

Delay Dynamics: Variables Affecting Emergency Responders' Response Time in Vehicular Accidents Within the Province of Marinduque

Allen Laurenz L. Pascua, MSCJ¹*, Henedina A. Lagumen, PhD¹

¹ College of Criminal Justice and Criminology, Manuel S. Enverga University Foundation, Lucena City, Philippines

* allenlaurenzpascua76@gmail.com

Date Submitted:
August 27, 2026

Date Accepted:
September 22, 2026

Date Published:
October 14, 2026

DOI:
10.5281/zenodo.23367808

ABSTRACT

The present study aimed to identify the factors influencing emergency response time to provide a set of actionable recommendations designed to directly improve response efficiency and reduce delays. The research utilized a descriptive design, relying on survey-based data collection from emergency responders, composed of personnel from the Bureau of Fire Protection (BFP), Philippine National Police (PNP), Municipal Disaster Risk Reduction and Management Office (MDRRMO), and the Provincial Hospital. Additionally, community members residing in accident-prone areas were also surveyed. Descriptive and inferential statistics were employed to describe and explore the differences in the perceptions of the respondents on the community involvement,

infrastructure quality, and the operational challenges faced by emergency responders. Results revealed that while emergency responders frequently arrived at accident sites within seven to thirty minutes, this timeframe was generally perceived as insufficient for preventing the worsening of injuries, with both community members and emergency personnel indicating the need for improved response times. Contributing factors to these delays included weak communication infrastructure, limited accessibility in remote areas, and inadequate knowledge among the public on how to respond or communicate effectively during emergencies. Moreover, the province's road network and infrastructure, although partially supportive, were found to hinder optimal routing and fast deployment due to limited alternate routes and maintenance issues. Despite some effective traffic management systems, delays were exacerbated by the lack of strategically located Emergency Medical Service stations and poor signal coverage in rural zones. Community participation emerged as a critical yet underutilized factor; although both groups agreed that community involvement could significantly reduce response time, there was a noted deficiency in public preparedness and training.

Keywords: *vehicular accidents, community involvement, emergency response, response time, public safety*

INTRODUCTION

A vehicular accident, also known as a traffic accident, is referred to as an unexpected and unintended event involving one or more vehicles on the road. These incidents often lead into injuries, fatalities, and damage on property, constituting a major global issue. They are responsible for approximately 1.19 million deaths each year, along with countless non-fatal injuries that have substantial economic and social impacts. The causes of such accidents are varied, with speeding, distracted driving, intoxication due to alcohol or drugs, and the lack of safety measures like seatbelts and helmets being among the most

common factors. Human error frequently exacerbates these risks, highlighting the urgent need for safer transportation systems. Particularly vulnerable are pedestrians, cyclists, and motorcyclists, who face higher risks of severe injuries and fatalities (Anderson et al., 2023).

The response time of emergency vehicles proves most crucial in such cases to minimize fatalities and casualties due to accidents involving road vehicles. Most important among these is the commonly known as the “Golden Hour,” which is the first 60 minutes followed by an injury related to trauma on which medical intervention or delays results in a marked elevation of survival rates. Quick response in an emergency enables medical experts to intervene early and thus prevent some complications such as extreme blood loss, organ failure, or even shock. Indeed, such a condition that may otherwise be treatable turns out fatal if not acted on promptly. In this respect, rapid responses curtail the extent of injuries due to the stabilization of victims of accidents and prevention of secondary damage particularly in cases like spinal injuries that may result in permanent damage if mishandled. This highlights the ideal standard response time between 3-5 minutes set by the Philippine National Police (PNP) Revitalized 911 Program. The PNP introduced significant improvements under the Department of Interior and Local Government’s (DILG) Revitalized 911 Program. This initiative aims to ensure that over 90% of emergency calls are addressed within 3 to 5 minutes. This efficiency is made possible through enhanced call handling and dispatch systems, with the Philippines now rivaling international standards in emergency response times. However, in urban areas with heavy traffic, such as Metro Manila, there may be slight delays (ASTIG PH, 2023). Similarly, some places with the same geographical challenges as the province of Marinduque do not meet the standard time due to multiple factors (Zhou et al., 2023).

Vehicular accidents often necessitate the response of emergency vehicles, and this is usually affected by the region where the accident occurs, together with other local factors. In fact, the Quezon City Police District has implemented a three-minute response time standard as part of its Tactical Motorcycle Riding Units and other initiatives. This program is seen as a best practice and is being recommended for replication across Metro Manila (Dalizon, 2023). Such time may be more extended in rural areas or with difficult road conditions, infrastructure, or resource limitations. The recent overall service and performance of the emergency ambulance service (EAS) provider for both public and private exceeds the standard time for response and service that cannot reach the 100% required coverage using the 3 to 5 minutes standard time of response. To solve this concern, adding new stations for obtaining performance measures as an optimal routing system was proposed. The creation of policies and procedures in relation to standard communication system, work schedule, and dispatch mechanisms as for emergency response action are also included (Estember et al., 2020).

In the Philippines, mostly in urban areas like Metro Manila, the delayed response of the emergency medical services is very much affected by road disturbances and infrastructural problems. Traffic congestion, especially on EDSA, primarily caused by poor urban planning and poorly developed infrastructure, generally results in a critical delay in the response of the ambulance. The same goes for minor incidents such as vehicle breakdown that cause a hindrance to traffic flow and worsen the situation. With such problems like flooding and bad condition of roads, not mentioning the alternative roads are not available for such types of events, all these delay the response times of EMS. Such issues not only increase EMS response times but also raise mortality rates during emergencies because in such conditions the medical care does not arrive on time (Navarro & Latigar, 2022).

In the province of Marinduque, concerns about emergency response time for vehicular accidents are particularly pressing due to ongoing delays and inefficiencies. The Department of Interior and Local Government (DILG) has reported that response time in the region’s rural and remote areas frequently exceed recommended limits, primarily due to inadequate infrastructure and limited resources. In certain situations, response time can reportedly take over an hour, impacting the efficiency of emergency medical treatment significantly. According to the Philippine Institute of Development Studies (PIDS, 2021), urban centers in Marinduque enjoy relatively faster response times, while rural and far-flung areas experience

delays as a result of poor roads and the unavailability of emergency services. This contrast highlights the necessity for enhanced infrastructure and increased resource allocation to maximize response effectiveness in the entire area. A more critical incident was the vehicular accident in Torrijos, Marinduque, which claimed three lives and left 28 injured. Virola (2022) cited that a wedding party passenger jeepney plunged off a cliff in Barangay Cagpo after its brakes failed. Among the fatalities were the groom, a child, and an elderly relative. Injured victims were taken to hospitals in Boac and Lucena City. The driver was charged with reckless imprudence, highlighting the implications of mechanical failures and the importance of strict safety checks.

This demonstrates the critical significance of emergency response times to patient survival and recovery, particularly in the case of this province. It highlights how disparities in emergency medical services (EMS) between more prosperous and less prosperous regions can lead to slower responses and poorer health outcomes. Additionally, the concerning statistics on traffic-related fatalities in the Philippines necessitates the pressing need for enhancements in EMS and infrastructure, directly relating to the investigation of factors influencing emergency response times in vehicular accidents.

In communities like in the province of Marinduque, various local factors contribute to delays in response times of EMS. Most EMS service depends on volunteers, leading to shortages of personnel and increased time to response, especially when vehicular accidents occur. Funding constraints also limit the readiness of such equipment as fleets of ambulances. There is also a general lack of community awareness toward emergency services, given that in most places, locals are usually unfamiliar with how to report emergencies, thus creating delays in seeking EMS. These should be phased by improvement in community education and better funding models that may be able to lower response times (Rural Health Information Hub, 2024).

In the case of road infrastructure, similar to the province of Marinduque, delays of the ambulance response times take long sometimes especially in vehicular accidents. The narrow roads, poor maintenance, and challenging terrain of the island are some of the factors that result in such delays. Lack of correct signposts, sharp curves, and frequent road works characterize the rural areas as well. The congestive traffic in the town centers and few ambulances and emergency stations add to the problem. While all the elements combine to delay response, this may be pivotal in accidents threatening life. Better road infrastructure and structural improvements that enable improved, faster responses might shave down response times and increase chances for survival. Of vital importance is improvement of delayed emergency vehicle response times for emergencies in the province of Marinduque because it will lead to better health outcomes and increased public trust, among other implications concerning community safety. One of the main advantages that could be accrued by solving this problem would be cutting down on a considerably high amount of time it takes before emergency services reach accident victims (U.S. Fire Administration, 2023).

METHODS

Research Design

The study employed a quantitative research method to systematically gather and analyze data related to the factors influencing the response times of emergency personnel within the province of Marinduque. A descriptive research design was utilized as it allowed for an impartial examination of existing emergency response conditions without manipulating any variables. This made it a fitting approach for evaluating how real-world circumstances affect the overall efficiency of emergency operations.

To collect the necessary information, the researcher used a detailed checklist tailored to capture numerical data across key areas such as response time, community involvement, infrastructure quality, and emergency service performance. This tool was divided into several sections, each focusing on specific elements that may contribute to delayed response times. It included both closed-ended questions and Likert-scale items. For instance, some questions measured response duration with options like “under 10 minutes” or “between 10–20 minutes” to provide quantifiable insights. Meanwhile, the Likert-scale items gauged

perceptions on topics such as public awareness of emergency hotlines, road conditions, and the quality of communication between emergency service providers and the public. Input gathered during the pilot phase was used to refine and improve the final version of the questionnaire, ensuring it effectively captured the most relevant and accurate data.

Data collection was conducted personally by the researcher who visited local communities and key institutions such as the Bureau of Fire Protection (BFP), the Philippine National Police (PNP), the Municipal Disaster Risk Reduction and Management Office (MDRRMO), and the Provincial Hospital. The checklist was distributed randomly to capture a diverse range of views. This non-disruptive strategy was suitable for assessing the influence of current conditions on emergency response performance.

Ethical considerations were strictly followed and informed consent was secured from all participants prior to their involvement. Participation was voluntary and individuals had the freedom to decline or withdraw at any point without penalty. Those who opted out were replaced to fulfill the sample size requirement. This careful and ethical methodology aimed to produce meaningful data that could support improvements in emergency management and overall safety in Marinduque..

Research Locale

The research was carried out in Marinduque Province which is located in the Philippines' MIMAROPA region. This location was selected due to increasing concerns over the delayed response time to vehicular accidents, an important matter concerning public safety and emergency management within the province. The research focused specifically on the province's road networks, emergency response facilities (e.g., Municipal Police Stations, Municipal Fire Stations, Municipal Disaster Risk Reduction and Management Offices, and the Provincial Hospital), and communities most affected by vehicular accidents or those communities residing near accident prone areas.

Sampling Technique

The respondents were composed of emergency responders (e.g., Municipal Police Stations personnel, Municipal Fire Stations personnel, Municipal Disaster Risk Reduction and Management Office personnel and the Provincial Hospital personnel), local government officials, and community members who reside near accident prone areas or have been involved in vehicular accidents or emergency response situations.

To determine the appropriate sample size for this study, the Raosoft sample size calculator was utilized. The calculator was preset with a 5% margin of error, a 95% confidence level, a response distribution of 50%, from the total population size of 239,207. Based on these parameters, the recommended sample size was calculated for each municipality. The total population of Boac is 57,283, with a recommended sample size of 382. Buenavista, with a population of 26,043, had a recommended sample size of 379, while Gasan, with a population of 36,197, suggested a sample size of 381. Mogpog has a population of 34,516 and a recommended sample size of 380, and Santa Cruz, with a population of 54,692, also suggested a sample size of 382. Finally, Torrijos, with a population of 30,476, had a recommended sample size of 380. There was a total of 2,284 respondents for the whole province.

For each municipality, the sample size included 6 personnel from the local emergency response agencies, specifically 2 from the Bureau of Fire Protection (BFP), 2 from the Philippine National Police (PNP), and 2 from the Municipal Disaster Risk Reduction and Management Office (MDRRMO). Additionally, 2 personnel were included from the Provincial Hospital, which is centrally located in Boac.

Table 1 presents the distribution of respondents across six municipalities in the province of Marinduque, highlighting both community members and emergency responders involved in the study. A total of 2,284 respondents participated, consisting of 2,246 community members and 38 emergency responders. The community respondents were proportionally selected based on the total population of each municipality, ensuring balanced representation. For instance, Boac, the most populous municipality with 57,283 residents, contributed 374 community respondents, while Buenavista, the least populous with

26,043 residents, had 373 respondents showing that even smaller municipalities were equally considered in the data collection. Each municipality was assigned two representatives from key emergency agencies: the Bureau of Fire Protection (BFP), the Philippine National Police (PNP), and the Municipal Disaster Risk Reduction and Management Office (MDRRMO), totaling 36. Additionally, Boac was the only municipality to include two representatives from the Provincial Hospital, likely due to its role as the province's central medical hub. This sampling design ensured a diverse and comprehensive representation of both public perception and professional experience, thereby strengthening the reliability of the study's findings regarding emergency response systems in the region.

Participants were requested to sign an informed consent form to confirm their voluntary participation in the study. They were clearly briefed about the study's purpose and informed that they could receive a copy of the research findings upon request. To protect their privacy and maintain confidentiality, the researcher allowed participants to withhold their names and any personal details that were not necessary for the research.

Table 1. *Number of Respondents Per Municipality*

Municipalities	Total Population	Sample Size	Community	Number Of Emergency Responders			
				BFP	PNP	MDRRMO	Provincial Hospital
Boac	57,283	382	374	2	2	2	2
Buenavista	26,043	379	373	2	2	2	
Gasan	36,197	381	375	2	2	2	
Mogpog	34,516	380	374	2	2	2	
Santa cruz	54,692	382	376	2	2	2	
Torrijos	30,476	380	374	2	2	2	
Total	239,207	2,284	2,246	12	12	12	2

Table 2 presents the demographic distribution of both community members and emergency responders who participated in the study. Among community respondents, a striking 86% (2,635 out of 3,059) fall within the 16–25 age bracket, indicating that the majority of insights reflect the perspectives of the youth. The remaining respondents are distributed across older age groups: 8% are aged 26–35, 3% are 36–45, and only a small fraction 4% combined are over 45 years old. In contrast, the age distribution of emergency responders shows a more experienced cohort, with 42% aged 26–35, 34% aged 36–45, and only 18% between 16–25. This suggests that while the community data may reflect less experience, the emergency responders surveyed likely bring professional maturity and field exposure.

Regarding geographic distribution, community respondents were evenly spread across the six municipalities of Marinduque, with Torrijos contributing the most (20%), followed by Boac and Buenavista (both 18%), and the rest contributing between 14–15%. Emergency responders were similarly distributed, with a slightly higher concentration in Boac (21%), likely due to the presence of the Provincial Hospital. The remaining municipalities contributed evenly, each with 16% of the emergency personnel.

In terms of agency affiliation, the emergency response team consisted equally of personnel from the Philippine National Police (PNP), the Bureau of Fire Protection (BFP), and the Municipal Disaster Risk Reduction and Management Office (MDRRMO), each comprising 32% of the total sample. Only 5% came from the Provincial Hospital, reflecting its singular location in Boac. In terms of years of service, over half (55%) of the emergency responders had 1–5 years of service, indicating a fairly young but possibly dynamic staff. In contrast, 24% had 6–10 years of service, and the rest had more than 10 years of service. This range indicates a balance of new ideas and experienced know-how in the emergency response groups.

Table 2. *Distribution of the Respondents as to Demographics*

A. Age	Community Members		Emergency Response Team	
	Frequency	Percentage	Frequency	Percentage
16-25	2635	86%	7	18%
26-35	230	8%	16	42%
36-45	86	3%	13	34%
46-55	68	2%	2	5%
56-65	21	1%	-	
66-75	19	1%	-	
Total	3059	100%	38	100%
B. Address/Station	Community Members		Emergency Response Team	
	Frequency	Percentage	Frequency	Percentage
Mogpog	464	15%	6	16%
Boac	544	18%	8	21%
Gasán	436	14%	6	16%
Buenavista	548	18%	6	16%
Sta. Cruz	454	15%	6	16%
Torrijos	613	20%	6	16%
Total	3059	100%	38	100%
C. Emergency Services/ Agency	Community Members		Emergency Response Team	
	Frequency	Percentage	Frequency	Percentage
PNP			12	32%
BFP			12	32%
MDRRMO			12	32%
Provincial Hospital			2	5%
Total			38	100%
D. Years of Service	Community Members		Emergency Response Team	
	Frequency	Percentage	Frequency	Percentage
1-5			21	55%
6-10			9	24%
11-15			4	11%
16-20			2	5%
21-25			2	5%
Total			38	100%

Sampling Design and Procedures

A purposive sampling method was found to be the most appropriate in targeting particular groups that are most important in solving the research aims. The research gathered information from emergency responders, including members of the Bureau of Fire Protection (BFP), Philippine National Police (PNP), Municipal Disaster Risk Reduction and Management Office (MDRRMO), and Provincial Hospital, and from members of the community living in accident hotspots. Each of these stakeholders brings unique roles and expertise that are crucial in understanding the factors that affect emergency responders' response times. The use of quota sampling allowed the researcher to intentionally select participants who were most likely to provide valuable insights, particularly when the target population is specialized rather than randomly distributed.

Given the need to capture diverse perspectives within these groups, purposive sampling was the primarily used as it involved intentionally choosing individuals based on their roles, professional knowledge, or direct experience with emergency response situations or areas prone to accidents. For instance, emergency responders offered expert insights on logistical challenges and operational barriers, while local community members shared firsthand experiences regarding the accessibility and timeliness of emergency services in their areas.

To address potential issues of non-participation, the researcher also employed convenience sampling as a supplementary method to ensure sufficient representation. Convenience sampling permitted the choice of those who were readily available and willing to participate in the study, thus ensuring the desired sample size was maintained while still being in accord with the purpose of the research.

RESULTS AND DISCUSSION

Part I. Baseline Assessment of Emergency Response

Table 3 presents the perceptions of both community members and emergency responders regarding the average response time of emergency responders to vehicular accidents in the province of Marinduque. The data reveals a consensus that emergency response times typically exceed seven (7) minutes but do not go beyond thirty (30) minutes, as indicated by an average mean of 3.67 (interpreted as “Agree”). While this reflects a moderate level of agreement, it also highlights that the current response time falls short of the international standard of eight (8) minutes for emergency medical services. This suggests a critical gap in the emergency response system, implying that lives and recovery outcomes may be compromised due to these delays. This underscores the need for a province-wide assessment and restructuring of EMS deployment strategies to bring response times closer to international benchmarks.

Interestingly, the data also shows a shared recognition of the negative impact of delayed emergency responses on victim outcomes and accident escalation, as reflected in the average mean of 3.55 for the statement indicating that current response times are insufficient to prevent the worsening of vehicular accident situations. This perspective underscores that both community members and emergency responders recognize the severe consequences of delayed responses. This insight has significant policy implications, emphasizing the need to improve EMS efficiency through faster response times and better preparedness. This includes ensuring adequate on-site stabilization skills and implementing community-based first aid initiatives.

Additionally, the statement that emergency responders usually reach the scene within seven (7) minutes received the lowest average rating of 3.18, which is closer to a neutral stance. This suggests a lack of consensus, indicating that prompt EMS arrival is neither consistent nor standardized across the province. This inconsistency points to potential systemic issues, such as insufficient ambulance resources, inadequate coverage in remote areas, or logistical challenges like traffic and road conditions. Addressing these problems requires not only investing in necessary equipment but also improving coordination, possibly by using online tracking systems, GIS-based dispatch, and enhanced emergency response training.

Given that time is a critical factor in emergency responses, it should be prioritized by relevant agencies to ensure that interventions are both effective and timely. These findings align with global and national EMS trends. As Basnawi (2023) noted, rapid emergency response times are closely linked to higher survival rates in critical cases like cardiac arrest and trauma. Delays beyond the crucial seven-minute mark significantly reduce chances of survival and lead to poorer health outcomes, which reflects the community’s concern over the inadequacy of current response times.

Additionally, Thompson et al. (2020) highlighted that inefficiencies in emergency response in rich and poor regions are usually the result of variations in infrastructure, resource allocation, and training. Marinduque Province, as a poor region, most probably suffers from these systemic restrictions, which are observable as slow emergency response. This is especially worrisome considering the vulnerability of the area to traffic accidents and road fatalities, as evidenced by the unfortunate accident in Torrijos, Marinduque, where delayed emergency response could have impacted survival rates (Virol, 2022).

The need for more responsive EMS is also highlighted through local examples. For example, the more effective response in Gasan, Marinduque, where the minor incident was immediately addressed, demonstrates the possibility of timely intervention (Myles, 2024). However, such instances appear to be exceptions rather than the norm, given the average ratings from both community and emergency personnel. Mendezona (2023) emphasized that road traffic accidents remain a major public health concern in the

Philippines, accounting for thousands of deaths annually and indicating a substantial burden on the emergency response system.

Taken together, the data illustrated in Table 3 and the supporting literature suggest that while there is some operational functionality in the emergency services, there remain significant gaps in timeliness that hinder the optimal results.

Table 3. *Average Response Time of Emergency Responders to Vehicular Accidents in the Province of Marinduque*

Indicators	Community Member Respondents		Emergency Response Team Respondents		Average Mean	
	WM	Verbal Interpretation	WM	Verbal Interpretation	WM	Verbal Interpretation
1. Emergency responders frequently arrive at the vehicular accident site within seven (7) minutes.	2.46	Disagree	3.89	Agree	3.18	Partially Agree
2. Emergency responders frequently arrive at the vehicular accident site exceeding seven (7) minutes but not more than thirty (30) minutes.	2.92	Partially Agree	4.42	Strongly Agree	3.67	Agree
3. Emergency responders frequently arrive at the vehicular accident site exceedingly more than thirty (30) minutes.	3.78	Agree	2.63	Partially Agree	3.21	Partially Agree
4. Overall, the response time of emergency responders is insufficient to prevent the worsening of vehicular accident situations within the province.	3.85	Agree	3.24	Partially Agree	3.55	Agree

Legend: 1.00-1.80 – Strongly Disagree; 1.81-2.60 – Disagree; 2.61-3.40 – Partially Agree; 3.41-4.20 – Agree; 4.21-5.00 – Strongly Agree

Table 4 illustrates the views of both community members and emergency responders on the influence of the community on emergency response times. Both groups expressed strong agreement that community involvement in delivering first aid or initiating early coordination can significantly decrease response times, with the average mean of 4.28, with verbal description of “Strongly Agree”. This highlights the need to strengthen community engagement through appropriate training and awareness. In addition, both groups admitted that the ignorance of emergency procedures among the community leads to delays (AM = 4.16). Nonetheless, there was less agreement concerning the sufficiency of the knowledge of community members to carry out actions such as giving first aid prior to responders’ arrival (AM = 3.02). This suggests the need for special training for community members as well as emergency responders in order to increase response effectiveness overall. This is consistent with UnitekEMT (2024) which pointed out that the timeliness of ambulance and Emergency Medical Services (EMS) responses greatly depends on the role played by the community. Community actions can either promote or hamper emergency response operations, as noted by the study. One major reason for delays includes public unawareness of traffic rules, which makes people more vulnerable, raises the levels of morbidity and mortality, and shows the importance of more effective emergency management policies as well as greater public awareness.

Moreover, participants concurred that an absence of community information on emergency procedures is a factor in delayed EMS response times (AM = 4.16). UnitekEMT (2024) concurred with

this, indicating that timely and correct accident reporting is critical in enabling timely EMS deployment. Unfortunately, response times tend to be affected by wrong or partial information made by witnesses or passers-by, thus resulting in uncertainty about the location of the accident. Limited public awareness on how to report emergencies appropriately can further hinder EMS effectiveness.

Interestingly, the item that received the lowest agreement from both groups ($AM = 3.02$) indicates that community members generally do not have sufficient knowledge on how to act in the event of a vehicular accident, such as administering first aid before emergency responders arrive. This suggests a clear gap in public emergency preparedness. Moreover, UnitekEMT (2024) highlighted how the conduct of local drivers especially those unfamiliar with yielding to emergency vehicles can contribute to traffic congestion and delays in ambulance travel time, compounding the issue.

Table 4. *Community Impact on the Response Time of Emergency Responders to Vehicular Accidents in the Province of Marinduque*

Indicators	Community Member Respondents		Emergency Response Team Respondents		Average	
	WM	Verbal Interpretation	WM	Verbal Interpretation	WM	Verbal Interpretation
1. Community members are knowledgeable about the emergency contact numbers of agencies in the province of Marinduque (e.g., BFP, PNP, MDRRMO, Marinduque Provincial Hospital).	2.81	Partially Agree	3.76	Agree	3.29	Partially Agree
2. In the event of a vehicle accident, community members immediately call the appropriate authorities or emergency responders.	2.97	Partially Agree	3.95	Agree	3.46	Agree
3. In the event of a vehicle accident, community members have sufficient knowledge on how to act, such as providing first aid before emergency responders arrive.	2.74	Partially Agree	3.29	Partially Agree	3.02	Partially Agree
4. The community's lack of knowledge about emergency procedures causes delays in the response time of emergency vehicles.	4.13	Agree	4.18	Agree	4.16	Agree
5. Community participation in providing first aid or early coordination with emergency responders can significantly reduce response time and ensure immediate medical attention for severe injuries.	4.21	Strongly Agree	4.34	Strongly Agree	4.28	Strongly Agree

Legend: 1.00-1.80 – Strongly Disagree; 1.81-2.60 – Disagree; 2.61-3.40 – Partially Agree; 3.41-4.20 – Agree; 4.21-5.00 – Strongly Agree

Part II: Comparative Perception Analysis

Table 5 discloses the community members and emergency responders' perceptions on how the current infrastructure and road network in the province of Marinduque affect the efficiency of emergency responders during vehicular accidents.

As can be seen, they agreed that the current traffic management within the province effectively prioritizes emergency vehicles, reducing response time to vehicle accidents, which obtained an average mean of 3.83. They partially agreed that the design and layout of the road network within the province do not support efficient routing for emergency responders resulting in delays in emergency response times to vehicular accidents, with an average mean of 3.40. This reflects uncertainty among the respondents as to whether there is really an effective route and road network that could facilitate faster emergency response. This finding aligns directly with the literature asserting that the quality of infrastructure is a core determinant of emergency response efficiency.

According to Simmons et al. (2023), well-maintained roads and systematic traffic management significantly reduce emergency response delays. This supports the relatively high score on traffic management in the province, indicating some success in prioritizing emergency vehicles and possibly implementing basic traffic protocols that assist EMS units. However, the uncertainty reflected in the respondents' partial agreement about the road layout ($AM = 3.40$) finds reinforcement in Anderson et al.'s study (2023) which revealed that even dense or complex road networks, while appearing adequate, can still cause delays—either due to congestion or design inefficiencies.

In Marinduque's rural areas, the shortcomings of the provincial road system, including unpaved roads and limited connectivity, significantly hinder the efficiency of EMS. This observation is reinforced by Rezvani et al. (2024) who highlighted that insufficient infrastructure in rural regions leads to extended EMS travel times and burdens emergency services. The respondents' partial agreement with the effectiveness of the road network may reflect the visible difficulties, such as impassable routes or poor road conditions in key access zones.

Moreover, Santos et al. (2023) emphasized that rural provinces like Marinduque typically face issues such as dilapidated infrastructure and limited access routes, both of which are likely the underlying factors behind the skepticism among respondents regarding the effectiveness of the road network. This concern is echoed by Bijani et al. (2021) who noted that sparse EMS unit distribution, coupled with poor road quality, amplifies delays.

Thus, the Table 5 findings do not merely reflect opinions but they are substantiated by a growing body of empirical research indicating that inefficient or insufficient road networks remain a bottleneck to timely EMS interventions, particularly in rural and geographically isolated areas.

Table 5. *How the Current Infrastructure and Road Network in the Province of Marinduque Affect The Efficiency of Emergency Responders During Vehicular Accidents*

Indicators	Community Member Respondents		Emergency Response Team Respondents		Average	
	WM	Verbal Interpretation	WM	Verbal Interpretation	WM	Verbal Interpretation
1. The current quality of road infrastructure within the province is insufficient to support the timely response of emergency responders to accidents.	3.76	Agree	3.32	Partially Agree	3.54	Agree
2. The design and layout of the road network within the province do not support efficient routing for	3.56	Agree	3.24	Partially Agree	3.40	Partially Agree

emergency responders resulting in delays in emergency response times to vehicular accidents.						
3. The frequency of road maintenance and upkeep within the province is insufficient to prevent delays in emergency response time, thus hindering timely assistance during vehicular accidents due to unfinished road constructions.	3.69	Agree	3.45	Agree	3.57	Agree
4. There is a lack of alternative routes within the province, which adds to delays caused by traffic or road obstructions during emergency response.	3.84	Agree	3.39	Partially Agree	3.62	Agree
5. The current traffic management within the province effectively prioritizes emergency vehicles, reducing response time to vehicle accidents.	3.74	Agree	3.92	Agree	3.83	Agree

Legend: 1.00-1.80 – *Strongly Disagree*; 1.81-2.60 – *Disagree*; 2.61-3.40 – *Partially Agree*; 3.41-4.20 – *Agree*; 4.21-5.00 – *Strongly Agree*

Table 6 shows the existing challenges faced by emergency responders in the province of Marinduque when addressing vehicular accidents that affect the response times.

As shown by the data, both the community members and emergency responders strongly agreed that weak signal or faulty communication device affects the coordination of emergency responders, making it difficult to relay crucial information and request additional assistance from emergency responders in the province (AM = 4.41). This implies that communication system is a vital tool that could aid effective emergency response.

They also strongly agreed that the distance of the accident site from the nearest emergency service station has a significant impact on response time, especially in remote or hard-to-reach areas in the province (AM = 4.40). This emphasizes that there should be emergency service stations in every strategic location in the province.

They partially agreed about traffic congestion in the province that causes significant delays in responding to vehicular accidents (AM = 3.69). This is because of the traffic management system in the province which effectively prioritizes emergency vehicles that leads to a reduction in response times for some vehicle accidents. Respondents, both community member and response team, strongly agreed that weak signals and malfunctioning of communication equipment or gadgets are one of the major obstacles in coordination efforts as reflected by an average rating of 4.41. This finding aligns with the conclusion of Lian and Wang (2024) who identified that communication challenges especially in some remote regions often resulted in miscommunication and improper allocation of emergency resources. The challenges in transmitting vital information or requesting support highlights the need for better communication systems such as GPS and improved devices to boost the effectiveness of emergency responses.

In a similar vein, the respondents' strong consensus on the impact of the distance between accident sites and emergency stations ($AM = 4.40$) is in agreement with Richards et al. (2023) who found that long travel distances, resource shortages, and poor road conditions are significant factors that delay emergency responses in rural areas. Flores et al. (2021) also pointed out that in isolated regions of the Philippines, where islands and mountains complicate access, EMS units often have to take longer or indirect routes, further delaying medical assistance and negatively affecting patient recovery.

These results cumulatively substantiate the suggestion that emergency service stations be strategically located across the province to enhance accessibility and minimize response time.

On the other hand, the comparatively lower level of agreement with traffic congestion being an obstacle to timely response ($AM = 3.69$) indicates the respondents' opinion that existing traffic management strategies in the province work well in giving priority to emergency vehicles. This perception corroborates the earlier finding in Table 6 where traffic management was perceived to be functional in allowing swift movement for emergency responders.

Moreover, Cruz et al. (2023) emphasized that, in the Philippines, delays in emergency responses are often compounded by insufficient training among EMS providers and the lack of established road networks. This points out that in addition to solving logistical and technological concerns, enhancing responder capacity and infrastructure is still crucial.

Table 6. *Existing Challenges Faced by Emergency Responders in the Province of Marinduque When Addressing Vehicular Accidents That Affect the Response Times*

Indicators	Community Member Respondents		Emergency Response Team Respondents		Average	
	WM	Verbal Interpretation	WM	Verbal Interpretation	WM	Verbal Interpretation
1. The insufficient number of vehicles (e.g., ambulances, fire trucks, or rescue vehicles) and emergency response personnel causes delays in responding to vehicular accidents.	4.04	Agree	3.68	Agree	3.86	Agree
2. Traffic congestion in the province causes significant delays in responding to vehicular accidents.	4.00	Agree	3.37	Partially Agree	3.69	Agree
3. The distance of the accident site from the nearest emergency service station has a significant impact on response time, especially in remote or hard-to-reach areas in the province.	4.32	Strongly Agree	4.47	Strongly Agree	4.40	Strongly Agree
4. The lack of clear directions or incorrect location information from the caller or witness causes delays in locating and reaching the vehicular accident site within the province, resulting in slower emergency response.	4.28	Strongly Agree	4.45	Strongly Agree	4.37	Strongly Agree
5. Weak signal or faulty communication device affects the coordination of emergency responders, making it difficult to relay crucial information and request	4.34	Strongly Agree	4.47	Strongly Agree	4.41	Strongly Agree

additional assistance from emergency responders in the province.						
6. Weather conditions, such as heavy rain or thick fog, cause response delays due to poor visibility, slippery roads, and increased risks for emergency responders while traveling to and from the vehicle accident site in the province.	4.22	Strongly Agree	4.13	Agree	4.18	Agree
7. Aggressive or uncooperative individuals at the vehicle accident site in the province, such as agitated bystanders or victims, pose additional challenges for emergency responders, potentially slowing down necessary interventions and compromising their safety.	4.21	Strongly Agree	4.16	Agree	4.19	Agree
8. Untrained individuals attempting to move injured victims improperly may exacerbate their injuries and pose additional challenges for emergency responders in delivering proper medical care and transportation during vehicular accidents in the province.	4.26	Strongly Agree	4.34	Strongly Agree	4.30	Strongly Agree

Legend: 1.00-1.80 – Strongly Disagree; 1.81-2.60 – Disagree; 2.61-3.40 – Partially Agree; 3.41-4.20 – Agree; 4.21-5.00 – Strongly Agree

Table 7 shows the perception of both community members and emergency responders on the strategies presented that could be an answer to reduce response times for emergency teams in Marinduque for such vehicular accidents. Overall, there is a strong agreement among both groups on all the proposed strategies which indicates that they have seen it as effective in minimizing response times to accidents.

Particularly, they strongly agreed that the increase in public awareness, prompt proper and timely action and assist in reducing emergency response times in the province is the sum of disseminating more information and education to the public regarding emergency procedures in the event of vehicular accidents. It earned the highest average mean of 4.58, indicating it as the most effective among the strategies identified.

The strategic installation of CCTV cameras and streetlights in such locations where road accidents often happen in the province comes next in the rank, with an average mean of 4.48. It helps in monitoring events and decreasing the response time of emergency vehicles by providing real-time visibility and faster identification of accidents. The result recognizes the importance of community cooperation as well as the adequate infrastructure and equipment for a successful emergency response.

This finding underscores a strong agreement among both community members and emergency responders in regard to the effectiveness of various strategies in reducing emergency response times in road accidents in the town. The strategy with the highest rank, community education and information dissemination about emergency protocols, illustrates the critical role of public awareness to improve the response time. Cruz (2023) highlighted that infrastructure improvements and public awareness are key to boost the effectiveness of EMS, especially in rural and developing regions.

Next is the strategic placement of CCTV cameras and streetlights (AM = 4.48) that provides help in the detection and monitoring of such accidents more swiftly and enables more effective emergency deployment. Harper (2023) also advocated this campaign in integrating advanced traffic management technologies such as CCTV camera and smart traffic management system to improve situational awareness

and speed up the EMS responses especially when paired with GPS route optimization. With the province having limited road networks and challenging terrain, these technologies offer a practical solution to overcome logistical obstacles which frequently delay the EMS response.

As the data highlights the importance of adapting road safety strategies to local conditions, Lu et al. (2022) pointed out that provinces like Marinduque may have smaller populations and lower traffic volumes than metropolitan areas like Metro Manila, but facing significant risks due to inadequate infrastructure, unsafe road conditions, and poor driving habits. This supports the findings of the present study on enhancing the road networks, traffic management system, and use of modern technologies such as CCTV for traffic monitoring.

Table 7. *Strategies That Can Be Implemented to Reduce the Response Time of Emergency Responders to Vehicular Accidents in the Province of Marinduque*

Indicators	Community Member Respondents		Emergency Response Team Respondents		Average	
	WM	Verbal Interpretation	WM	Verbal Interpretation	WM	Verbal Interpretation
1. Improving road infrastructure (repairing and expanding roads) can shorten the response time of emergency responders in responding to vehicular accidents in the province.	4.24	Strongly Agree	4.45	Strongly Agree	4.35	Strongly Agree
2. The construction of dedicated emergency lanes on major roads can significantly improve the response time of emergency responders by providing them with unobstructed routes, reducing delays caused by traffic congestion, and ensuring quicker access to vehicular accident sites within the province.	4.37	Strongly Agree	4.55	Strongly Agree	4.46	Strongly Agree
3. Upgrading communication and dispatch systems, such as an on-demand service app, a centralized website, or an easily accessible Facebook page, should be implemented to improve coordination between the community and emergency responders. This will enable people to report accidents quickly and request assistance more efficiently, ultimately reducing emergency response time.	4.39	Strongly Agree	4.53	Strongly Agree	4.46	Strongly Agree
4. The strategic placement of CCTV cameras and streetlights in areas where	4.37	Strongly Agree	4.58	Strongly Agree	4.48	Strongly Agree

vehicular accidents frequently occur within the province can aid in monitoring incidents and reducing the response time of emergency vehicles by providing real-time visibility and quicker identification of accidents.						
5. The strategic placement of emergency stations near high-traffic areas or accident-prone locations within the province can help reduce the response time of emergency vehicles by ensuring quicker access to incident sites and providing immediate assistance.	4.37	Strongly Agree	4.47	Strongly Agree	4.42	Strongly Agree
6. Emergency response time can be improved by increasing the number of emergency vehicles and personnel, ensuring faster deployment and more efficient handling of vehicular accidents within the province.	4.35	Strongly Agree	4.55	Strongly Agree	4.45	Strongly Agree
7. Providing additional information and education to the community about emergency procedures during vehicular accidents can enhance public awareness, encourage prompt and appropriate actions, and contribute to faster emergency response times in the province.	4.40	Strongly Agree	4.76	Strongly Agree	4.58	Strongly Agree

Legend: 1.00-1.80 – Strongly Disagree; 1.81-2.60 – Disagree; 2.61-3.40 – Partially Agree; 3.41-4.20 – Agree; 4.21-5.00 – Strongly Agree

Table 8 illustrates the community members and emergency responders' perceptions on the possible effect of faster response times for victims of vehicular accidents in the province. In general, the respondents have strong agreement on all the identified indicators.

As shown by the findings, the respondents strongly agreed that additional education and training for the community on emergency procedures during vehicular accidents will significantly reduce the response time of emergency responders in the province (AM = 4.60). This finding again emphasizes the need to strengthen community involvement and giving them adequate knowledge and trainings so that they will be skilled enough to assist in emergency response and act as multipliers.

Moreover, the respondents strongly agreed that a faster response time will result in the quicker transportation of victims of vehicular accidents to medical facilities in the province (AM = 4.55).

The strong agreement among both community members and emergency responders on all indicators reflects a shared understanding of the life-saving potential of prompt EMS interventions. The increased community education and training on emergency procedures would significantly reduce the

response time. This supports the notion about empowering communities which plays a crucial role in strengthening local or community emergency response capabilities.

Practically, involving the community in emergency medical services is supported by research studies as a way of reducing EMS response time. Trained community members can be initial responders or providers of such critical information during emergencies. They can take proactive steps such as contacting emergency services, offering basic first aid, or guiding EMS personnel to the location. This approach aligns with contemporary public health strategies that prioritize community-driven interventions for emergency readiness and response.

The study of Byrne et al. (2019) underscored the importance of prompt EMS response in 2,268 counties across the United States. They revealed a strong connection between delayed EMS response times and increased fatality rates from motor vehicle crashes. Even after accounting for factors like rural versus urban locations, time spent on-scene and in transit, availability of trauma care, and traffic safety regulations, the study found that delays in EMS intervention were a significant contributor to MVC fatalities. These findings support the data in Table 9, reinforcing the critical impact of response time on survival rates, regardless of whether the setting is rural or urban.

Moreover, the respondents' strong agreement that quicker EMS response leads to faster transportation of victims to medical facilities ($AM = 4.55$) resonates with the evidence presented by Byrne et al. (2019). Their study demonstrated that reduced response and transport times play a vital role in increasing the chances of survival following vehicular accidents. Delays in either phase can severely impact the "golden hour", the critical period immediately following a traumatic injury when prompt medical treatment is most effective.

Table 8. *Possible Effect of Faster Response Times for Victims of Vehicular Accidents in the Province of Marinduque*

Indicators	Community Member Respondents		Emergency Response Team Respondents		Average	
	WM	Verbal Interpretation	WM	Verbal Interpretation	WM	Verbal Interpretation
1. A faster response time will result in the quicker transportation of victims of vehicular accidents to medical facilities in the province.	4.38	Strongly Agree	4.71	Strongly Agree	4.55	Strongly Agree
2. A faster emergency vehicle response time can significantly reduce fatalities and severe injuries in vehicular accidents within the province.	4.35	Strongly Agree	4.68	Strongly Agree	4.52	Strongly Agree
3. Improving response time of emergency responders to vehicular accidents will enhance public trust and confidence in emergency services in the province.	4.35	Strongly Agree	4.68	Strongly Agree	4.52	Strongly Agree
4. Additional education and training for the community on emergency procedures during vehicular accidents will significantly reduce the response time of emergency responders in the province.	4.38	Strongly Agree	4.82	Strongly Agree	4.60	Strongly Agree

Legend: 1.00-1.80 – Strongly Disagree; 1.81-2.60 – Disagree; 2.61-3.40 – Partially Agree; 3.41-4.20 – Agree; 4.21-5.00 – Strongly Agree

Part III: Strategic Intervention and Recommendations

Table 9 illustrates the significant difference in the perceptions of community members and emergency responders. As observed, the only significant discrepancy in their views pertains to the challenges faced by emergency responders in dealing with vehicular accidents. The computed t-value of -4.6190116, which exceeds the critical t-value, and the p-value of 0.000, which is below 0.05, indicate that the null hypothesis suggesting no significant difference in their perceptions is rejected. This suggests that the respondents perceive this issue differently, likely due to their distinct roles or perspectives on the matter. Community members, though they may occasionally experience these situations, are primarily external observers, whereas emergency responders are directly involved in handling these incidents.

In contrast, the t-values related to perceptions about the average response time of emergency responders, the community's influence on response times, and the effect of the province's infrastructure and road network on responder efficiency are all below the critical t-values. Moreover, the p-values are above the 0.05 threshold, indicating that there are no significant differences in respondents' views on these factors, with minimal variations in the ratings provided. This consistency aligns with recent findings, such as those by Richards et al. (2023), which noted that delays in EMS response in rural areas are often attributed to long travel distances, poor infrastructure, and inadequate equipment—issues commonly faced by similar communities. In the context of the Philippines, Cruz et al. (2023) highlighted that inadequate training for EMS personnel and limited road networks remain persistent challenges in resource-constrained provinces, leading to a unified understanding among stakeholders and consistent assessments of EMS performance.

In areas like Marinduque, which are geographically isolated, the terrain itself becomes a significant factor. Flores et al. (2021) explained that the island province's difficult landscape and underdeveloped infrastructure compel emergency responders to take longer, sometimes indirect routes, resulting in delayed interventions that negatively affect patient outcomes. These structural challenges are widely recognized by both local residents and emergency personnel, which helps explain the observed lack of significant variation in their perceptions. Moreover, the issue of communication breakdowns is a factor identified by Lian and Wang (2024), adding another layer to the delay in response times. Inadequate coordination between dispatchers and responders, coupled with outdated or absent GPS and communication systems, leads to inefficiencies in mobilization. This again is a shared reality among emergency responders and community members in remote regions, reinforcing homogeneity in their assessment.

Table 9. *Significant Difference Between the Perceptions of Community Members and Emergency Responders*

Variables	t	P-value	t critical two-tail	Decision	Impression at 0.05 level of significance
Average response time of emergency responders to vehicular accidents	-0.5674199	0.59101102	2.44691185	Fail to Reject Ho	Not Significant
Role of the Community and their effect on the response time of emergency responders in vehicular accidents	-1.4168291	0.19427567	2.30600414	Fail to Reject Ho	Not Significant
How the current infrastructure and road network in the province of Marinduque affect the efficiency of emergency responders during vehicular accidents	0.49840548	0.62593676	2.14478669	Fail to Reject Ho	Not Significant

Existing challenges faced by emergency responders in the province of Marinduque when addressing vehicular accidents	-4.6190116	0.0005912	2.17881283	Reject Ho	Significant
---	------------	-----------	------------	-----------	-------------

Legend: If $t > t_{critical}$, reject the null hypothesis; if p is less than .05, the result is statistically significant.

CONCLUSION

Based on the findings, the following conclusions are derived:

The arrived response time of emergency responders to vehicular accidents in the province is generally delayed occurring beyond the ideal seven-minute mark. The perceptions of the community members and emergency responders on the impact of the community on the response time of emergency responders to vehicular accidents reveals that emergency responders and residents have the highest agreement on the community participation providing first aid or early coordination with emergency responders which significantly reduce the response time and ensure immediate medical attention for severe injuries.

Both respondents acknowledged that the existing traffic management system in the province efficiently prioritizes emergency vehicles, leading to a reduction in response time to vehicle accidents. They partially agreed that the road network's design and layout within the province hinder effective routing for emergency responders, leading to delays in response times to vehicular accidents.

Emergency responders in Marinduque encounter challenges when dealing with vehicular accidents, such as poor signal reception or malfunctioning communication devices, which disrupt coordination and complicate the transmission of essential information and requests for further assistance.

The distance of the accident site from the nearest emergency service station also has a significant impact on response time, especially in remote or hard-to-reach areas in the province and traffic congestion in the province causes significant delays in responding to vehicular accidents. These findings reveal strategies that should be implemented to reduce the response time of emergency responders to vehicular accidents in the province of Marinduque as both community members and emergency responders strongly agreed that providing additional information and education to the community about emergency procedures during vehicular accidents can enhance public awareness, encourage prompt and appropriate actions, and contribute to faster emergency response times in the province and placement of CCTV cameras and streetlights in areas where vehicular accidents frequently occur within the province which can aid in monitoring incidents and reducing the response time of emergency vehicles by providing real-time visibility and quicker identification of accidents.

There was no significant difference in the perceptions of emergency responders and local residents on the existing challenges when responding to vehicular accidents while their perceptions differed on the average response time of emergency responders, the community's influence on response times, and the effect of the province's infrastructure and road network on responder efficiency.

REFERENCES

- Anderson, J., Chen, M., Gupta, L., Patel, S., & Thompson, R. (2023). Urban and rural road networks and emergency vehicle performance. *Transportation Research Part B: Methodological*, 161, 112–126.
<https://doi.org/10.1016/j.trb.2023.03.002>
- ASTIG PH. (2023, November 10). *Pinoys get faster help: Direct 911 calls to local responders*. ASTIG: Philippine News & Reviews. <https://www.astig.ph>
- BaliTambayan. (2022, December). *8-anyos na batang nangangaroling sa Marinduque, patay matapos mabundol ng van* [Child fatally struck by van while caroling in Marinduque]. GMA News Online.

- <https://www.gmanetwork.com/news/balitambayan/promdi/855267/8-anyos-na-batang-nangangaroling-sa-marinduque-patay-matapos-mabundol-ng-van/story/>
- Basnawi, A. (2023). Addressing challenges in EMS department operations: A comprehensive analysis of key issues and solution. *Reports*, 1(1), Article 3. <https://doi.org/10.3390/reports1010003>
- Bijani, M., Ali Cheraghi, M., Reza Heydari, M., Khaleghi, A., & Reza Gholami, M. (2021). Major challenges and barriers in clinical decision-making as perceived by emergency medical services personnel: A qualitative content analysis. *BMC Emergency Medicine*, 21(1), Article 11. <https://doi.org/10.1186/s12873-021-00408-4>
- Byrne, J. P., Mann, N. C., Dai, M., Mason, S. A., Karanicolas, P. J., Rizoli, S., Nathens, A. B., & Tallon, J. M. (2019). Association between emergency medical service response time and motor vehicle crash mortality in the United States. *JAMA Surgery*, 154(4), 286–293. <https://doi.org/10.1001/jamasurg.2018.5097>
- Cruz, J. (2023). Improving emergency response in developing regions: Lessons from the Philippines. *International Journal of Emergency Management*, 21(4), 456–472. <https://doi.org/10.1504/IJEM.2023.1004567>
- Dalizon, A. P. (2024, November 30). QCPD's 3-minute response time at its best. *Journal News*. <https://journalnews.com.ph/qcps-3-minutes-response-time-at-its-best>
- Department of the Interior and Local Government. (2022). *Annual report on emergency response times in MIMAROPA*. <https://www.dilg.gov.ph>
- Estember, R., Isip, I. G., & Misal, M. A. (2020, March). *An optimization-based approach model for the improvement of the performance of emergency medical service ambulances* [Paper presentation]. 9th Annual International Conference on Industrial Engineering and Operations Management, Dubai, UAE. <https://index.ieomsociety.org/index.cfm/article/view/ID/1958>
- Flores, L. J., Tonato, R. A., Dela Paz, G. A., & Ulep, V. G. (2021). Optimizing health facility location for universal health care: A case study from the Philippines. *PLOS ONE*, 16(9), Article e0256821. <https://doi.org/10.1371/journal.pone.0256821>
- Harper, L. (2023). Reducing emergency vehicle response time: Strategies and technologies. *Transportation Research Part A: Policy and Practice*, 168, 115–130. <https://doi.org/10.1016/j.tra.2023.02.004>
- Lian, C., & Wang, J. (2024). Multi-actor cooperation for emergency supply support: A simulation of behavior diffusion based on social networks. *Natural Hazards*, 120(3), 1241–1262. <https://doi.org/10.1007/s11069-023-06256-8>
- Lu, J. K. (2022). The impact of emergency medical services response times on patient outcomes: A systematic review. *Prehospital Emergency Care*, 26(1), 55–68. <https://doi.org/10.1080/10903127.2022.2032445>
- Lu, J. L., Herbosa, T. J., & Lu, S. F. D. (2022a). Analysis of transport and vehicular road crash cases in Metro Manila from 2016 to 2020. *Acta Medica Philippina*, 56(15), 18–26. [suspicious link removed]
- Lu, J. L., Herbosa, T. J., & Lu, S. F. D. (2022b). Analysis of transport and vehicular crash cases using the Online National Electronic Injury Surveillance System (ONEISS) from 2010 to 2019. *Acta Medica Philippina*, 56(1), 45–52. [suspicious link removed]
- Marinduque News. (2018). *Slippery roads lead to bus overturn in Torrijos*. <https://marinduquenews.com/bus-tumaob-sa-torrijos-mga-pasahero-ligtas/>
- Marinduque News. (2019a). *18-year-old student dies in Santa Cruz motorcycle collision*. <https://marinduquenews.com/estudyanteng-biktima-sa-karambola-ng-3-motorsiklo-sa-santa-cruz-pumanaw-na/>
- Marinduque News. (2019b). *Heavy vehicle crash in Torrijos results in one death and ten injuries*. <https://marinduquenews.com/1-patay-10-sugatan-sa-banggaan-ng-truck-chariot-sa-torrijos/>
- Marinduque News. (2019c). *Motorcycle crash in Buenavista exposes poor road infrastructure*. <https://marinduquenews.com/1-sugatan-sa-banggaan-ng-motorsiklo-delivery-truck-sa-buenavista/>
- Marinduque News. (2021). *Municipal health officer succumbs to motorcycle collision injuries*. <https://marinduquenews.com/municipal-health-officer-ng-boac-nasawi-sa-aksidente-sa-motorsiklo/>
- Mendezona, B. (2013, May 8). *Security matters: Emergency vehicle operation*. Security Matters Magazine. <https://securitymatters.com.ph/2013/05/08/emergency-vehicle-operations/>
- Navarro, A., & Latigar, J. (2022). *Road and rail transport infrastructure in the Philippines: Current state, issues, and challenges* (Discussion Paper Series No. 2022-34). Philippine Institute for Development Studies. <https://pidswebs.pids.gov.ph/CDN/document/pidsdps2234.pdf>

- Rezvani, S. M. H. S. (2024). Urban resilience index for critical infrastructure: A scenario-based approach to disaster risk reduction in road networks. *Sustainability*, 16(10), Article 4143. <https://doi.org/10.3390/su16104143>
- Richards, S. (2023). Emergency medical services in remote and rural areas: Challenges and solutions. *Journal of Rural Health*, 39(2), 234–247. <https://doi.org/10.1111/jrh.12567>
- Rural Health Information Hub. (2024). *Rural emergency medical services (EMS) and trauma*. <https://www.ruralhealthinfo.org/topics/emergency-medical-services>
- Santos, V. (2023). Emergency response times and road infrastructure in the Philippines: A regional analysis. *Journal of Transportation and Public Safety*, 12(3), 215–230.
- Simmons, R. (2023). The role of road infrastructure in emergency response times: A case study. *Journal of Transportation Engineering*, 149(7), Article 04323002. <https://doi.org/10.1061/JTEPBS.0000576>
- Thompson, J. R., Patel, A., & Ramos, M. E. (2020). Regional disparities in emergency medical services: A comparative study of high- and low-income settings. *Prehospital and Disaster Medicine*, 35(4), 389–395. <https://doi.org/10.1017/S1049023X20000538>
- UnitekEMT. (2024, October 19). *Community outreach: EMTs educating and engaging with the public*. <https://www.unitekemt.com/blog/community-outreach-emts-educating-and-engaging-with-the-public/>
- U.S. Fire Administration. (2023). *Emergency vehicle and roadway operation safety*. Federal Emergency Management Agency. <https://www.usfa.fema.gov/a-z/vehicle-roadway-safety.html>
- Virola, M. (2022, December 5). 3 die, 28 hurt as jeepney carrying wedding guests falls into ravine in Marinduque. *Philippine Daily Inquirer*. <https://newsinfo.inquirer.net/1701263/3-die-28-hurt-as-jeepney-carrying-wedding-guests-falls-into-ravine-in-marinduque>
- Zhou, X., Chen, Y., Li, Y., Liu, B., & Yu, Z. (2023). Spatiotemporal data-driven multiperiod relocation optimization of emergency medical services: Maximum equality objective. *ISPRS International Journal of Geo-Information*, 12(7), Article 269. <https://doi.org/10.3390/ijgi12070269>