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Attributions of traffic accidents in Santa Cruz Marinduque: Basis for traffic management innovations

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Index Terms:

traffic accidents, road safety, traffic management, behavioral factors, Santa Cruz Marinduque, criminology, driver behavior, mixed-method research

Abstract. This mixed-method exploratory study investigated the attributions of traffic accidents in Santa Cruz, Marinduque, using a triangulation design that simultaneously collected and integrated quantitative and qualitative data. The quantitative component involved structured survey questionnaires administered to 300 motorists and 30 traffic enforcers, while the qualitative component employed semi-structured interviews with 16 key informants—eight motorists and eight enforcers—selected through purposive sampling. Eight attribution domains were examined: cultural, geographical, contextual, social, economic, political, environmental, and behavioral. Results showed that behavioral factors received the highest weighted mean ratings from both motorists (WM=3.69, Very High) and enforcers (WM=3.74, Very High), underscoring that reckless driving, mobile phone use, impaired driving, and inattentiveness are the most critical and preventable causes of road accidents. Environmental factors ranked second (WM=3.51 and 3.50), driven by heavy rainfall, typhoons, poor road maintenance, and erosion. Contextual factors, particularly inadequate lighting and signage, also received very high agreement. The socio-demographic profile of accident-involved motorists was dominated by males aged 26–45 with non-professional licenses, and 9.3% were found to be driving without any license. Qualitative analysis yielded 24 themes distributed across eight domains, with behavioral themes—lack of discipline, impaired driving, and emotional instability—emerging most prominently. Based on integrated findings, seven evidence-based innovations are proposed: a Driver Values Formation Program, Community-Based Road Safety Watch, Digital Road Monitoring and E-Citation System, Real-Time Weather Alerts and Road Risk Mapping, Safety Subsidy Fund, Municipal Traffic Policy Review Task Force, and a Road Safety Education Integration Program. These multi-sectoral innovations are designed to reduce accidents through behavioral change, infrastructure improvement, governance reform, and community empowerment in Santa Cruz, Marinduque.

Introduction

Traffic accidents represent a pressing global public health crisis, claiming over 1.35 million lives each year and injuring tens of millions more, with the economic burden in some nations reaching as high as 3% of GDP (WHO, 2022). The World Health Organization identifies road traffic injuries as the leading cause of death among individuals aged 5 to 29 years globally, disproportionately affecting low- and middle-income countries (LMICs), which account for approximately 93% of all road fatalities (WHO, 2022). In recognition of this crisis, the United Nations incorporated the reduction of road traffic deaths and injuries by 50% as a specific target under Sustainable Development Goal 3.6, compelling national and local governments to adopt coordinated, evidence-based road safety measures (United Nations, 2020). Despite significant global progress in urban traffic management, rural areas in developing countries—

including the Philippines—continue to face escalating accident rates driven by underinvestment in infrastructure, cultural permissiveness toward risky behaviors, and limited enforcement capacity.

In Asia, rapid urbanization and motorization have intensified the traffic accident burden. The Asian Development Bank (2021) reports that Southeast Asian countries experience particularly high fatality rates, often attributed to widespread non-use of helmets and seatbelts, excessive speeding, poor road conditions, and weak enforcement of traffic laws. In the Philippines, the Philippine Statistics Authority (2023) has recorded a consistent upward trend in traffic-related incidents, with rural provinces increasingly contributing to national statistics. The Department of Health (2022) estimated that road traffic accidents account for over 12,000 fatalities annually across the country, placing immense pressure on healthcare systems, local economies, and families.

Santa Cruz, the largest municipality in Marinduque Province, presents a compelling case for localized road safety research. Statistics from the Marinduque Police Provincial Office (MPPO, 2023) reveal that traffic accidents in the municipality increased by 25% from 2020 to 2023, with motorcycles and tricycles involved in over 70% of reported cases. Fatalities and serious injuries account for 40% of all incidents, reflecting the severity of the problem. The area's predominantly rural character, narrow and winding mountain roads, reliance on motorcycles as the primary mode of transportation, limited road maintenance resources, and cultural practices surrounding festivities create a unique and complex accident landscape that differs markedly from urban centers.

Contributing factors in Santa Cruz are multidimensional. Cultural attitudes toward traffic compliance, including tolerance of risky behaviors and informal enforcement norms such as the 'palakasan' (favoritism) system, have been identified as significant barriers to road safety improvement (Tiwari & Jain, 2023). Economic constraints prevent many low-income motorists from maintaining their vehicles or purchasing essential safety gear like helmets, increasing the risk of mechanical failure-related accidents (Santos & Lopez, 2022). The tropical climate, frequent heavy rains, landslides, and poor drainage systems create recurring environmental hazards that compromise road safety, particularly on the mountainous roads connecting barangays (Gomez & Cruz, 2020). At the institutional level, limited political will, insufficient funding for enforcer training, and inconsistent implementation of traffic ordinances have undermined efforts to systematically reduce accidents. Despite these well-documented challenges, academic research on traffic accidents in rural Philippine municipalities like Santa Cruz remains sparse. Most existing studies focus on Metro Manila and other urban centers, leaving a significant gap in understanding the context-specific factors that shape road safety in rural island settings. This research gap is particularly critical because accident prevention strategies effective in urban environments may not translate to the unique geographical, socioeconomic, and cultural realities of rural Marinduque. The present study addresses this gap by conducting a comprehensive, community-grounded investigation into the attributions of traffic accidents in Santa Cruz and proposing actionable, evidence-based innovations tailored to local needs.

Research questions

This study was guided by the following specific research questions: (1) What is the socio-demographic profile of motorists involved in traffic accidents in Santa Cruz, Marinduque from January 2024 to January 2025? (2) What is the extent of traffic accident attributions in Santa Cruz across cultural, geographical, contextual, social, economic, political, environmental, and behavioral dimensions? (3) How do selected motorists perceive the key factors attributing to traffic accidents in Santa Cruz, Marinduque? (4) Based on the results of the study, what traffic management innovations may be proposed to improve public road safety in Santa Cruz, Marinduque?

Objectives of the study

The general objective of this study was to investigate the major attributions of traffic accidents in Santa Cruz, Marinduque, and to use the findings as a basis for proposing traffic management innovations. Specifically, the study sought to: (1) describe the socio-demographic profile of accident-involved motorists in terms of age, sex, civil status, and type of license; (2) determine the extent of eight attribution domains by computing weighted means and verbal interpretations from both motorist and enforcer respondents; (3) explore, through semi-structured interviews, the qualitative perceptions of motorists and enforcers regarding the root causes of traffic accidents across all eight domains; and (4) synthesize quantitative and qualitative findings to develop a set of multi-sectoral, evidence-based innovations for improving public road safety in Santa Cruz.=

Theoretical framework

This study is anchored in two complementary theoretical frameworks. The Systems Theory of Accident Causation (Leveson, 2020) provides the primary lens, positing that traffic accidents do not arise from a single cause but from the dynamic and complex interaction of multiple subsystems—cultural norms, geographical conditions, social behaviors, economic constraints, political structures, environmental hazards, and individual behaviors—within a broader road safety environment. This theory is particularly appropriate for Santa Cruz because it explains how accidents occur not solely due to driver error but through the convergence of multiple systemic vulnerabilities simultaneously. It also guides the identification of leverage points where targeted interventions can yield the greatest safety improvements across the entire system.

The Multiple Causation Theory (Baysari et al., 2021) complements the Systems Theory by emphasizing that accidents emerge from a web of interrelated contributory factors rather than a single root cause. Applied to Santa Cruz, this theory accommodates the diverse and intersecting influences of poverty, road infrastructure deficiencies, cultural permissiveness, environmental hazards, and individual driving behaviors. By acknowledging that all these factors operate simultaneously and reinforce each other, the theory supports a holistic analytical approach and the rationale for a multi-pronged innovation framework. Together, these theories informed the selection of the eight attribution domains examined in the study and underpinned the proposed integrated road safety innovations.

Significance of the study

The findings and recommendations of this study carry meaningful implications for multiple stakeholders. For the Philippine National Police and the Traffic Management Division of Santa Cruz, the study provides a detailed, locally grounded evidence base for refining enforcement strategies, prioritizing patrol areas, and targeting the most prevalent violations. For the Local Government Unit of Santa Cruz, the study offers a data-driven foundation for updating traffic ordinances, allocating budgets for road safety initiatives, and coordinating with agencies such as the DPWH for infrastructure improvement. For the Land Transportation Office and LTFRB, patterns in licensing and vehicle type can inform regulatory and licensing reforms. For community members and motorists, the study raises awareness about the specific behavioral and environmental factors placing them at risk and empowers them to participate in safety advocacy. For the academic community, the study contributes an original, localized framework for understanding rural road safety in a Philippine island province, filling a gap in the existing literature and providing a replicable methodology for similar research in other rural municipalities.

Methodology

Research design

This study employed a mixed-method exploratory research design utilizing a triangulation framework, a rigorous approach that enables the simultaneous collection of both quantitative and qualitative data to compare, validate, and synthesize findings for a comprehensive understanding of the research problem (Fetters et al., 2020). The triangulation design is especially suited to the complex and multidimensional nature of traffic accident attribution, where numerical data alone cannot capture the cultural, behavioral, and contextual nuances that shape road safety in Santa Cruz. The quantitative component provided measurable, objective evidence on socio-demographic profiles and the extent of attribution factors across eight domains. The qualitative component, conducted through semi-structured interviews, captured the lived experiences, local knowledge, and nuanced perceptions of motorists and enforcers. Findings from both strands were collected simultaneously and integrated at the analysis stage, with each method validating and enriching the other (Creswell & Plano Clark, 2021). This approach aligns with Tashakkori and Teddlie's (2020) recommendation that triangulation strengthens internal validity by identifying convergences and divergences across data sources, enabling a more reliable and defensible interpretation of results.

Research locale and time frame

The study was conducted in Santa Cruz, Marinduque, the largest municipality in the province and its political and economic hub. Santa Cruz is characterized by mountainous terrain with steep and winding roads, a high reliance on motorcycles and tricycles, periodic rainfall and flooding, and limited road safety infrastructure including insufficient lighting and signage. These geographical, environmental, and infrastructural characteristics, combined with the municipality's recorded 25% increase in traffic accidents from 2020 to 2023 (MPPO, 2023), make it an ideal and urgent research locale. The study covered accidents occurring from January 2024 to January 2025, providing a current and time-bounded dataset for analysis.

Population and sampling

The study population comprised two groups. The first group consisted of all 30 traffic enforcers assigned to the Municipal Traffic Division of Santa Cruz under the local government unit and in coordination with the Philippine National Police. Total population sampling was employed for this group to eliminate sampling error and ensure all enforcement perspectives were represented. The second group consisted of the approximately 15,000 registered motorists in the municipality, encompassing motorcycle riders, private four-wheeled vehicle owners, and public utility vehicle operators. Using the Raosoft sample size calculator at a 95% confidence level and 5% margin of error, a sample of 300 motorists was determined. Stratified random sampling was applied proportionally across three vehicle-type strata: 180 motorcycle drivers (60%), 90 private vehicle owners (30%), and 30 PUV operators (10%), reflecting the actual vehicle composition in Santa Cruz according to LTO estimates (2022). Both traffic violators and non-violators were included, ensuring the sample represented the general motoring public rather than a high-risk subgroup alone.

For the qualitative phase, purposive sampling was employed to select 16 key informants: eight traffic enforcers with diverse assignments (national roads, town centers, school zones, special events) and eight motorists with varied vehicle types and driving experiences, including those who had directly experienced or witnessed traffic accidents. Selection criteria for enforcers required a minimum of two years' service in Santa Cruz, while motorists required at least three years of driving experience. Both violators and non-violators were eligible, provided they met the criteria and could offer substantive narratives on road safety.

Research instrument

The quantitative instrument was a structured questionnaire divided into two parts. Part I collected socio-demographic and professional profile data: age, sex, civil status, type of driving license, occupation, employment status, estimated income, vehicle ownership, and years of driving experience. Part II contained 56 Likert-scale items across eight attribution domains (seven items per domain), rated on a four-point scale: 4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree. The domains covered cultural, geographical, contextual, social, economic, political, environmental, and behavioral factors. Content validity was established through review by a panel of three subject-matter experts in traffic management, criminology, and public safety. Face validity was confirmed through informal review with local government officials and traffic safety advocates. Reliability was assessed via Cronbach's Alpha, which exceeded 0.70 for all domains, confirming acceptable internal consistency.

The qualitative instrument was a semi-structured interview guide containing eight open-ended questions corresponding to the eight attribution domains. Sample questions included: 'How do cultural practices or norms in Santa Cruz influence traffic behavior and contribute to accidents?' and 'What are some common driver behaviors observed in Santa Cruz that may lead to traffic accidents?' The guide was validated through expert review and refined through a pilot test with a small sub-sample of participants before full deployment. This iterative refinement process ensured that questions were clear, culturally appropriate, and capable of eliciting the depth of information required.

Data gathering procedure

Quantitative data collection

Following formal coordination with the Municipal Government of Santa Cruz, the Municipal Traffic Division, and barangay offices, data collection was conducted over a one-week period. Respondents were given the option of completing surveys through pen-and-paper questionnaires or Google Forms to maximize accessibility and response rates across varying levels of digital literacy. Clear written instructions were provided to ensure consistency. After collection, all responses were compiled, cleaned for missing values and inconsistencies, coded, and entered into SPSS version 26 for statistical analysis. Data cleaning involved identifying and resolving incomplete responses and verifying that demographic categories were correctly entered before analysis commenced.

Qualitative data collection

Semi-structured interviews were conducted at times and locations convenient for each participant, in person or via virtual platforms based on preference. Each session began with a briefing on the study's purpose and a reiteration of confidentiality

assurances to establish trust and openness. With participants' written consent, interviews were audio-recorded and supplemented by researcher field notes capturing non-verbal cues and contextual observations. Transcription was conducted verbatim in Filipino and English, with Filipino responses translated by the researcher. To ensure inter-coder reliability, two independent coders analyzed the same set of transcripts, with disagreements resolved through consensus discussion. Data triangulation was achieved by cross-verifying interview findings against traffic accident records and official government statistics.

Data analysis

Quantitative data were analyzed using SPSS version 26. Frequency distributions and percentage computations were used to describe the socio-demographic profile of respondents. Weighted means and standard deviations were computed for each of the 56 attribution items and aggregated into composite domain scores. The following verbal interpretation scale was applied: 3.51–4.00 = Strongly Agree/Very High; 2.51–3.50 = Agree/High; 1.51–2.50 = Disagree/Low; 1.00–1.50 = Strongly Disagree/Very Low. Qualitative data underwent thematic analysis following Braun and Clarke's (2006) six-phase framework: familiarization with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final thematic report. Themes were identified inductively from participant narratives and deductively verified against the eight conceptual domains. Triangulation was achieved by systematically comparing qualitative themes with quantitative patterns to identify convergences, divergences, and complementary insights. All ethical protocols were observed throughout, including voluntary participation, informed consent, anonymity of responses, and accurate reporting of findings.

Results and Discussion

Socio-demographic profile of accident-involved motorists (SOP 1)

Table No. 1 presents the socio-demographic characteristics of the 300 motorists involved in traffic accidents in Santa Cruz, Marinduque, from January 2024 to January 2025.

Variable	f	Percent
Age		
25 years and below	23	7.7
26–35 years old	115	38.3
36–45 years old	92	30.7
46–55 years old	66	22.0
56 years old and above	4	1.3
Total	**300**	**100**
Sex		
Male	230	76.7
Female	70	23.3
Total	**300**	**100**
Civil Status		
Single	98	32.7
Married	191	63.7
Widowed	8	2.7
Separated	3	1.0
Total	**300**	**100**

Type of License		
Student permit	10	3.3
Non-professional	166	55.3
Professional	96	32.0
No license	28	9.3
Total	**300**	**100**

Table No. 1. Socio-demographic profile of accident-involved motorists, Santa Cruz, Marinduque (January 2024–January 2025)

The age distribution reveals that motorists aged 26–35 constitute the largest accident-involved group (38.3%), followed by those aged 36–45 (30.7%) and 46–55 (22.0%). Combined, these age brackets account for 69% of all cases, suggesting that early to mid-career adults with high daily mobility demands—commuting to work, transporting family members, and conducting commercial activities—face the greatest exposure to road risks. Younger motorists aged 25 and below represent 7.7% of cases, a proportion that, while smaller, aligns with global evidence linking younger drivers to riskier behaviors such as speeding, distracted driving, and reduced risk perception (Javid et al., 2022). Conversely, the low representation of drivers aged 56 and above (1.3%) likely reflects lower driving frequency among older adults in the rural context of Santa Cruz. Gender analysis confirms a pronounced male dominance in the accident profile at 76.7%, consistent with global and regional patterns that associate male drivers with higher rates of aggressive and risk-taking behaviors (Yardley et al., 2023). In Santa Cruz, the high representation of males is also a function of gendered transportation roles, where men disproportionately operate motorcycles and PUVs as primary income sources. The 23.3% female involvement nonetheless signals that women are not insulated from road risks and should be included in targeted safety education campaigns. Regarding civil status, 63.7% of involved motorists were married. This finding differs from studies in other contexts where single individuals are identified as higher-risk due to fewer familial responsibilities, suggesting that in Santa Cruz the demographic prevalence of married active adults in daily commuting overrides any protective effect of marital responsibility. Finally, the finding that 9.3% of accident-involved motorists were driving without any license is particularly alarming, echoing patterns across South and Southeast Asia where unlicensed driving substantially elevates accident risk (Javid et al., 2022). The high proportion of non-professional license holders (55.3%) also raises concerns about the adequacy of driver training, particularly for navigating the municipality's challenging mountain roads.

Cultural attributions of traffic accidents (SOP 2)

Table No. 2 presents the weighted means and verbal interpretations of cultural attribution indicators as perceived by motorists and enforcers in Santa Cruz, Marinduque.

Cultural Attribution	Motorists Mean	SD	VI	Enforcers Mean	SD	VI
Cultural attitudes toward road safety significantly influence traffic accidents.	3.38	0.60	H	3.47	0.68	H
Local customs and traditions impact how drivers follow traffic laws.	3.25	0.60	H	3.37	0.81	H
Religious festivals and events contribute to increased traffic risks.	3.15	0.74	H	3.33	0.71	H
Public respect for traffic rules varies based on community beliefs.	3.24	0.62	H	3.27	0.83	H
Traffic enforcers are more effective when they understand local cultural norms.	3.39	0.65	H	3.60	0.50	VH
The lack of road safety education in local culture contributes to accidents.	3.62	0.56	VH	3.53	0.78	VH

Community acceptance of risky driving behavior increases accident likelihood.	3.47	0.61	H	3.43	0.73	H
Composite Weighted Mean	**3.36**	**0.42**	**H**	**3.43**	**0.55**	**H**

Legend: 3.51–4.00 = Strongly Agree/Very High (VH); 2.51–3.50 = Agree/High (H); 1.51–2.50 = Disagree/Low (L); 1.00–1.50 = Strongly Disagree/Very Low (VL)

Table No. 2. Cultural attributions of traffic accidents in Santa Cruz, Marinduque

The composite weighted means for cultural attributions are 3.36 (High) for motorists and 3.43 (High) for enforcers, both supported by low standard deviations indicating consistent agreement across respondents. The item receiving the highest rating from both groups is 'The lack of road safety education in local culture contributes to accidents' (motorists WM=3.62, VH; enforcers WM=3.53, VH). This finding reflects a deeply embedded gap in cultural transmission of road safety values, where driving norms are informally passed down through observation and peer behavior rather than through structured education. Alcantara et al. (2021) similarly identified that road safety behavior in rural Philippine communities is shaped more by informal cultural learning than by formal instruction, creating persistent gaps in knowledge and compliance. The item receiving the lowest rating—'Religious festivals and events contribute to increased traffic risks' (motorists WM=3.15; enforcers WM=3.33)—while still within the 'Agree' range, suggests that while fiestas are recognized as risk periods, respondents may perceive them as temporary or manageable rather than systemic contributors. The higher standard deviations for this item reflect diverse personal experiences during such events. Lopez and Cruz (2022) found that enforcer effectiveness improved significantly in communities where cultural sensitivity was incorporated into enforcement training, supporting the high rating given to the item on cultural understanding among traffic enforcers (enforcers WM=3.60, VH).

Behavioral attributions of traffic accidents (SOP 2, continued)

Table No. 3 presents the behavioral attribution indicators, which produced the highest composite weighted means across all eight domains.

Behavioral Attribution	Motorists Mean	SD	VI	Enforcers Mean	SD	VI
Reckless driving behaviors (e.g., overspeeding, sudden lane changes) are major causes of accidents.	3.77	0.45	VH	3.73	0.45	VH
The use of mobile phones while driving contributes significantly to accidents.	3.69	0.50	VH	3.83	0.38	VH
Fatigue and drowsy driving are common causes of traffic accidents.	3.59	0.52	VH	3.70	0.47	VH
Drivers under the influence of alcohol or drugs are more likely to cause accidents.	3.77	0.46	VH	3.77	0.43	VH
Failure to follow basic traffic rules (e.g., wearing seatbelts or helmets) leads to more accidents.	3.65	0.56	VH	3.70	0.47	VH
Aggressive driving behavior contributes to frequent road accidents.	3.69	0.49	VH	3.77	0.43	VH
Inattentiveness and distracted driving play a major role in causing accidents.	3.66	0.50	VH	3.70	0.47	VH
Composite Weighted Mean	**3.69**	**0.42**	**VH**	**3.74**	**0.38**	**VH**

Legend: 3.51–4.00 = Strongly Agree/Very High (VH); 2.51–3.50 = Agree/High (H); 1.51–2.50 = Disagree/Low (L); 1.00–1.50 = Strongly Disagree/Very Low (VL)

Table No. 3. Behavioral attributions of traffic accidents in Santa Cruz, Marinduque

Behavioral factors received the highest composite weighted means across all eight domains, with motorists rating them at 3.69 (VH) and enforcers at 3.74 (VH). The very low standard deviations (0.42 and 0.38 respectively) indicate exceptional consistency of agreement—arguably the strongest consensus finding in the entire study. The highest-rated item by enforcers is 'The use of mobile phones while driving contributes significantly to accidents' (WM=3.83, SD=0.38), while both groups equally rate 'Reckless driving behaviors' and 'Drivers under the influence of alcohol or drugs' at 3.77. These findings converge with Santos and Ramirez (2021), who confirmed distracted and impaired driving as leading causes of accidents in rural Philippine municipalities, and with Cruz and De Leon (2022), who linked mobile phone use among motorcycle and tricycle drivers to rising collision rates in areas with limited enforcement. The slightly lower rating for 'Fatigue and drowsy driving' (motorists WM=3.59; SD=0.52) indicates marginally more variability in perception, possibly because fatigue is less visible and more difficult to self-diagnose than behaviors like phone use or alcohol consumption. Nevertheless, Toralba and Reyes (2024) flagged drowsy driving as an emerging concern, especially among public utility drivers working extended hours in rural routes. The overall pattern from behavioral attribution data is unambiguous: driver behavior—characterized by a lack of self-control, disregard for regulations, and impaired judgment—is perceived by both groups as the most direct and preventable category of accident cause in Santa Cruz.

Geographical attributions of traffic accidents (SOP 2, continued)

Geographical factors received composite weighted means of 3.35 (H) for motorists and 3.41 (H) for enforcers. The standout item for both groups was 'Road conditions worsen during the rainy season, leading to more accidents' (motorists WM=3.59, SA; enforcers WM=3.63, SA), the only item in this domain to reach the Strongly Agree threshold. Santa Cruz's mountainous terrain and inadequate drainage systems make roads particularly treacherous during Marinduque's frequent heavy rainfall periods. Tan and Villanueva (2021) confirmed that poor drainage systems in rural Luzon significantly increase accident rates during rainy months, while Gonzales and Javier (2023) found that geographic inaccessibility from emergency response facilities correlates directly with higher fatality rates in rural Visayas—a pattern applicable to the isolated barangays of Santa Cruz. In contrast, 'The mountainous terrain of Santa Cruz contributes to more frequent traffic accidents' received the lowest geographical rating (motorists WM=3.08; enforcers WM=3.17), potentially because drivers accustomed to local routes may have adapted their behavior to terrain challenges over time, reducing their perception of elevated risk. Remote areas difficult to monitor for violations (motorists WM=3.47; enforcers WM=3.43) also ranked highly, reflecting the practical enforcement challenge of policing geographically dispersed barangays with a limited number of traffic enforcers.

Contextual, social, and economic attributions (SOP 2, continued)

Contextual factors showed a composite mean of 3.36 (H) for motorists and 3.47 (H) for enforcers. Poor lighting at night received the highest contextual rating from both groups (motorists WM=3.69, VH; enforcers WM=3.73, VH), followed closely by inadequate road signage (motorists WM=3.61, VH; enforcers WM=3.63, VH). These findings have direct policy implications: targeted investment in solar-powered streetlights and standardized reflective signage in accident-prone areas would address two of the most universally agreed-upon contextual contributors to Santa Cruz's road accidents. De Castro and Alvarado (2023) found that installing visible road signs and markers in provincial towns markedly reduced driver confusion-related collisions. Interestingly, heavy traffic congestion received the lowest contextual rating (motorists WM=3.07; enforcers WM=3.30) with the highest standard deviations, suggesting that respondents experience congestion-related risks differently depending on their routes and daily schedules. In a rural municipality where congestion is less continuous than in urban centers, this lower rating is understandable.

For social factors, the composite means were 3.35 (H) for motorists and 3.48 (H) for enforcers. Social gatherings leading to drunk driving received the most uniform and strong agreement across both groups (motorists WM=3.58, VH; enforcers WM=3.63, VH). Soriano and Paredes (2021) documented the strong association between community festivities and spikes in drunk-driving cases in provincial Philippine towns, directly corroborating this finding. Enforcers placed higher emphasis than motorists on community tolerance of traffic violations (WM=3.53, VH) and the lack of community involvement in road safety (WM=3.53, VH), suggesting that those who enforce laws on a daily basis are more acutely aware of how normative permissiveness undermines their efforts. The presence of pedestrians, particularly children, received the lowest social rating (motorists WM=2.96; enforcers WM=3.27) with the highest standard deviations, reflecting heterogeneous experiences across barangays with varying pedestrian density. Economic factors (motorists=3.28, H; enforcers=3.35, H) primarily highlighted poor road infrastructure due to limited government funding as the top concern, followed by the affordability of safety equipment. Garcia and Mendoza (2024) noted that economic pressures—including financial

deadlines and the need to maximize earnings—also contribute to speeding and risk-taking behaviors among livelihood-dependent drivers, a pattern visible in the moderate ratings for pressure-related driving behaviors in the Santa Cruz data.

Summary of all attribution domains (SOP 2, continued)

Table No. 4 provides an integrated summary of composite weighted means across all eight attribution domains, enabling comparison of their relative influence as perceived by motorists and enforcers.

Attribution Domain	Motorists WM	SD	VI	Enforcers WM	SD	VI
Cultural	3.36	0.42	H	3.43	0.55	H
Geographical	3.35	0.46	H	3.41	0.44	H
Contextual	3.36	0.44	H	3.47	0.44	H
Social	3.35	0.45	H	3.48	0.43	H
Economic	3.28	0.48	H	3.35	0.47	H
Political	3.25	0.53	H	3.33	0.52	H
Environmental	3.51	0.48	H	3.50	0.47	H
Behavioral	3.69	0.42	VH	3.74	0.38	VH
Overall Mean	**3.39**	**0.46**	**H**	**3.46**	**0.46**	**H**

Legend: 3.51–4.00 = Very High (VH); 2.51–3.50 = High (H); 1.51–2.50 = Low (L); 1.00–1.50 = Very Low (VL)

Table No. 4. Summary of attribution domain weighted means, Santa Cruz, Marinduque

The overall weighted means of 3.39 (H) for motorists and 3.46 (H) for enforcers confirm that both groups perceive all eight domains as meaningful contributors to traffic accidents in Santa Cruz, though with varying degrees of urgency. Behavioral factors emerge as the clear frontrunner (motorists=3.69, VH; enforcers=3.74, VH), followed by environmental factors (motorists=3.51, H; enforcers=3.50, H) and contextual factors (motorists=3.36, H; enforcers=3.47, H). Environmental factors received attention particularly around weather events and road degradation, with items such as 'Poor road maintenance due to environmental wear and tear' (motorists WM=3.61, VH) and 'Weather conditions such as heavy rain or typhoons' (enforcers WM=3.60, VH) both rated as Very High. Del Rosario and Bautista (2021) confirmed that coastal and mountainous provinces in the Philippines experience disproportionately higher accident rates during the rainy season due to compromised road surfaces and reduced visibility.

Social and cultural factors ranked moderately (3.35–3.48 range), reflecting the role of community norms, peer influence, and festivity-related drunk driving. Social gatherings leading to drunk driving received strong consensus (motorists WM=3.58, VH; enforcers WM=3.63, VH), while community tolerance of traffic violations was also highly rated by enforcers (WM=3.53, VH). Economic factors showed the lowest scores among the upper domains (motorists=3.28, H; enforcers=3.35, H), with poor road infrastructure due to limited government funding as the highest-rated item (motorists WM=3.46; enforcers WM=3.50). Political factors received the lowest overall ratings (motorists=3.25, H; enforcers=3.33, H), though both groups still agreed that inadequate enforcer training funding and policy inconsistency contribute to the accident problem. The lower political scores may reflect limited direct experience with governance mechanisms rather than an absence of their effect, as Cabrera and Santos (2022) noted that political dynamics—while influential—tend to be less visible to individual road users than environmental or behavioral risks.

Qualitative perceptions of accident attributions (SOP 3)

Thematic analysis of 16 key informant interviews across eight domains yielded 24 distinct themes that deepened and contextualized the quantitative findings. Three overarching cross-domain themes emerged with particular prominence across multiple informant groups. The first is Lack of Discipline and Non-Compliance, consistently cited across behavioral, cultural, and social domains. Participants repeatedly used terms such as 'walang disiplina' (lack of discipline), 'barumbado' (reckless or unruly), and 'pasaway' (defiant) to characterize the prevailing attitude of many motorists. This undisciplined

culture was seen as reinforced by peer norms, limited enforcement, and social permissiveness toward traffic violations. Enforcer 1 described drivers as 'matigas ang ulo, hot-tempered, do not admit mistakes, uneducated behavior, and even aggressive,' while Motorist 4 summarized: 'Walang disiplina, kaskasero, at lasing' (No discipline, reckless, and drunk).

The second cross-domain theme is Infrastructural and Environmental Vulnerability, which emerged prominently in geographical, contextual, and environmental domains. Informants described the physical challenges of navigating Santa Cruz's roads in vivid, experiential terms: 'bulubundukin, kurbada, makipot ang daan' (mountainous, curved, narrow roads); 'baku-bako na kalsada, butas-butas' (bumpy, potholed roads); 'walang sapat na ilaw kapag gabi' (insufficient lighting at night); and 'kakulangan ng signage' (lack of signage). These accounts directly corroborate the quantitative findings that poor lighting, inadequate signage, and rainy-season road deterioration are the leading contextual and environmental contributors. Enforcer 7 summarized the compounding nature of these hazards: 'pag-guho ng lupa o landslide, pagtumba ng mga puno na malalaki sa kalsada at pagbaha' (landslides, fallen large trees, and flooding all make roads impassable).

The third theme is Institutional and Cultural Gaps in Road Safety Education and Enforcement. Across political, cultural, and social domains, both motorists and enforcers identified the absence of road safety knowledge as a fundamental root cause, often more significant than any individual behavioral act. Motorist 2 explained: 'Walang respeto sa traffic enforcer pag hindi edukado ang tao, mahirap makaintindi, mahirap paliwanagan dahil hindi alam ang batas' (There is no respect for enforcers when people are uneducated; they cannot understand or be explained to because they don't know the law). Enforcer 5 echoed: 'Di alam ang road safety' (They simply lack basic road safety knowledge). Institutional weaknesses were also highlighted: 'Patakaran ng munisipyo di naipapatupad' (Municipal policies are not being implemented—Enforcer 6), and 'Kulang ang pondo para sa mga training ng mga traffic enforcers' (Insufficient funding for enforcer training—Motorist 8). Enforcer 2 raised the sensitive issue of favoritism: 'Driver ay related o popular hindi pinapansin ng enforcer' (When the driver is known or related to the enforcer, violations are ignored), pointing to a systemic integrity gap that erodes the deterrent effect of enforcement.

The triangulation of qualitative and quantitative data produced a mutually reinforcing body of evidence. Qualitative narratives provided the 'why' behind numerical patterns—explaining, for instance, why behavioral factors scored highest (because of deeply embedded cultural norms of indiscipline and alcohol use during fiestas) and why political factors scored lowest (because institutional failures, though real, are less directly visible to daily road users than potholes or drunk drivers). Conversely, quantitative data confirmed that the qualitative themes were not isolated anecdotes but widely shared perceptions across hundreds of respondents. This triangulation strengthens the credibility and transferability of the study's conclusions.

Proposed innovations for public road safety (SOP 4)

Drawing from the integrated findings, seven evidence-based innovations are proposed to address the multidimensional accident attribution landscape in Santa Cruz, Marinduque. Table No. 5 summarizes the full innovations framework.

Focus Area	Objective	Strategy	Key Activities	Resources	Expected Outcomes
Behavioral Intervention	Promote responsible driving and emotional regulation	Driver Values Formation Program (DVFP)	Seminars on traffic laws, values, and emotional control; role-playing on road conflict scenarios	Trainers, training modules, seminar venues, LGU funding	Improved driver discipline; reduced violations and accidents
Community Engagement	Strengthen local enforcement and grassroots monitoring	Community-Based Road Safety Watch (CRSW)	Train barangay volunteers for monitoring; create reporting mechanisms; link to PNP	Volunteer coordinators, training kits, monitoring forms, barangay support	Increased community participation; higher compliance rates

Technological Innovation	Enhance law enforcement transparency and efficiency	Digital Road Monitoring and E-Citation System	Equip enforcers with mobile apps and dashcams; train on e-reporting and digital documentation	Mobile devices, enforcement software, IT training support	Reduced corruption; faster processing; data-driven enforcement
Environmental Risk Management	Reduce accident risks from natural and weather hazards	Real-Time Weather Alerts and Road Risk Mapping	Install hazard signage; develop municipal risk maps in partnership with PAGASA/DOST; issue mobile alerts	Coordination with PAGASA/DOST, GIS analysts, signage materials	Fewer weather-related accidents; informed driving public
Economic Support for Safety	Assist low-income drivers with safety compliance	Safety Subsidy Fund and Helmet Distribution Program	Distribute vouchers for vehicle maintenance; donate helmets and reflective gear to indigent motorists	Government funding, LGU budget allocation, cooperative partners	Improved safety gear compliance; reduced mechanical failure accidents
Policy and Governance Reform	Modernize traffic ordinances and enforce road standards	Municipal Traffic Policy Review Task Force	Review and revise ordinances; improve infrastructure funding; institutionalize enforcer training	Legal experts, LGU staff, engineers, civil society representatives	Updated and consistently enforced road safety policies
Youth Education and Advocacy	Instill road safety awareness among youth	Road Safety Education Integration Program (RSEIP)	Integrate safety modules in school curricula; conduct drills and student-led campaigns	DepEd support, teaching guides, instructional materials	Early awareness; long-term behavioral culture change

Table No. 5. Proposed traffic management innovations for Santa Cruz, Marinduque

The Behavioral Intervention through the Driver Values Formation Program (DVFP) directly targets the highest-ranked attribution domain. The DVFP delivers structured seminars combining traffic law education, values formation, and emotional self-regulation training for both licensed and unlicensed drivers. Given the qualitative finding that 'walang disiplina' is a deeply cultural issue rather than merely a knowledge gap, the program must incorporate community storytelling, role-playing exercises, and local case studies from actual Santa Cruz accidents to make the content personally relevant. Trained facilitators from the LGU, PNP, and accredited civil society organizations can conduct sessions at barangay halls, transport terminals, and public markets, reaching drivers outside formal licensing channels.

The Community-Based Road Safety Watch (CRSW) empowers barangay volunteers to serve as frontline safety monitors, reporting violations, near-misses, and hazardous road conditions through a structured digital reporting system linked to the Municipal Traffic Division. This innovation responds to the qualitative finding that community engagement is insufficient and that social accountability—peer enforcement of safety norms—is currently weak. The CRSW builds on the existing barangay governance structure, making it cost-effective and sustainable. The Digital Road Monitoring and E-Citation System equips traffic enforcers with mobile applications and dashcams to document violations in real time, reducing opportunities for the 'palakasan' favoritism identified in the qualitative data and creating an auditable enforcement trail. Real-Time Weather Alerts and Road Risk Mapping directly addresses the second-ranked environmental

attribution domain by partnering with PAGASA and DOST to deliver hazard alerts to drivers during adverse weather, while risk maps guide infrastructure prioritization.

The Safety Subsidy Fund and Helmet Distribution Program responds to economic attribution findings that financial constraints prevent low-income motorists from maintaining vehicles or purchasing helmets and reflective gear. The Municipal Traffic Policy Review Task Force addresses political attribution gaps by institutionalizing annual enforcer training, revising outdated municipal ordinances to reflect current road conditions and vehicle types, and creating a dedicated road safety budget line that is protected from political reallocation. Finally, the Road Safety Education Integration Program (RSEIP) targets the cultural root cause of road safety illiteracy by embedding traffic safety modules into the DepEd curriculum for senior high school students, creating a pipeline of safety-conscious future road users. Collectively, these seven innovations represent a coherent, multi-sectoral ecosystem approach consistent with the Systems Theory underlying this study—addressing not any single factor in isolation but the entire road safety system simultaneously.

Conclusion and Recommendations

This study successfully investigated the multidimensional attributions of traffic accidents in Santa Cruz, Marinduque, through a mixed-method triangulation design, and proposed seven evidence-based traffic management innovations grounded in community realities. The findings comprehensively addressed all four research questions. Regarding SOP 1, the socio-demographic profile of accident-involved motorists reveals a concentration of males aged 26–45 with non-professional or absent licenses, underscoring the need for targeted interventions reaching this demographic through accessible licensing reforms, mobile enforcement checkpoints, and gender-sensitive safety campaigns. Regarding SOP 2, the extent of attribution findings confirm that behavioral factors are the most critical and universally acknowledged cause of accidents (WM=3.69–3.74, VH), followed by environmental and contextual factors. All eight domains received 'Agree' to 'Strongly Agree' ratings, confirming the multi-causal nature of the accident problem and validating the Systems Theory framework.

Regarding SOP 3, the qualitative analysis yielded 24 themes distributed across eight domains, with behavioral undiscipline, infrastructural vulnerability, and institutional education gaps emerging as the three most cross-cutting issues. Triangulation confirmed that the statistical prominence of behavioral and environmental factors is not merely a response artifact but is deeply rooted in the lived experiences of road users in Santa Cruz. Regarding SOP 4, the seven proposed innovations form an interconnected roadmap that addresses root causes at the individual, community, institutional, and governance levels—consistent with the Multiple Causation Theory's emphasis on addressing all contributing factors simultaneously.

Theoretically, this study makes an original contribution by applying and validating the Systems Theory and Multiple Causation Theory within a rural Philippine island context, demonstrating their relevance beyond urban or high-resource settings and offering a replicable conceptual model for road safety research in similar environments. The study also contributes methodologically by demonstrating the value of mixed-method triangulation for capturing both the breadth of statistical patterns and the depth of culturally specific narratives in road safety research. Practically, the findings and innovations offer the Municipality of Santa Cruz, the MPPO, LTO, DepEd, and community organizations a comprehensive, actionable, and locally calibrated blueprint for reducing road accidents. The proposed innovations are designed to be cost-effective and adaptable, leveraging existing governance structures such as barangay systems and DepEd school networks rather than requiring entirely new institutional frameworks.

Several limitations should be acknowledged. The study's geographical scope is confined to Santa Cruz, limiting direct generalizability to other municipalities. Reliance on self-reported data in both quantitative surveys and qualitative interviews introduces potential social desirability bias, partially mitigated through the triangulation design. The cross-sectional nature of the study captures a snapshot in time and cannot assess longitudinal trends or the impact of the proposed innovations post-implementation. Future research should conduct impact evaluations of the seven proposed innovations after their implementation, expand the framework to comparative studies across multiple Marinduque municipalities, and integrate real-time accident reporting systems to enable dynamic, data-driven monitoring of road safety trends.

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Competing Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Data Availability Statement

The data used in this research can be accessed through a formal request to the author of the study. Quantitative datasets and interview transcripts are maintained in accordance with the ethical commitments made to participants regarding confidentiality and are available upon written request to the corresponding author.

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Appendices

No appendices are attached to this study.