. This underscores the importance of robust educational initiatives to enhance public awareness and understanding of road safety principles.

Public attitudes prioritizing convenience over safety, such as double parking or illegal U-turns, are also identified as contributing factors to road incidents in the Philippines, supported by a mean score of 4.48 and a moderate standard deviation of 0.55. This highlighted the need to promote a shift in attitudes towards prioritizing safety over convenience to mitigate the risk of accidents.

Additionally, insufficient awareness about the importance of wearing seat belts and helmets is noted to escalate further the risk of injuries and fatalities in road crashes, as indicated by the mean score of 4.49 and a moderate standard deviation of 0.55. This underscores the importance of targeted campaigns and enforcement measures to promote compliance with safety regulations. Involving communities in road safety efforts through programs like neighborhood watch, advocacy groups, and local partnerships enhances public awareness and fosters a shared responsibility for road safety (World Health Organization, 2023).

Overall, the assessment indicated a strong consensus among respondents regarding the significant role of public awareness and attitude factors in contributing to road incidents in the Philippines, as evidenced by the high overall mean score of 4.52 and a moderate standard deviation of 0.50. Thus, public awareness and attitudes are pivotal in shaping road safety outcomes (Mid-Hudson News, 2024).

C. Road infrastructure and Design

Table 9 comprehensively assessed road infrastructure and design factors contributing to road incidents in the Philippines. Firstly, poor road maintenance, including issues like potholes and uneven surfaces, is identified as a significant contributor to road crash incidents, with a mean score of 4.68 and a moderate standard deviation of 0.57. This indicated a strong consensus among respondents who strongly agree that inadequate road maintenance poses risks to road users and contributes to accidents.

Table 9. Assessment on road infrastructure and design factors that contributory to the road incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Poor road maintenance, such as potholes and uneven surfaces, contributes to road crash incidents in the Philippines.	4.68	0.57	Strongly Agree
2. Lack of proper road signage and markings leads to confusion among drivers and increases the risk of incidents.	4.42	0.68	Strongly Agree
3. Inadequate street lighting on roads results in decreased visibility, especially at night, leading to a higher incidence of road crashes.	4.67	0.47	Strongly Agree
4. Deficient pedestrian infrastructure, like poorly maintained sidewalks and lack of pedestrian crossings, poses hazards that contribute to road incidents.	4.64	0.53	Strongly Agree
5. Insufficient or outdated road design that does not account for increasing traffic volumes and changing vehicle dynamics further exacerbates road crash incidents in the Philippines.	4.64	0.48	Strongly Agree
OVERALL	**4.61**	**0.48**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Similarly, the lack of proper road signage and markings is recognized as a factor leading to confusion among drivers and increasing the risk of incidents, as evidenced by the mean score of 4.42 and a moderate standard deviation of 0.68. This underscores the importance of clear and visible signage for enhancing road safety and effectively guiding drivers.

Deficient pedestrian infrastructure, such as poorly maintained sidewalks and a lack of pedestrian crossings, is also identified as posing hazards contributing to road incidents, with a mean score of 4.64 and a moderate standard deviation of 0.53. This underscores the need for improved infrastructure to ensure the safety of pedestrians and reduce the risk of accidents.

Additionally, insufficient or outdated road design that fails to account for increasing traffic volumes and changing vehicle dynamics exacerbates road crash incidents in the Philippines, as reflected by the mean score of 4.64 and a moderate standard deviation of 0.48. This highlighted the importance of incorporating modern design principles and considering future traffic patterns in road infrastructure projects.

Pembuain et al. (2019) state that various elements in road infrastructure formation can increase the risk of traffic accidents. Factors such as inadequate sight distance, poor safety barrier installations, improper alignment, presence of hazards by the roadside, lack of drainage, and insufficient road features for pedestrians and cyclists can contribute to accidents.

Ahmed (2013) argues that proper planning, designing, constructing, and maintaining road infrastructure is essential for enhancing road safety135. Elements like road geometry, signage, road surface conditions, visibility, and separation of different road users play a crucial role in preventing accidents and reducing their impact.

Overall, the assessment indicated a strong consensus among respondents regarding the

significant role of road infrastructure and design factors in contributing to road incidents in the Philippines, as evidenced by the high overall mean score of 4.61 and a moderate standard deviation of 0.48. Road infrastructure and design play a critical role in road safety and can significantly impact the occurrence and severity of road crash incidents (World Bank Group, n.d.).

D. Technological Intervention

Table 10 assesses technological intervention factors contributing to road incidents in the Philippines. Firstly, the inadequate implementation of advanced safety technologies, such as Anti-lock Braking Systems (ABS) and Electronic Stability Control (ESC), is identified as hindering the reduction of road crash incidents, with a mean score of 4.00 and a relatively high standard deviation of 1.04. This suggests a general agreement among respondents that the lack of proper implementation of these technologies poses challenges to improving road safety, although some perceptions may vary.

Similarly, the limited use of technologies like speed limit monitoring systems or lane departure warning systems is recognized as contributing to a higher prevalence of incidents on Philippine roads, as evidenced by the mean score of 3.83 and a relatively high standard deviation of 1.42. This indicated a consensus among respondents that greater adoption of these technologies could help mitigate road incidents, albeit with differing opinions.

Moreover, the insufficient adoption of automated enforcement systems, such as red-light and speed cameras, contributes to the high rate of road crash incidents in the country, supported by a mean score of 3.87 and a relatively high standard deviation of 1.45. This suggests a general acknowledgment of the role of automated enforcement in enhancing road safety, although opinions may vary regarding its effectiveness.

Additionally, the need for more investment in intelligent transportation systems, including traffic management software and vehicle-to-infrastructure communication, is identified as impairing overall road safety measures in the Philippines, with a mean score of 4.40 and a relatively low standard deviation of 0.54. This indicated a strong consensus among respondents who strongly agreed with the importance of investing in these systems to improve road safety.

Table 10. Assessment on technological intervention factors that contributory to the road incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Inadequate implementation of advanced safety technologies, such as Anti-lock Braking Systems (ABS) and Electronic Stability Control (ESC), hinders the reduction of road crash incidents in the Philippines.	4.00	1.04	Agree
2. Limited use of technologies like speed limit monitoring systems or lane departure warning systems results in a higher prevalence of incidents on Philippine roads.	3.83	1.42	Agree
3. Insufficient adoption of automated enforcement systems, such as red-light cameras and speed cameras, contributes to the high rate of road crash incidents in the country.	3.87	1.45	Agree
4. Lack of investment in intelligent transportation systems, including traffic management software and vehicle-to-infrastructure communication, impairs the overall road safety measures in the Philippines.	4.40	0.54	Strongly Agree

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
5. Slow integration of emerging technologies like connected vehicles and autonomous driving features delays the potential reduction of road crash incidents in the Philippines.	4.19	0.82	Agree
OVERALL	**4.06**	**0.98**	**AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Furthermore, the slow integration of emerging technologies like connected vehicles and autonomous driving features is noted to delay the potential reduction of road crash incidents in the Philippines, with a mean score of 4.19 and a moderate standard deviation of 0.82. This suggests a general agreement among respondents that faster integration of these technologies could yield benefits for road safety, although some perceptions may vary.

Wheeler (2023), the development of autonomous vehicles holds promise in revolutionizing road safety. These vehicles utilize sensors, cameras, and AI algorithms to navigate roads autonomously, potentially eliminating accidents caused by human factors like fatigue, distraction, or impaired driving. ADAS technologies encompass a range of features such as lane departure warning, adaptive cruise control, automatic emergency braking, blind-spot detection, and more. These systems assist drivers in avoiding collisions, maintaining safe distances, and staying within lanes, thus reducing the risk of accidents caused by human error.

Overall, the assessment indicated a general agreement among respondents regarding the role of technological intervention factors in contributing to road incidents in the Philippines, as evidenced by the overall mean score of 4.06 and a relatively high standard deviation of 0.98. Wheeler (2023), Technological interventions are pivotal in enhancing road safety and reducing the frequency and severity of road crash incidents

E. Enforcement measures implemented

Table 11 presented an assessment of enforcement measures implemented by factors contributing to road incidents in the Philippines. Firstly, inconsistent enforcement of traffic laws and regulations is identified as creating a lenient environment contributing to road crash incidents, with a mean score of 4.09 and a moderate standard deviation of 0.92. This suggests a general agreement among respondents that the lack of consistent enforcement undermines road safety efforts, though opinions may vary to some extent.

Similarly, the lack of enforcement against drunk driving and overspeeding is recognized as allowing dangerous behaviors to persist, thereby increasing the risk of incidents on Philippine roads, as evidenced by the mean score of 4.22 and a moderate standard deviation of 0.92. This indicated a strong consensus among respondents who strongly agreed with the importance of strict enforcement against these behaviors.

Moreover, insufficient penalties for traffic violations are noted to fail to deter reckless driving practices, leading to a higher incidence of road crashes, with a mean score of 3.73 and a relatively high standard deviation of 1.53. This suggests some variability in perceptions regarding the effectiveness of penalties in deterring reckless driving, although there is general agreement that stricter enforcement is needed.

Inadequate monitoring and enforcement of vehicle roadworthiness standards contribute to an increased likelihood of incidents due to

poorly maintained vehicles, supported by a mean score of 4.22 and a moderate standard deviation of 0.83. This underscores the importance of robust enforcement measures to uphold vehicle safety standards.

Table 11. Assessment on enforcement measures implemented factors that contributory to the road incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Inconsistent enforcement of traffic laws and regulations creates a lenient environment that contributes to road crash incidents in the Philippines	4.09	0.92	Agree
2. Lack of enforcement against drunk driving and over speeding allows dangerous behaviors to persist, increasing the risk of incidents on Philippine roads.	4.22	0.92	Strongly Agree
3. Insufficient penalties for traffic violations fail to deter reckless driving practices, leading to a higher incidence of road crashes.	3.73	1.53	Agree
4. Inadequate monitoring and enforcement of vehicle roadworthiness standards result in an increased likelihood of incidents due to poorly maintained vehicles.	4.22	0.83	Strongly Agree
5. Limited enforcement of seat belt and helmet laws leads to non-compliance among drivers and passengers, contributing to the severity of injuries in road crash incidents in the Philippines	4.13	0.99	Agree
OVERALL	**4.08**	**0.94**	**AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Additionally, limited enforcement of seat belt and helmet laws is noted to lead to non-compliance among drivers and passengers, contributing to the severity of injuries in road crash incidents in the Philippines, with a mean score of 4.13 and a moderate standard deviation of 0.99. This highlighted the need for stricter enforcement of safety regulations to improve compliance and mitigate the impact of accidents.

National Highway Traffic Safety Administration (n.d.), strict enforcement of traffic laws is essential for ensuring compliance and deterring risky behaviors. This includes speed enforcement, breathalyzer tests for alcohol-impaired driving, seatbelt and child restraint enforcement, and enforcement of traffic signal violations. Visible and consistent enforcement conveys the importance of obeying traffic laws.

Enforcement measures should create a deterrent effect to be effective. This can be achieved by increasing the perceived likelihood of being caught for traffic violations and imposing appropriate penalties. Higher fines, license suspension, and other consequences for non-

compliance can discourage risky behaviors and promote responsible driving.

Overall, the assessment indicated a general agreement among respondents regarding the role of enforcement measures in contributing to road incidents in the Philippines, as evidenced by the overall mean score of 4.08 and a moderate standard deviation of 0.94. Enforcement measures are crucial in reducing road crash incidents and promoting road safety (National Highway Traffic Safety Administration, n.d.).

F. Summative Assessment

The summative assessment shown in Table 12 provided an overview of factors contributing to road incidents in the Philippines. In the results, human behavior emerges as the primary contributor to road incidents, with a mean score of 4.64 and a narrow standard deviation of 0.41, indicating a strong consensus among respondents who strongly agree with this assessment. This factor ranks first in the assessment, underscoring the importance of addressing human behaviors such as speeding, distracted driving, and aggressive driving tendencies to improve road safety.

Road infrastructure and design follow closely behind, with a mean score of 4.61 and a moderate standard deviation of 0.48, indicating a strong consensus among respondents who strongly agree with the significance of this factor. This highlighted the crucial role of well-maintained roads, proper signage, and pedestrian infrastructure in preventing road incidents and ensuring the safety of road users.

Public awareness is also identified as a significant contributor to road incidents, with a mean score of 4.52 and a moderate standard deviation of 0.50. This suggests a strong consensus among respondents regarding the importance of raising awareness and promoting responsible road behavior. This factor ranks third in the assessment, emphasizing the need for educational campaigns and initiatives to enhance public understanding of road safety principles.

Table 12. Summative assessment on the factors that contributory to the road incidents

	FACTORS	MEAN	SD	VERBAL INTERPRETATION	RANK
1.	Human Behavior	4.64	0.41	Strongly Agree	1
2.	Public Awareness	4.52	0.50	Strongly Agree	3
3.	Road infrastructure and Design	4.61	0.48	Strongly Agree	2
4.	Technological Interventions	4.06	0.98	Agree	5
5.	Enforcement measures applied	4.08	0.94	Agree	4
	OVERALL	**4.38**	**0.52**	**STRONGLY AGREE**	

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Enforcement measures applied are recognized as important contributors to road safety. With a mean score of 4.08 and a moderate standard deviation of 0.94, respondents generally agreed regarding the role of enforcement in reducing road incidents. This factor ranks fourth in the assessment, highlighting the importance of consistent and stringent enforcement efforts to promote compliance with traffic laws and regulations.

Technological interventions rank fifth in the assessment, with a mean score of 4.06 and a relatively high standard deviation of 0.98, indicating some variability in perceptions among respondents. While there is agreement that technological advancements can enhance road safety, there may be differing opinions on their effectiveness and implementation.

Mohanty et al. (2022) stated that drivers' behavior plays a significant role in road inci-

dents. Factors such as speeding, reckless driving, distracted driving, driving under the influence of alcohol or drugs, and fatigue can significantly increase the risk of accidents. The design and condition of roads and infrastructure are critical factors. Poor road maintenance, lack of proper signage, inadequate lighting, confusing intersections, and absence of safety features like guardrails can contribute to road incidents. The condition of vehicles, including maintenance, age, and adherence to safety standards, can impact road safety. Mechanical failures, worn-out tires, faulty brakes, and lack of safety features in vehicles can increase the likelihood of accidents. Apart from driver behavior, other human factors like pedestrian behavior, cyclist behavior, and interactions between different road users can contribute to road incidents. Understanding these dynamics is crucial for improving safety.

The enforcement of traffic laws, effectiveness of penalties, presence of law enforcement officers, and adherence to safety regulations all play a role in preventing road incidents. Vigorous enforcement can deter risky behaviors and promote compliance. He integration of technology, such as advanced driver assistance systems (ADAS), autonomous vehicles, vehicle-to-infrastructure communication, and big data analytics, can enhance road safety by preventing accidents and mitigating risks.

Overall, the summative assessment indicated a strong consensus among respondents regarding the significant role of human behavior, road infrastructure, and design, public awareness, enforcement measures, and technological interventions in contributing to road incidents in the Philippines, with an overall mean score of 4.38 and a narrow standard deviation of 0.52, indicating a high level of agreement across all factors.

Investigating the challenges among the factor's contributory to road crash incidents

A. Human Behavior

Table 13 assessed challenges related to human behavior factors contributing to road crash incidents in the Philippines. Addressing the issue of speeding emerges as a significant challenge, with a mean score of 4.29 and a moderate standard deviation of 0.75. This suggests a strong consensus among respondents regarding the difficulty of effectively tackling speeding behaviors to reduce road crash incidents.

Implementing effective measures to deter and detect driving under the influence of alcohol or drugs is recognized as another significant challenge. This is supported by a high mean score of 4.68 and a narrow standard deviation of 0.47, which indicated a strong consensus among respondents regarding addressing impaired driving behaviors.

Similarly, educating and raising awareness about the dangers of distracted driving, mainly related to phone use, is identified as a significant challenge, with a mean score of 4.69 and a narrow standard deviation of 0.46. This underscores the need for robust educational initiatives to mitigate the risks associated with distracted driving.

Table 13. Assessment on the challenges in human behavior factor contributory to road crash incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Addressing the issue of speeding, which remains a significant factor in road crash incidents	4.29	0.75	Strongly Agree
2. Implementing effective measures to deter and detect driving under the influence of alcohol or drugs.	4.68	0.47	Strongly Agree
3. Educating and raising awareness about the dangers of distracted driving, particularly related to phone use.	4.69	0.46	Strongly Agree
4. Enforcing strict adherence to traffic rules and regulations to reduce incidents caused by non-compliance.	4.72	0.45	Strongly Agree

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
5. Combating aggressive driving behaviors through enforcement and education initiatives to make roads safer for everyone.	4.64	0.62	Strongly Agree
OVERALL	**4.60**	**0.43**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Enforcing strict adherence to traffic rules and regulations to reduce incidents caused by non-compliance is also acknowledged as challenging. With a mean score of 4.72 and a narrow standard deviation of 0.45, respondents strongly agree that stringent enforcement measures are important to promote compliance with traffic laws.

Additionally, combating aggressive driving behaviors through enforcement and education initiatives to make roads safer for everyone is challenging, with a mean score of 4.64 and a moderate standard deviation of 0.62. This highlighted the complexity of addressing aggressive driving tendencies and the need for comprehensive strategies to address this issue.

Miran (2023) mentioned that one of the major challenges is distracted driving, which includes activities like texting, talking on the phone, eating, or adjusting controls while driving. Distractions divert the driver's attention from the road, increasing the risk of accidents. Overcoming the challenge of impaired driving requires effective law enforcement and public awareness campaigns.

Some drivers exhibit risk-taking behaviors like running red lights, ignoring traffic signs, or engaging in dangerous maneuvers (Miran, 2023). Understanding the motivations behind such behaviors and promoting a culture of safe driving practices are essential in addressing this challenge

Overall, the assessment indicated a strong consensus among respondents regarding the challenges associated with human behavior factors contributing to road crash incidents, with an overall mean score of 4.60 and a narrow standard deviation of 0.43.

B. Public Awareness

Table 14 presents a comprehensive assessment of challenges in public awareness and attitudes contributing to road crash incidents in the Philippines. The assessment reveals a consistent and strong consensus among respondents, with mean scores ranging from 4.50 to 4.53 and moderate standard deviations around 0.50 for each indicator, indicating a high level of agreement on the challenges faced.

Firstly, overcoming the public's lack of awareness regarding road safety guidelines and practices emerges as a significant challenge, with a mean score of 4.53. This underscores the critical need for targeted educational initiatives to enhance public understanding and promote safe road behaviors.

Similarly, changing the prevailing attitude of complacency towards traffic rules and regulations is recognized as a crucial challenge, supported by a mean score of 4.50. Addressing this challenge requires concerted efforts to instill a culture of compliance and responsibility among road users.

Developing compelling education and awareness campaigns to address misconceptions and ignorance about road safety is also noted as a priority, with a mean score of 4.52. This highlighted the importance of disseminating accurate information and dispelling myths to promote informed decision-making on the roads.

Encouraging the public to prioritize safety over convenience and comply with traffic regulations to prevent accidents is also a significant challenge, with a mean score of 4.52. This underscores the need to promote a shift in attitudes toward prioritizing safety and compliance with traffic laws.

Furthermore, promoting understanding and adherence to the importance of wearing seat belts and helmets to reduce the severity of injuries in road crashes is highlighted as a crucial endeavor, with a mean score of 4.52. This emphasizes the importance of promoting safety measures to minimize the impact of accidents.

Mid-Hudson News (2024) stated that many individuals may need more knowledge about road safety practices, traffic rules, and the potential risks associated with certain behaviors. This lack of knowledge can contribute to unsafe practices on the road. Public awareness campaigns may face challenges in combating complacency among individuals who believe that road crashes only happen to others and underestimate their vulnerability. Some individuals may need more access to information about road safety due to various factors such as socioeconomic disparities, lack of education, or limited availability of resources. Bridging this information gap is crucial for promoting safer behaviors.

Overall, the assessment indicated a strong consensus among respondents regarding the challenges in public awareness and attitudes contributing to road crash incidents, with an overall mean score of 4.52 and a relatively low standard deviation of 0.49.

Table 14. Assessment on the challenges in public awareness and attitudes factor contributory to road crash incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Overcoming the lack of awareness regarding road safety guidelines and practices among the public	4.53	0.50	Strongly Agree
2. Changing the prevailing attitude of complacency towards traffic rules and regulations to enhance road safety.	4.50	0.50	Strongly Agree
3. Developing effective education and awareness campaigns to address misconceptions and ignorance about road safety.	4.52	0.50	Strongly Agree
4. Encouraging the public to prioritize safety over convenience and comply with traffic regulations to prevent accidents.	4.52	0.50	Strongly Agree
5. Promoting understanding and adherence to the importance of wearing seat belts and helmets to reduce the severity of injuries in road	4.52	0.50	Strongly Agree
OVERALL	**4.52**	**0.49**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

C. Road infrastructure and Design

Table 15 provides a comprehensive assessment of challenges in road infrastructure and design contributing to road crash incidents in the Philippines. The assessment indicated a strong consensus among respondents, with mean scores ranging from 4.46 to 4.48 and a moderate standard deviation of 0.55 for each indicator, suggesting a high level of agreement on the challenges faced.

Addressing poor road maintenance issues like potholes and uneven surfaces is a significant challenge, with a mean score of 4.46. This underscores the urgent need to prioritize road maintenance to mitigate the risks of deteriorating road conditions.

Similarly, improving road signage and markings to reduce confusion among drivers and lower the risk of collisions is recognized as a crucial challenge, supported by a mean score of 4.48. Enhancing signage and markings can enhance road user awareness and improve overall safety on the roads.

Table 15. Assessment on the challenges in road infrastructure and design factor contributory to road crash incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Addressing poor road maintenance issues like potholes and uneven surfaces that contribute to accidents.	4.46	0.55	Strongly Agree
2. Improving road signage and markings to reduce confusion among drivers and lower the risk of collisions.	4.48	0.55	Strongly Agree
3. Enhancing street lighting along roads to improve visibility, particularly at night, and decrease accidents.	4.48	0.55	Strongly Agree
4. Upgrading pedestrian infrastructure with well-maintained sidewalks and proper crossings to enhance pedestrian safety and reduce accidents.	4.48	0.55	Strongly Agree
5. Updating road design to accommodate increasing traffic volumes and changing vehicle dynamics for improved road safety.	4.48	0.55	Strongly Agree
OVERALL	**4.47**	**0.54**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Enhancing street lighting along roads to improve visibility, particularly at night, and decrease accidents is also a critical challenge, with a mean score of 4.48. Adequate lighting is essential for ensuring visibility and reducing the likelihood of accidents, especially in low-light conditions.

Upgrading pedestrian infrastructure with well-maintained sidewalks and proper crossings to enhance pedestrian safety and reduce accidents is another significant challenge, with a mean score of 4.48. This emphasizes the importance of creating safer pedestrian environments to reduce the risk of accidents involving vulnerable road users.

Updating road design to accommodate increasing traffic volumes and changing vehicle dynamics for improved road safety is also identified as a priority, with a mean score of 4.48. This underscores the need for proactive planning and design considerations to ensure road infrastructure keeps pace with evolving transportation needs.

McBride et al. (2023) stated that one of the significant challenges is the lack of regular maintenance of roads, leading to potholes, cracks, and uneven surfaces. These issues can increase the risk of accidents, especially during adverse weather conditions; overcrowded roads, bottlenecks, and inadequate capacity can lead to traffic congestion, erratic driving behaviors, and increased chances of rear-end collisions or sideswipes Roads that are designed for higher speeds than the posted limits, or vice versa, can create a mismatch that compromises safety. Inappropriate road design about speed limits can lead to accidents due to driver misjudgment. Lastly, infrastructure that

does not cater to the needs of persons with disabilities, such as a lack of wheelchair ramps, audible signals at crossings, or tactile paving, can create barriers to safe mobility and increase risks for these individuals.

Overall, the assessment indicated a strong consensus among respondents regarding the challenges in road infrastructure and design contributing to road crash incidents, with an overall mean score of 4.47 and a moderate standard deviation of 0.54.

D. Technological Intervention

Table 16 assesses technological intervention challenges contributing to road crash incidents in the Philippines. The assessment indicates a strong consensus among respondents, with mean scores ranging from 4.15 to 4.48 and a moderate standard deviation of 0.50 to 1.10 for each indicator.

Implementing advanced safety technologies such as ABS and ESC to reduce road crash incidents is a significant challenge, with a mean score of 4.47. This highlighted the importance of leveraging existing technologies to enhance road safety measures effectively.

Increasing technology like speed limit monitoring and lane departure warning systems to enhance road safety is also challenging, with a mean score of 4.15. While respondents agree on the potential benefits of such technologies, there may be some variability in perceptions regarding their effectiveness and implementation.

Similarly, enhancing the adoption of automated enforcement systems like red light cameras and speed cameras to deter traffic violations and reduce accidents is recognized as a challenge, with a mean score of 4.15. This suggests a consensus among respondents on the importance of automated enforcement but also indicates some variability in opinions regarding their implementation.

Investing in intelligent transportation systems, including traffic management software and vehicle-to-infrastructure communication, for better road safety measures is highlighted as a priority, with a mean score of 4.48. This underscores the importance of leveraging technology to improve overall road safety outcomes.

Integrating emerging technologies like connected vehicles and autonomous driving features to decrease road crash incidents in the Philippines is also crucial, with a mean score of 4.48. This suggests a strong consensus among respondents on the potential of emerging technologies to revolutionize road safety.

Chang et al. (2020) also stated that one of the primary challenges is the cost of implementing advanced safety technologies in vehicles and on roadways. The initial investment required for integrating technologies like Automated Emergency Braking Systems, lane departure warning systems, or vehicle-to-vehicle communication can be a barrier, especially for widespread adoption. Tim (2024), ensuring compatibility and standardization of safety technologies across different vehicle models and road infrastructure is essential for maximizing their effectiveness. While advanced safety technologies can enhance road safety, drivers must understand their capabilities and limitations.

Overall, the assessment indicated a strong consensus among respondents regarding the challenges in technological intervention contributing to road crash incidents, with an overall mean score of 4.34 and a moderate standard deviation of 0.69.

Table 16. Assessment on the challenges in technological intervention factor contributory to road crash incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Improving the implementation of advanced safety technologies such as ABS and ESC to reduce road crash incidents.	4.47	0.50	Strongly Agree
2. Increasing the use of technology like speed limit monitoring and lane departure warning systems to enhance road safety.	4.15	1.10	Agree

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
3. Enhancing the adoption of automated enforcement systems like red light cameras and speed cameras to deter traffic violations and reduce accidents.	4.15	1.10	Agree
4. Investing in intelligent transportation systems including traffic management software and vehicle-to-infrastructure communication for better road safety measures.	4.48	0.50	Strongly Agree
5. Integrating emerging technologies like connected vehicles and autonomous driving features to potentially decrease road crash incidents in the Philippines.	4.48	0.50	Strongly Agree
OVERALL	**4.34**	**0.69**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

E. Enforcement measures implemented

Table 17 provides a comprehensive assessment of challenges in enforcement measures contributing to road crash incidents in the Philippines. The assessment indicated a strong consensus among respondents, with mean scores ranging from 4.43 to 4.61 and a moderate standard deviation of 0.49 to 0.78 for each indicator.

Ensuring consistent enforcement of traffic laws and regulations to create a safer road environment and reduce accidents emerges as a significant challenge, with a mean score of 4.61. This underscores the importance of strictly adhering to traffic laws to promote safer road behaviors.

Strengthening enforcement against drunk driving and overspeeding to curb dangerous behaviors and enhance road safety is also a crucial challenge, with a mean score of 4.58. This emphasizes the need for stringent enforcement measures to deter reckless driving practices effectively.

Implementing more effective penalties for traffic violations to deter reckless driving practices and decrease the occurrence of road crashes is highlighted as a priority, with a mean score of 4.57. This underscores the importance of imposing penalties that serve as a deterrent to irresponsible driving behavior.

Improving monitoring and enforcing vehicle roadworthiness standards to reduce accidents caused by poorly maintained vehicles is also recognized as a significant challenge, with a mean score of 4.58. This emphasizes the importance of ensuring that vehicles on the road meet safety standards to minimize the risk of accidents.

Enhancing enforcement of seat belt and helmet laws to promote compliance among drivers and passengers, ultimately reducing the severity of injuries in road crash incidents in the Philippines, is a crucial endeavor, with a mean score of 4.43. This highlighted the importance of promoting compliance with safety regulations to minimize the impact of accidents.

National Highway Traffic Safety Administration (n.d.) stated that One of the primary challenges is allocating sufficient resources, including personnel, equipment, and funding, to support robust enforcement efforts. More resources can be needed to maintain the frequency and effectiveness of enforcement activities, impacting the overall deterrence of traffic violations. Ensuring consistent enforcement across all regions and road types is essential for

creating a deterrent effect and promoting compliance with traffic laws. Disparities in enforcement levels or coverage can lead to selective adherence to rules and behaviors, undermining the effectiveness of enforcement measures.

Overall, the assessment indicated a strong consensus among respondents regarding the challenges in enforcement measures contributing to road crash incidents, with an overall mean score of 4.55 and a moderate standard deviation of 0.53.

Table 17. Assessment on the challenges in enforcement measures implemented factor contributory to road crash incidents

INDICATORS	MEAN	SD	VERBAL INTERPRETATION
1. Ensuring consistent enforcement of traffic laws and regulations to create a safer road environment and reduce accidents.	4.61	0.49	Strongly Agree
2. Strengthening enforcement against drunk driving and overspeeding to curb dangerous behaviors and enhance road safety.	4.58	0.49	Strongly Agree
3. Implementing more effective penalties for traffic violations to deter reckless driving practices and decrease the occurrence of road crashes.	4.57	0.50	Strongly Agree
4. Improving monitoring and enforcement of vehicle roadworthiness standards to reduce accidents caused by poorly maintained vehicles.	4.58	0.49	Strongly Agree
5. Enhancing enforcement of seat belt and helmet laws to promote compliance among drivers and passengers, ultimately reducing the severity of injuries in road crash incidents in the Philippines.	4.43	0.78	Strongly Agree
OVERALL	**4.55**	**0.53**	**STRONGLY AGREE**

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

F. Summative Assessment

The summative assessment, shown in Table 18, provides a comprehensive overview of the challenges contributing to road crash incidents in the Philippines.

Human Behavior emerges as the primary factor contributing to road crash incidents, with a mean score of 4.60 and a relatively low standard deviation of 0.43. Respondents strongly agreed that this is significant. This underscores the critical role of addressing behaviors such as speeding, drunk driving, and distracted driving to improve road safety outcomes.

Enforcement measures applied rank second in importance, with a mean score of 4.55 and a moderate standard deviation of 0.53. This highlights the importance of consistently enforcing traffic laws and regulations to create a safer road environment. Strengthening enforcement against dangerous behaviors like drunk driving and overspeeding and implementing effective penalties for traffic violations is crucial in reducing road crash incidents.

Road Infrastructure and Design rank third, with a mean score of 4.47 and a moderate standard deviation of 0.54, indicating a strong consensus among respondents regarding the

challenges in this area. Improving road maintenance, signage, lighting, pedestrian infrastructure, and road design to enhance safety is essential for mitigating road crash incidents.

Public awareness follows closely behind, with a mean score of 4.52 and a standard deviation of 0.49, indicating a high level of agreement among respondents regarding the challenges in raising public awareness about road safety guidelines and practices. Educating the public, changing attitudes towards traffic rules, and promoting safety measures such as seat belt and helmet usage are crucial in improving road safety.

Technological Interventions rank fifth, with a mean score of 4.34 and a higher standard deviation of 0.69, indicating some variability in respondents' perceptions. While technologies like advanced safety features and intelligent transportation systems hold promise for enhancing road safety, challenges in implementation and adoption need to be addressed.

As supported by the World Health Organization (2023), inadequate road infrastructure, including poorly maintained roads, lack of proper signage, insufficient lighting, and absence of pedestrian crossings, contributes significantly to road accidents. Improving infrastructure quality and design is crucial to enhancing road safety. The prevalence of old and poorly maintained vehicles on Philippine roads poses a safety risk. Ensuring vehicle roadworthiness, promoting safety features like airbags and ABS, and implementing vehicle inspection programs are vital for improving vehicle safety standards. Insufficient public awareness about road safety practices, limited driver education programs, and gaps in safety campaigns contribute to a lack of knowledge among road users. Increasing awareness through targeted campaigns and educational initiatives is essential for promoting safe behaviors.

Table 18. Summative assessment on the challenges in contributory to road crash incidents

FACTORS	MEAN	SD	VERBAL INTERPRETATION	RANK
Human Behavior	4.60	0.43	Strongly Agree	1
Public Awareness	4.52	0.49	Strongly Agree	4
Road infrastructure and Design	4.47	0.54	Strongly Agree	3
Technological Interventions	4.34	0.69	Strongly Agree	5
Enforcement measures applied	4.55	0.53	Strongly Agree	2
OVERALL	**4.50**	**0.48**	**STRONGLY AGREE**	

Mean Interval	Verbal Interpretation
1.00 – 1.79	Strongly Disagree
1.80 – 2.59	Disagree
2.60 – 3.39	Neutral
3.40 – 4.19	Agree
4.20 – 5.00	Strongly Agree

Conclusions

The results gathered in the conduct of the study have provided the following conclusions:

1. The research findings highlighted a multifaceted array of factors contributing to road crash incidents, with human behavior, public awareness, road infrastructure, technology, and law enforcement all playing critical roles. Key human factors include speeding, driving under the influence, distracted and aggressive driving, and non-adherence to traffic rules, exacerbated by a general lack of awareness and complacency towards safety guidelines. Inadequate road infrastructure and design, such as poor maintenance and outdated layouts, further compound these issues. The need for more implementation of advanced safety technologies and consistent enforcement of traffic laws, including penalties for violations and monitoring of vehicle standards, also significantly contribute to the problem. Addressing these factors through comprehensive interventions and enhanced public awareness is crucial for improving road safety.

2. The multifaceted challenges faced by the Philippine National Police Highway Patrol Group in reducing road crash incidents, emphasizing the significant role of human behavior, public awareness, road infrastructure, technology, and enforcement. Human behavior factors such as speeding, DUI, and aggressive driving present considerable difficulties. Public awareness challenges, including overcoming misconceptions and promoting safety over convenience, are equally critical. Road infrastructure issues, such as poor maintenance and inadequate signage, underscore their impact. Technological challenges in implementing advanced safety systems and intelligent transportation emerged as crucial, with substantial agreement among respondents. Lastly, consistent enforcement of traffic laws and stricter penalties for violations are imperative for enhancing road safety. Addressing these challenges comprehensively is essential for improving road safety outcomes in the Philippines.

Based on the outcome of the study, recommendations are the following;

1. The PNP Highway Patrol Group should develop an action plan focused on multiple interventions to improve road safety. This includes prioritizing education and awareness campaigns to address human behavior factors and implementing stricter enforcement measures to discourage risky driving. Initiating public awareness programs to promote a safety culture and collaborating with relevant agencies to improve road infrastructure and design through regular maintenance and enhanced signage are also critical. Furthermore, integrating advanced safety technologies and automated enforcement systems will enhance road safety. Strengthening enforcement efforts and increasing penalties for traffic violations will further deter risky behaviors and ensure compliance with road safety regulations.
2. The PNP Highway Patrol Group should prioritize comprehensive measures to enhance road safety. These include addressing human behavior through education and awareness campaigns, stricter enforcement measures, and policies to discourage risky driving. Initiatives to enhance public awareness via education campaigns, community engagement, and targeted messaging are essential for promoting a safety culture on the roads. Coordinating with relevant agencies to improve infrastructure, such as regular maintenance, road design upgrades, and better signage, is crucial for safer roads. Adopting and integrating advanced safety technologies and intelligent transportation systems will further enhance safety measures. Strengthening enforcement through regular monitoring, stricter penalties for traffic violations, and rigorous enforcement of roadworthiness standards and safety regulations is imperative.

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