

Preventing Motorcycle Accidents: A Multi-Institutional Model

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Abstract

As urban traffic becomes increasingly dense, the use of motorcycles has increased in metropolitan areas. Given the multifaceted nature of traffic accidents, there is a pressing need for constructive interaction among the various institutions involved in managing motorcycle traffic safety. The aim of this study is to present a multi-institutional prevention model for motorcycle accidents. This applied research used a mixed-methods approach, combining qualitative content analysis and quantitative descriptive-survey methods. In the qualitative phase, the statistical population consisted of experts and managers from organizations related to motorcycle traffic safety. Participants were selected using non-probability purposive sampling until theoretical saturation was achieved. In the quantitative phase, the statistical population included 9,223 individuals selected via convenience sampling. The statistical population in the quantitative section consisted of Judicial Experts, Traffic Accident Experts from the Iran Highway and Traffic Police Department, Traffic Police Headquarters of Iranian National Police, the Ministry of Roads and Urban Development, and the Civil Affairs Department of the Ministry of Interior, who were selected based on their availability. Sampling in the qualitative section was conducted purposefully based on criteria, while in the quantitative section, it was done using stratified random sampling proportional to the size of each stratum in the total population, resulting in a sample size of 384 individuals according to the Morgan table. The multi-institutional prevention model includes the following dimensions: organizational structure ($t = 26.894$), inter-institutional communication ($t = 25.251$), multifaceted cultural development ($t = 25.392$), technical factors ($t = 12.436$), and comprehensive education ($t = 10.281$). The organizational structure dimension had the highest impact, while comprehensive education had the lowest. All factor loadings were above 0.50 and statistically significant at the 95% confidence level. The prerequisites for a multi-institutional approach to preventing motorcycle accidents include developing an appropriate organizational structure, fostering inter-institutional communication, promoting multifaceted cultural development, implementing intelligent control systems, and providing comprehensive education. Emphasizing these dimensions and adopting an interdisciplinary approach to traffic management can lead to improved safety for motorcyclists.

Keywords: Inter-Institutional Communication, Multi-Institutional Prevention, Traffic Safety, Motorcycle Accidents

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1. Introduction

In Iran, traffic accidents are one of the leading causes of death, with motorcyclists comprising a significant portion of the victims. Alongside the increasing use of motorcycles, the number of accidents and resulting fatalities has also risen, making motorcyclists some of the most vulnerable road users today. In the country's major cities, motorcycles are not merely a means of transportation—they serve multiple functions and play a critical role in the economic livelihood of their owners and their families. Despite offering minimal protection and being inefficient in terms of safety, motorcycles are still considered cost-effective for many people, especially in cities where public transportation is inadequate and traffic congestion is widespread.

Given the rising density of traffic in large cities, the low fuel consumption of motorcycles, economic fluctuations, traffic restrictions, and their high maneuverability compared to other vehicles, motorcycles have become increasingly popular among lower-income groups. It is anticipated that in the near future, usage will also rise significantly among other segments of society (Ehsanpour, Shayegan, & Haqqshenas, 2022, p. 6). According to published reports, motorcyclists are 34% more likely to die in traffic accidents than other road users, and 90% of motorcycle crashes result in serious injuries or death (Khoshroudi, Eini, & Souri, 2016, p. 48). Legally, all general traffic and transportation laws apply to motorcyclists (Article 20 of the Traffic Violations Law). However, in practice, the situation is quite different. Motorcyclists routinely violate numerous regulations, and there is little oversight of their traffic behavior. This lack of enforcement has led to an increase in the speed and attractiveness of this mode of transportation (Khaksari, 2014, p. 37). Motorcyclists often commit repeated traffic violations, which in turn causes frequent conflicts with other road users (Hamidi, 2021). Consequently,

motorcycle-related traffic accidents remain high and continue to rise. To effectively control these incidents, it is essential to properly enforce traffic laws, reduce violations, design safer motorcycles and roadways, and implement proper road safety regulations to improve motorcyclists' behavior and prevent accidents (Ehsanpour & Zeraatpeyma, 2024, p. 67).

Countries that have successfully addressed traffic safety issues typically did so through clear policy development. One of the most fundamental steps in traffic safety policymaking is identifying stakeholders and affected parties (i.e., involved institutions), gathering information about their responsibilities, and determining each institution's share in contributing to or resolving the issue (Amiri, Souri, Khanke, Momeni, & Eini, 2014, p. 12). Ensuring the safety of motorcyclists is a multidisciplinary issue involving various organizations. Effective control is only possible through collaborative efforts among all stakeholders within a comprehensive implementation plan aimed at improving traffic safety (Rahimov & Vatandoost, 2012, p. 81). In recent years, a new approach known as the “multi-institutional approach to crime and violation prevention” has emerged, which mobilizes relevant organizations to work together in the prevention and control of specific offenses. This approach has proven particularly effective in addressing traffic-related violations due to their multifactorial nature (Maroufi & Saqafi, 2022, p. 413). The complex and multi-dimensional nature of traffic issues and motorcyclist safety across various sectors has rendered traditional methods of establishing traffic discipline and preventing accidents among motorcyclists ineffective and inefficient. The traffic police alone cannot resolve the multifaceted challenges related to motorcycle accidents.

Therefore, a new interdisciplinary framework is required—one that incorporates a scientifically designed model for multi-institutional

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prevention of motorcycle accidents involving all responsible bodies. Moreover, compared to single-agency interventions, the multi-institutional approach assumes that all entities—such as law enforcement authorities, executive and administrative organizations, the three branches of government (as outlined in Article 156 of the Constitution), and other relevant agencies—each play a unique role in the broader chain of accident and violation prevention. For this reason, coordinated and preventive collaboration among government institutions is essential in implementing effective preventative strategies. The integration of multi-institutional prevention dimensions and components within organizations involved in traffic safety—particularly those affecting motorcycle accidents, which account for nearly half of all traffic fatalities in metropolitan areas including the capital—can create a solid foundation for institutionalizing inter-organizational cooperation. This would also support the effective implementation of traffic safety policies, especially by the Traffic Police of FARAJA (Maroufi & Saqafi, 2022, p. 413).

Accordingly, this study aims to identify the factors influencing the multi-institutional prevention of motorcycle accidents. If implemented, the results of this research could hold significant value for all organizations responsible for traffic safety, particularly in the context of collaborative prevention strategies. The findings can inform future planning within national law enforcement and traffic police agencies, helping to assign responsibilities to relevant organizations and assess the impact of various factors in preventing motorcycle accidents. Through evidence-based strategies, this process can lead to enhanced safety and reduced accidents among this vulnerable group of road users.

This research seeks to propose a model capable of ensuring effective multi-institutional prevention of motorcycle crashes. It also highlights the necessity of establishing a central

supervisory body to define the responsibilities of traffic safety stakeholders, facilitate their cooperation, and collect periodic reports from involved institutions. Such a structure is critical for coordinating motorcycle traffic safety efforts and is essential for holding organizations accountable and fostering meaningful collaboration with the traffic police. By adopting this approach, it becomes possible to improve the overall safety of motorcyclists through shared responsibility and coordinated interventions. Considering the current absence of a cohesive and integrated prevention model—one that leverages contributions from government, private, and civil society institutions—this study addresses the following key research question: What is the structure of an effective multi-institutional model for the prevention of motorcycle accidents?

2. Literature Review

Nadimi, Naserlavi, Khalifeh, and Aminian (2025), in a study titled *"Analysis and Evaluation of Factors Affecting Accidents Involving Vulnerable Road Users in Urban Roads Using Association Rule Mining,"* found that the majority of fatal accidents involving vulnerable road users in Tehran involved pedestrians and motorcyclists. Most injury-related accidents were caused by collisions between vehicles and motorcycles (with a support level of 0.772). Environmental and road conditions were not significant contributors to motorcycle injury accidents; however, human factors—particularly unnecessary haste and rush (with a support level of 0.661)—had a major impact. The study emphasized that engineering interventions, legislative efforts, law enforcement, and educational activities could effectively reduce fatal and injury-related motorcycle accidents in Tehran.

Hosseini Aqda, Khani Sanij, and Rajabi Bahaabadi (2025), in their study on *"Estimating the Relative Importance of Factors Affecting Helmet Use,"* concluded that socio-economic variables such as age significantly influence the

relative importance of various factors. Heat was identified as the most significant barrier to helmet use, while embarrassment ranked lowest. The study also noted a visible lack of enforcement by the police, leading to widespread non-compliance with helmet laws among motorcyclists.

In a study titled *"Analysis of Factors Affecting the Severity of Motorcycle-Related Accidents,"* Tavakkoli Kashani, Najafpour Darou, Karami, and Mohammadi (2024) identified key factors influencing accident severity, including speed limits, type of collision, topography, road type, presence of road shoulders, poor lighting, and slippery road conditions. The study recommended focusing safety efforts on specific areas like curves and side roads, reducing speed limits, and improving rider training and skill development—insights that are valuable for policymakers and traffic safety managers.

Hassanpour and Asgari (2024), in their research on *"Impact Assessment of Road Safety Equipment and Roadside Furniture on the Number and Severity of Motorcycle Accidents,"* found that the restoration and upgrading of safety equipment and road furniture on Tehran's Imam Ali Expressway significantly reduced motorcycle accidents in 2022 compared to 2019. Specifically, the completion of some safety improvement projects on this expressway led to a 28% reduction in motorcycle accidents in District 13, a 29% reduction in District 15, and a 33% reduction in District 7. Experts identified lighting as the most impactful factor in reducing accidents, followed by the use of separators, speed bumps, crash cushions, and lane widening.

Salimi, Amiri, and Haghshenas (2024), in a study titled *"Identification of Managerial and Operational Factors in Reducing Motorcycle Traffic Accidents in Iran,"* found that effective prevention relies on components such as multi-institutional coordination, clear responsibility and accountability, a leading organizational body, and scientific education focused on

accident prevention. Given the preventable nature of injuries and the unpredictability of human error, the study highlighted the critical role of accurate managerial insight and long-term coordinated action among various institutions.

Ehsanpour and Haghshenas (2023), in their research *"Evaluation of the Impact of the Motor-Yar Program on Motorcycle Rider Traffic Safety,"* reported a significant reduction in traffic violations and accidents among participants. Average reductions were observed in helmet non-use violations (22.391), driving in exclusive bus lanes (10.853), carrying irregular loads (4.909), riding on sidewalks (1.871), wrong-way driving (12.364), and illegible license plates (18.287). Additionally, there was a notable decrease in property damage (8.52) and injury accidents (12.43). Inferential statistics confirmed a significant relationship between the implementation of the Motor-Yar program and improved motorcycle traffic safety. The program's focus on field-based training of offenders helped modify risky behaviors and enhance safety for this vulnerable road user group.

Maroufi and Saghafi (2022), in a study titled *"Multi-Institutional Approach to Preventing Traffic Offenses and Violations,"* found that a multi-institutional prevention approach is highly effective due to the multifactorial nature of traffic offenses. These violations stem from driver behavior, vehicle conditions, road infrastructure, regulations, and management oversight, necessitating the involvement of institutions such as the Ministries of Industry and Mines, Roads and Urban Development, Health, Education, and Higher Education. A cohesive, strategic, and non-overlapping policy framework among these institutions can significantly reduce traffic offenses, with a particular emphasis on the critical role of educational institutions.

Ehsanpour and Haghshenas (2022), in a study titled *"Factors Affecting Motorcycle Accident Prevention in Urban Areas from Drivers'*

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Perspectives in Golestan Province," identified that motorcyclists' social responsibility (28%), road geometry improvements and addressing high-risk areas (26%), and police enforcement of traffic violations (24%) were the most influential factors in preventing motorcycle accidents. Safety regulation education for motorcyclists (22%) was found to have the least impact.

Hosseini, Bakhtiari, Fakhrzad, and Mohebi (2022), in a study titled "Multi-Institutional Participation Model in Crime Detection Processes," identified key components across five dimensions: structural (command, management, supervision, organizational structure, planning, performance, and organization); environmental (adjacent systems, law, social commitment, public interest, community engagement, interaction, and participation type); systemic (human resource management, responses, coordination, information, and motivation enhancement); procedural (challenges, needs, regulations, complementary programs, and professional approaches); and technological (smart participation, media interactions, technology, education, and crime detection knowledge). These dimensions underscore the importance of a robust multi-institutional participation model, with statistically significant relationships identified in the model.

Tarhami, Saffarzadeh, Keshfi, and Ramezanzadeh (2021), in a study titled "Designing a Model for Preventing Motorcyclist Traffic Offenses and Violations," found that multi-institutional prevention of traffic accidents involves growth-oriented prevention (family- and school-based programs), social prevention (social restrictions, risk management, awareness, community-based programs, and specialized police training), situational prevention (patrols, covert monitoring, cameras, and intelligent violation detection systems), and criminal prevention (certainty, decisiveness, and severity of penalties).

Qotboddini and Nadimi (2021), in a study titled "Evaluation of Factors Affecting Motorcyclist Traffic Safety," found that increased instances of running red lights, speeding, using mobile phones, not wearing helmets, performing stunts, and sidewalk riding exacerbate accident severity. Conversely, improved motorcycle technical conditions and rider health reduce accident severity.

Amiri (2021), in a study examining the role of traffic culture education in controlling motorcyclists' traffic behavior, found that frequent violations such as running red lights, sidewalk riding, traveling against traffic, and unintentional infractions have made motorcycles a nuisance and a source of reduced public safety in major cities. Traffic culture education, followed by regulations and police enforcement, were identified as the most effective measures for controlling motorcyclists' behavior.

Javadian, Naderpour, Hassanzadeh, and Naderi (2020), in a study titled "Investigating Reasons for Citizens' Preference for Motorcycles Over Public Transportation," concluded that reducing motorcycle use requires strengthening inter-organizational collaboration, improving urban infrastructure for public transportation, and promoting appropriate culturalization to encourage its use. Public transportation is a viable alternative to motorcycles and private cars, provided citizens are persuaded and conditions for Pannonia are fully established.

Tranow and Perez (2023), in a study titled "Development of a Motorcycle Accident Prevention Model," found that although motorcyclists constitute only 3% of registered vehicles, they account for 14% of total traffic fatalities. In the United States, the number of motorcycles has nearly doubled over the past twenty years, raising concerns about associated risks. The study identified a direct correlation between impact speed, collision angle, type of opposing vehicle, and the severity of motorcyclist injuries, with collision angle

serving as a predictor of injury severity in vehicle-motorcycle crashes.

Emigun, Sani, Swimi, Fadile, and Obafunba (2022), in a study titled "Investigation of the Main Causes of Motorcycle Accident Fatalities in Lagos," found that from 2010 to 2019, enhanced collaboration among safety and traffic organizations, coupled with significant governmental transport policy changes aimed at improving user safety, led to a general decline in fatal motorcycle accidents in Lagos.

Chun, Kentu, Hirotsu, Tadanori, and Kenji (2022), in a study titled "Evaluation of the Effectiveness of Sustainable Safety Education Programs to Enhance Motorcyclist Traffic Culture in Vietnam," found that the effectiveness of rider training varies based on riders' experience. Improved hazard awareness primarily stems from increased safety awareness. Structural modeling showed that safety activities positively influence riders' confidence, safety awareness, happiness, comfort while riding, and independence in daily life. Altruistic motivation was identified as a key factor in promoting safe riding, emphasizing the need for ethical traffic behavior and nationwide safety culture education.

Samit, Brij, Rose, Wets, and Reuter (2022), in a study titled "Multi-Institutional Prevention of Hazardous Violations by Young Motorcyclists (Case Study: Manipal, India)," identified speeding, driving under the influence, and persistent technical faults as primary causes of motorcycle accidents. Additional risky behaviors among young motorcyclists included mobile phone use, traffic violations, and non-use of helmets. The study suggested that targeted awareness and training programs by universities, government authorities, and regional transport departments could enhance traffic safety for this group.

Khalid, Zulkiply, Soleh, Hamzah, Ariffin, Amir, Muhdjawi, Ahmad, Abu Qasim, and Khames (2021), in a study titled "Impact of

Motorcycle Safety Technologies on Accident Prevention from Riders' Perspectives," found that motorcyclists view advanced technologies as potentially effective in reducing risks, accidents, and injuries. Proposed safety technologies include anti-lock braking systems, electronic stability control, lane-keeping assistance, traction control on slopes, blind-spot detection, and automatic emergency braking. Mandating these technologies could enhance safety for motorcyclists and other road users.

Nadimi, Mansourifar, Shamsuddinilouri, and Soltaninejad (2021), in a study titled "Analysis of Traffic Violations Among Motorcyclists Using Structural Equation Modeling," found that rider characteristics are the most significant factor in violation commitment. As most motorcyclists are young with low income and education, enhanced training before licensing is crucial. Riders with prior violations or vehicle issues are more prone to further infractions, linked to inadequate enforcement in developing cities. Current fines were found to be insufficiently deterrent. The study's findings can contribute to reducing motorcyclist violations, promoting safer roads.

The review of the literature related to the research topic indicates that, in general, previous domestic and international studies have focused on analyzing and evaluating factors affecting accidents involving vulnerable road users, estimating the relative importance of factors influencing helmet use, identifying factors contributing to motorcycle accident prevention, designing models for preventing motorcyclist crimes and violations, evaluating factors affecting motorcyclist traffic safety, investigating reasons for citizens' preference for motorcycles, assessing components influencing the enhancement of motorcyclist safety culture, analyzing traffic violations among motorcyclists, examining the primary causes of fatalities in motorcycle accidents, developing multidimensional training models for motorcyclists, and conducting needs assessments for cognitive analysis of

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motorcyclist safety management. The points of convergence and divergence between this study and others are presented in Table (1).

Table 1. Points of Convergence and Divergence of Previous Research with This Study

Similarities	Differences
1. Factors affecting the prevention of motorcycle accidents	1. Lack of presenting a model in most previous studies
2. Designing prevention models for crimes and violations	2. Lack of multi-dimensional examination of factors affecting motorcycle accident prevention
3. Examining the role of traffic culture education in preventing motorcycle accidents	3. Examining the impact of frequent motorcycle rider violations on citizens' sense of security
4. Studying multi-agency participation	4. Studying the effect of safety improvements at accident-prone locations on accident severity
5. Investigating the impact of multi-agency prevention of motorcycle traffic violations	5. Usage rate of helmets among motorcyclists in different countries
6. The effect of motorcycle safety technologies on accident prevention	6. Factors affecting the control of motorcycle riders' traffic behavior
-	7. The impact of dedicated motorcycle lanes on preventing normalization of violations and organizing traffic
-	8. The role of individuals' beliefs and attitudes in correcting unsafe behaviors
-	9. Analysis of traffic violations among motorcyclists
-	10. Investigating the main causes of death in motorcycle accidents

Based on the provided information, it is evident that various studies have highlighted the role of structural, social, cultural, and educational factors of organizations involved in traffic safety in preventing violations and enhancing road safety. Emphasis has been placed on the need for collaboration between traffic police and organizations influencing motorcyclist safety. However, previous studies also exhibit certain weaknesses, which are outlined below:

- a. Weakness in comprehensive prevention and determining the responsibility of relevant institutions in the conducted research.
- b. Lack of attention in previous research to multifaceted prevention in enhancing motorcyclist traffic safety.
- c. Failure to provide a model for multi-institutional prevention of motorcyclists' traffic violations aimed at improving traffic safety.

- d. Absence of a cohesive and integrated model for multi-institutional prevention of motorcycle accidents.

Consequently, given the existing gap and the lack of precise background and literature providing an appropriate model in this field, this research practically and comprehensively presents a model that considers all aspects and dimensions of multi-institutional prevention of motorcycle accidents, contributing to the enrichment of the literature related to the research topic. Prevention: Linguistically, prevention means stopping, averting, safeguarding, and preserving health (Dehkhoda, 1998, p. 45). In literary terms, prevention includes stopping, obstructing, and foreseeing (Moein, 2002, p. 933). In a broader sense, prevention encompasses all measures taken against crime, violations, and offenders of safety and traffic regulations to reduce violations and delinquency, neutralizing traffic

violations to prevent accidents (Najafi Abrandabadi & Hashembeigi, 2022, p. 23).

If all involved components and institutions do not actively engage in preventing motorcyclists' violations and crimes to avoid accidents, punishment loses its preventive effect and may even lead to user non-compliance in unmonitored locations and times. Therefore, a model for multi-institutional prevention of motorcyclists' traffic violations and accidents must be developed for all users across different locations and times to enhance traffic safety and prevent accidents. Additionally, this model regulates and guides the behavior of drivers and enforcers in implementing the law in the areas of criminal-legislative, executive, judicial, and participatory policies aimed at multi-institutional accident prevention (Tarhami, Saffarzadeh, Kashfi, & Ramezanzadeh, 2021, p. 14).

Multi-Institutional Prevention: Multi-institutional prevention of crimes and violations is not a specific approach to prevention but a model through which coordinated responses, with the help of multiple effective institutions and a combination of situational and social strategies, can achieve prevention (Goris & Walters, 1999, p. 204). Thus, multi-institutional prevention of crimes and violations can be considered applied knowledge aimed at formulating and developing scientific policies and guidelines for all organizations involved in an issue to prevent and reduce crimes and violations through observations, monitoring, and systematic analysis of strengths and weaknesses (Niazpour, 2003, p. 45). It can also be defined as the coordinated application of various judicial, quasi-judicial, administrative, and public institutions to enable an effective criminal policy for preventing incidents and violations (Hosseini, 2010, p. 11). Multi-institutional prevention involves simultaneous, transparent, realistic, and flexible cooperation among involved institutions to enhance the alignment of interdisciplinary perspectives in

complex, multifaceted tasks through strategies that leverage participatory leadership of effective institutions (Amjolo, Isiguzo, Agbasoga, & Ogbuagu, 2010, p. 31). This approach considers crime and violation prevention as a comprehensive, problem-oriented process rather than a bureaucratic one, requiring potential cooperation and mobilization of information, capacities, and resources of various institutions. Over the past three decades, crime and violation prevention has represented a paradigm shift in crime control and criminal justice, fundamentally changing the management of prevention and the structures of social relationships (Crawford, 2007, p. 893). Concepts such as multi-institutional, inter-institutional, participation, cooperation, coordination, and interaction are key features of crime and violation prevention policies and discourses in recent decades. In this regard, establishing a meta-institution as a comprehensive entity for the exchange of ideas and information among various institutions becomes essential. This meta-institution, composed of members from institutions involved in preventing crimes and violations, can have a formal or informal structure. Undoubtedly, if this meta-institution has a legal status and structure, it will enjoy greater durability and continuity and can better oversee the implementation of decisions made by the institutions.

Inter-Organizational Communication: Inter-organizational communication involves the process of creating and exchanging messages within a network of interconnected and regulated relationships in a secure environment (Windahl, Olson, & Signitzer, 1997, p. 148). It emphasizes relationships that organizations establish with other institutions in their external structures, in addition to internal relationships, to achieve their objectives. The realization of inter-organizational communication pertains to issues such as information flow, information sharing, reputation, collaboration, competition, coalition-building, and power dynamics

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(Aslanpour & Shahbazi, 2011, p. 69). Forms of Multi-Institutional Communication: Every communication and collaboration must include six elements: structure, leadership, information, identity, continuity, and resources (Rahmati, 2023, p. 152). Three key points should be noted: In active communication and collaboration between institutions, there must be an equal distribution of power, and the more powerful group should not impose its perspective. Mutual trust in sharing information and perspectives is also a vital component of collaboration (Liddle & Gelsthorpe, 1994, p. 2). While multi-institutional prevention can occur without a formal structure, the absence of structure leads to a lack of communication among institutional representatives and ignorance of other institutions' policies and needs. A structure can enhance effectiveness and maximize available resources. This structure can be formal or informal. Informal structures, due to their friendlier and more personal relationships, increase local flexibility, allowing rapid responses to changing local conditions. However, informal structures may have drawbacks: first, a change in a key individual may disrupt the prevention program; second, accountability and evaluation may be challenging, and the scope of these structures may be limited.

In multi-institutional collaboration, a shared goal, cooperation, and coordination are essential. A coordinating institution must be designated to facilitate interaction and coordination among various institutions. Inter-institutional relationships take various forms. Gelsthorpe describes these relationships in five models:

a) Communication Model: This model applies where institutions recognize the need to interact with each other, but the interaction does not go beyond mere communication and contact. This communication can be one-way, two-way, or involve partial or complete information exchange.

b) Operational Model: In this model, institutions maintain their boundaries and identities but agree to undertake necessary operations and activities regarding a defined common issue. This model involves joint and mutual activities and may include one or more institutions agreeing to take appropriate actions on an issue.

c) Appointed Model: In this model, institutions work together in an organized and systematic manner. They define boundaries between institutions but can pool their resources to enhance their collective capacity, strength, and facilities to address a mutually agreed-upon issue.

d) Contractual Model: In this model, while maintaining their organizational distinctions, institutions collaborate on agreed-upon concerns and issues, sharing responsibilities and providing combined services to address the issue.

e) Integrated Model: In this model, institutions fully merge in all areas as per the agreement, becoming indistinguishable from one another. Regarding the defined common issue, institutions pool their resources to create a collective preventive function aimed at synergizing their capabilities (Liddle & Gelsthorpe, 1994, p. 8).

Thus, the multi-institutional approach to preventing crimes and violations can be considered a combination of theories, concerns, ideologies, expectations, resources, and the scope of authority and duties of various organizations on a specific issue, utilizing a set of formal and informal control mechanisms with different objectives. To align and synergize the capabilities of these institutions, precise and purposeful infrastructure and control are necessary (Brown, 2008, p. 115).

3. Theories of Prevention

Rational Choice Theory: Clark and Cornish introduced the rational choice theory. According to this approach, traffic offenders and potential delinquents are rational decision-

makers who seek to maximize their benefits after evaluating the risks and rewards of committing a violation or crime (Jafarian & Morshedi, 2010, p. 161). This theory posits that most traffic violations result from a choice made by the offending driver, who, after weighing the pros and cons of the violation, consciously decides to commit or refrain from it, rather than being driven by adverse psychological, economic, or social conditions as suggested by many criminological theories. This perspective assumes that the decision-making process for committing crimes and violations is similar to other decisions made by ordinary individuals. People sometimes choose to commit crimes or violations after assessing potential consequences and calculating the expected benefits and rewards compared to the costs and risks. Additionally, after deciding to achieve their goals, they select appropriate actions to carry out the violation (Sufi & Dehghan, 2009, p. 93).

Cultural and Social Theory: This theory does not focus on the individual but rather on organizations, groups, or institutions. According to this theory, corruption and crimes in society stem from organizational subcultures that deem criminal or offending behavior acceptable and permissible. The cultural and social theory suggests that criminal behaviors arise from such subcultures, where younger or newer members are drawn into criminal behavior by older or more established members. Chullinger and Clark, in a 1983 study, found that external workplace factors, such as economic pressures, are not significantly linked to crime commission. Instead, deviations and the commission of crimes and violations are associated with the influence of organizational culture. According to these authors, an organizational culture and work environment where employees feel a lack of control or, conversely, feel exploited, leads to the lowest productivity and the highest dissatisfaction among employees, to the extent that they consider committing crimes and violations

permissible and are drawn toward such behaviors (Varaei & Fattahi, 2016, p. 63).

Functionalism Theory: The explanation of the functions and roles of individual and social communication messages is derived from the functionalism theory in society. In social and traffic phenomena, functionalism involves attention to the role that institutions play in maintaining order and balance within the social framework and the traffic environment of users, justifying all events and institutionalized activities based on traffic needs to enhance or reduce traffic safety. Therefore, the roles and functions defined for traffic managers in ensuring a safe traffic environment include addressing needs such as education on order, continuity, integration, guidance, and the adaptation of enforceable laws to the traffic environment. In this perspective, the traffic environment for vehicles consists of various interconnected elements that operate systematically. In traffic safety management, functionalism encompasses the outcomes of all preventive measures in controlling traffic and establishing order, linking the various components of organizations involved in multi-institutional accident prevention. This enhances internal order and integration within organizations while increasing response capacity during crises based on realities (Fasihi, 2010, p. 112).

Accident: An unintentional, distressing, and unwanted incident among traffic users involving a chain of events, typically resulting in damage, injury, or fatality (Roshani & Javadnejad, 2013, p. 17). Traffic accidents or collisions refer to various incidents leading to injury, fatality, damage, or a combination thereof, resulting from the collision of one or more vehicles with each other, objects, humans, or animals (Hajiloo & Alinejad, 2018, p. 89). **Motorcycle Accidents:** A motorcycle accident is a sudden, unintentional, and distressing incident among traffic users involving a vehicle equipped with a power source, having two axles, and a maximum net weight of 550

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kilograms, which typically results in damage, injury, or fatality (Shahgholi & Maleki, 2018, p. 139).

Therefore, considering the theoretical foundations, multi-institutional prevention, inter-organizational communication, theories related to multi-institutional communication, and finally, the organizations effective in enhancing motorcyclist traffic safety, the

manner of inter-organizational communication in multi-institutional prevention of motorcycle accidents, the exploratory approach of the research, and the theoretical background, the main objective and sub-objectives of this research, along with a summary of the most important concepts addressed in this study, have been compiled and defined in Table (2).

Table 2. Theoretical Framework of the Research

Concept	Definition	Source
Prevention	Anything employed against crime, violation, and offenders of safety and traffic laws to reduce violations and offenses, and to neutralize traffic violations in order to prevent accidents.	Najafi Abrandabadi, 2003
Institution	A set of behavioral rules created by humans to manage and shape the expected interactions between individuals, which form reciprocal relationships; these interactions define the path of human society's evolution throughout history and are key to understanding historical changes.	Rahmati, 2023
Multi-agency Prevention	Simultaneous, transparent, realistic, and flexible cooperation of involved institutions on a topic to increase the compatibility of interdisciplinary views in complex and multifaceted tasks with a strategy benefiting from coordinated actions under participatory leadership of involved institutions; this approach considers crime and violation control as comprehensive and problem-oriented rather than bureaucratic. It requires potential cooperation and mobilization of information, capacities, and resources of various institutions.	Hosseini, 2010
Accident	Any type of incident leading to injury, death, damage, or a combination thereof caused by the collision of one or more vehicles with each other, objects, humans, or animals.	Roshani & Javandnejad, 2013
Motorcycle Accident	An unintended, sudden, and unfortunate incident involving traffic users and a vehicle equipped with a motor, having two wheels and a maximum net weight of 550 kg, which usually results in damage, injury, or death.	Shahgholi & Maleki, 2018

Considering the theoretical foundations, multi-institutional prevention, inter-organizational communication, theories related to multi-institutional communication, and finally, the key organizations effective in enhancing motorcyclist traffic safety, the manner of inter-organizational communication in the multi-institutional prevention of motorcycle

accidents, along with the exploratory approach of the research, a schematic diagram visually describing the theoretical relationships between the variables of multi-institutional prevention of motorcycle accidents has been developed as the conceptual model of the research, as illustrated in figure (1).

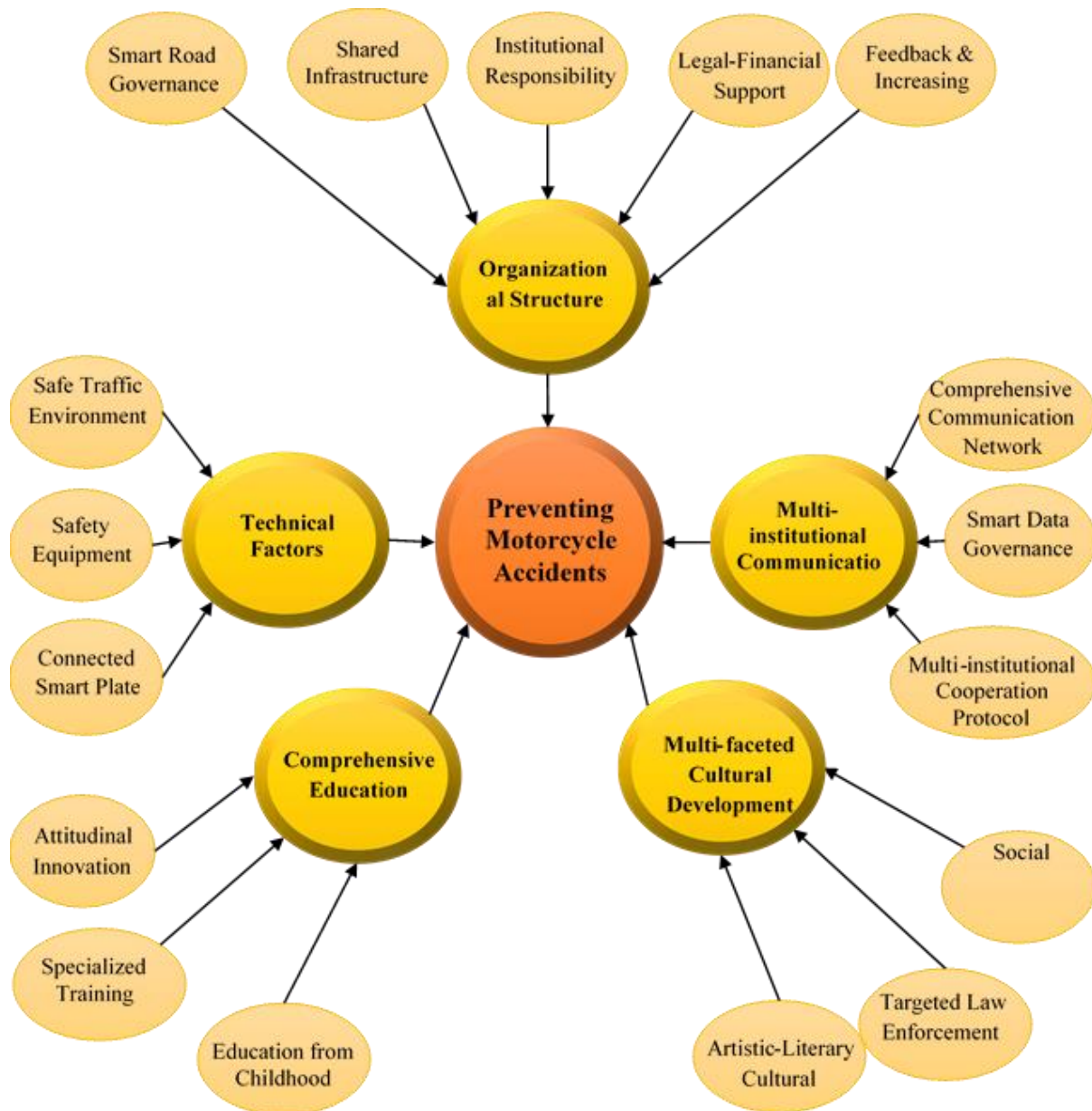


Figure 1. conceptual model of the research

4. Research Methodology

This study is applied in terms of its objective and employs a mixed-method exploratory approach. This approach was chosen due to the multi-institutional nature of the topic and the complexities associated with multi-institutional prevention of motorcyclist accidents. In the qualitative phase, semi-structured interviews were conducted with experts and professors from Amin Police Sciences University, the Ministry of Roads and Urban Development, the Deputy of Civil Affairs of the Ministry of

Interior, the Traffic Police Headquarters of the Iranian Police Force (Faraja), and experts from the Transportation and Traffic Deputy of the 22 districts of Tehran Municipality. These individuals had executive experience and sufficient knowledge of interdisciplinary traffic safety management. The sampling was non-probabilistic and purposive, continuing until theoretical saturation was achieved, which occurred after gathering insights from 19 experts. The interviews were conducted interactively with open-ended questions using a

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semi-structured format. To analyze the collected data, qualitative content analysis was performed using MAXQDA2020 software, and the extracted model from the qualitative phase was validated using structural equation modeling (SEM). After completing the interviews, in the qualitative phase, initial open coding was conducted to identify dimensions, followed by the extraction of concepts and categories. Axial coding was then performed based on the obtained concepts, and the resulting indicators were formulated into a researcher-designed questionnaire based on the subcategories of the axial concepts.

In the quantitative section, based on the extracted data, a researcher-made questionnaire was distributed among Judicial Experts, Traffic Accident Experts from the Iran Highway and Traffic Police Department, Traffic Police Headquarters of Iranian National Police, the

Ministry of Roads and Urban Development, and the Civil Affairs Department of the Ministry of Interior. Using a descriptive survey method, out of a total of 9,223 individuals, a sample of 384 people was selected according to the Morgan table through simple random sampling. As shown in Table (3), the selection was made using stratified random sampling proportional to the size of each stratum in the total population. The questionnaires were then distributed among the selected participants, the necessary data were collected, and confirmatory factor analysis was used to validate the model derived from the qualitative section, employing the structural equation modeling software SmartPLS 3. In addition, the reliability of the questionnaire was assessed using Cronbach's alpha coefficient, which was calculated to be 0.789.

Table 3. Results of Axial and Selective Coding of the Multi-Institutional Model for Motorcycle Accident Prevention

Sample Number of Participants	Judicial Experts	Traffic Accident Experts from the Iran Highway and Traffic Police Department,	Senior Managers of Traffic Police Headquarters of Iranian National Police,	Senior Managers of the Ministry of Roads and Urban Development	Senior Managers of the Civil Affairs Department of the Ministry of Interior
Number	2498	6324	182	121	98
Total	9223				

4.1. Validity and Reliability of the Research Instrument

Validity in measurement refers to accuracy, while reliability refers to consistency (Sadeh, 1996, p. 14). Reliability means that the results will be consistent when the measurement is repeated, and validity indicates that the research question truly measures what it is intended to measure.

In content analysis research, the most important aspect of validity concerns the accuracy of measuring the categories and subcategories related to the research problem. Scott's coefficient (Scott's Pi) or inter-coder agreement is suitable for assessing coding consistency, especially when there are many subcategories (Mohammadimehr, 2008).

The steps for calculating Scott's coefficient are as follows: between 10% and 20% of the total sample size is randomly selected. Considering the number and scope of the variables, several key variables are chosen along with their operational definitions and given to another individual for recoding. The percentage of agreement between the two coding, or the observed agreement percentage (P_o), is calculated using the following formula:

$$P_o = 100 \times \text{Total amount of items} / \text{Number of agreements between two coding}$$

4.2. Reliability Measurement

To calculate the reliability of the research, Scott's method was used.

$$n = \frac{(n-1)(se)^2 + PQN}{(n-1)(se)^2 + PQ}$$

N = Number of Content Units in the Study
 P = Level of Population Agreement
 $Q = (1-P)$
 n = Sample Size Required for Reliability
 Calculation
 $SE = 0.03$

Based on the calculations obtained from the conducted interviews, Table 4 was derived, which indicates a high level of reliability in the axial and selective coding processes used in this study.

Table 4. Results of Scott's Agreement Coefficient in the Conducted Interviews

	Expert Group	Number	Scott's Coefficient (%)
1	Faculty Members of Amin Police University	5	92.5
2	Ministry of Roads and Urban Development	3	89.8
3	Civil Affairs Department, Ministry of Interior	2	94.2
4	Traffic Police Headquarters of Iranian National Police	4	93.6
5	Deputy for Transportation and Traffic, Municipality	5	92.3
Total	—	19	92.48

These results demonstrate a high degree of coding reliability, confirming the consistency and dependability of the axial and selective coding conducted in this research.

5. Findings

5.1. Qualitative Findings

Stage One: After transcribing and typing the interviews conducted with participants in the qualitative section, the interviews—coded from 01 to 17—were analyzed. Some examples of the participants' responses are as follows:

- “From an engineering perspective, ensuring motorcycle safety can play a key role in preventing motorcycle traffic accidents.” (03)
- “As a fundamental strategy for sustainable multi-institutional prevention, I recommend strengthening social participation among motorcyclists to promote voluntary responsibility and enhance safety culture for traffic managers and other safety-related agencies.” (02)
- “Transforming the violation-handling process into a rapid, reliable, and timely system can control risky behaviors among all traffic users before such violations become normalized in society.” (08)
- “In my opinion, without the active and meaningful involvement of motorcyclists themselves (through their representative associations) in policymaking,

implementation, and monitoring, no solution will be sustainable or effective.” (09)

- “We must accept the reality that a motorcycle that does not meet design, manufacturing, equipment, and maintenance standards will be hazardous even for a skilled rider.” (013)
- “To support preventive actions, facilitate lawful enforcement against violators, and enhance the legal security of the agencies implementing the multi-institutional motorcycle accident prevention plan, these agencies require judicial support to ensure they have the legal authority and institutional backing to take necessary actions.” (13)
- “Even the best-issued programs require continuous control, monitoring, and feedback.” (09)
- “One of the key components for continuously evaluating the effectiveness of actions, improving programs, and fostering dynamic coordination among responsible agencies is multi-institutional feedback.” (014)
- “Strategic management is one of the most fundamental aspects of multidimensional prevention of motorcycle accidents, leading to macro-level policymaking, prioritization, resource allocation, coordination, and

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effective supervision at national and regional levels.” (017)

Additional technical discussions from experts across various institutions involved in motorcycle traffic safety were also recorded and transcribed.

Following the analysis and identification of indicators, the components, features, and dimensions of each concept in the multi-institutional motorcycle accident prevention

model were identified. The results of this process are presented in Table 5.

Based on the research questions and the selective coding developed from the theoretical framework, participants were given freedom to express their views. The interviews were conducted in a semi-structured format. After completing the interviews and indicator identification, the key components and dimensions were extracted.

Table 5. Results of Axial and Selective Coding of the Multi-Institutional Prevention Model

Selective Coding	Axial Coding	Frequency
Organizational Structure	Smart Governance of Roads	30
	Shared Infrastructure	28
	Institutional Responsibility in Upstream Documents	25
	Legal-Financial Support	27
	Feedback and Increased Competition	19
	Comprehensive Communication Network	27
Multi-agency Communication	Multi-agency Cooperation Protocol	29
	Smart Management Based on Data Governance	24
	Social Cultural Building	28
Multi-faceted Cultural Building	Artistic-Literary Cultural Building	23
	Targeted Law Enforcement	18
	Smart License Plate	29
Technical Factors	Safety of Motorcycle Traffic Environment	19
	Dedicated Motorcycle Equipment	23
	Attitudinal Innovation	21
Comprehensive Training	Specialized Training	26
	Training from Childhood	18

5.2. Axial Coding

After conducting the open coding process and identifying the main dimensions and components of the multi-agency prevention model for motorcycle accidents, axial coding was performed to integrate and merge the data extracted during the open coding phase through the analysis of interviews. In axial coding, one

of the open coding components is selected as the core phenomenon and placed at the center of the process, with other categories linked to it. Subsequently, the conceptual model of the study, based on the analysis of data derived from in-depth expert interviews, is illustrated in Figure (2) and was visualized using MAXQDA2022 software.

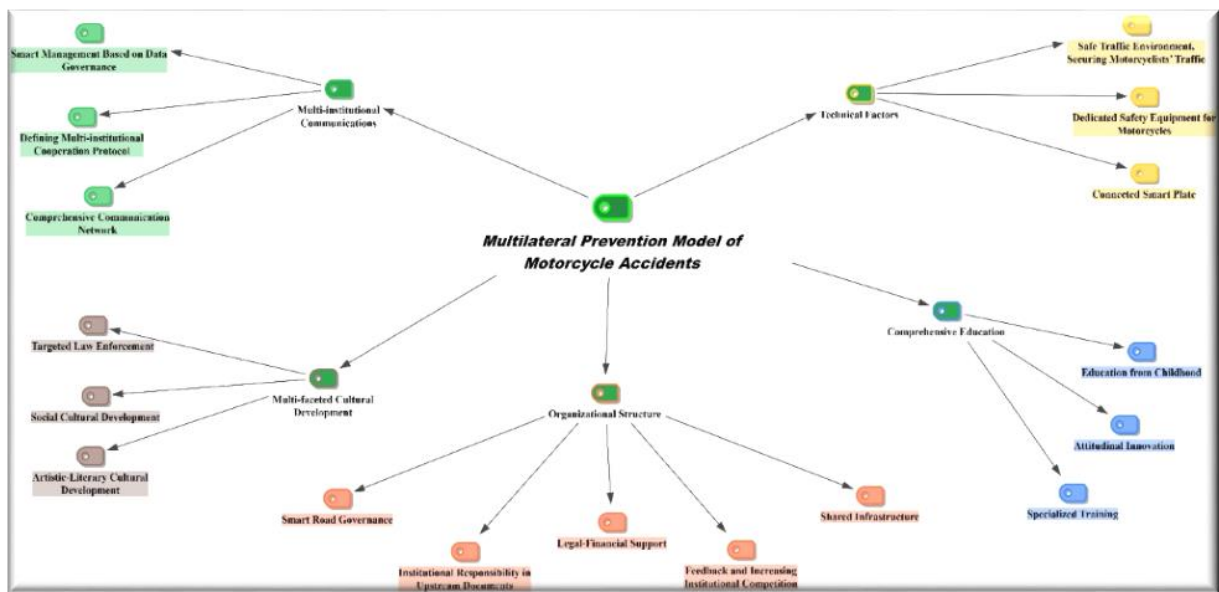


Figure 2. Conceptual research model

5.3. Quantitative Findings

To assess the reliability of the researcher-developed questionnaire, it was first tested on 35 randomly selected individuals from the target population. Cronbach's alpha was then used to analyze the questions and determine their internal consistency. All variable-related categories, as shown in Table 4, had Cronbach's alpha values above 0.78, confirming the reliability of the questionnaire.

In this study, exploratory factor analysis (EFA) was used to determine the results of semi-structured interviews concerning organizational structure, multi-agency cultural development,

technical factors, and comprehensive training for designing a multi-agency prevention model for motorcycle accidents, as evaluated by experts. Each dimension, its components, and indicators identified in the quantitative section of the research will be assessed.

For validating the model derived from the qualitative section, structural equation modeling (SEM) and confirmatory factor analysis (CFA) were performed using SmartPLS3 software. The factor loadings for all dimensions and components, obtained from the software output, are presented in Table 6.

Table 6. Questionnaire Information and Cronbach's Alpha Coefficients

Dimension	Component	Number of Questions	Cronbach's Alpha coefficient
Organizational Structure	Intelligent Road Governance	3	0.893
	Shared Infrastructure	3	0.862
	Institutional Responsibility in Upstream Documents	3	0.724
	Legal-Financial Support	3	0.720
	Feedback and Increased Competition	3	0.699
Multi-agency Communication	Comprehensive Communication Network	3	0.733
	Multi-agency Cooperation Protocol	3	0.769
	Intelligent Management Based on Data Governance	3	0.753
	Social Cultural Development	4	0.716

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Dimension	Component	Number of Questions	Cronbach's Alpha coefficient
Multi-faceted Cultural Development	Artistic-Literary Cultural Development	3	0.748
	Targeted Law Enforcement	2	0.712
	Smart License Plate	3	0.676
Technical Factors	Securing the Motorcycle Traffic Environment	3	0.725
	Specialized Motorcycle Equipment	3	0.812
Comprehensive Training	Attitudinal Innovation	3	0.725
	Specialized Training	4	0.806
	Education from Childhood	3	0.728

Furthermore, inferential statistics were conducted using SmartPLS3 software. This software was chosen due to its ability to provide the best results based on factor loadings in path analysis relationships, contributing to a more precise evaluation of the findings.

5.4. KMO Index and Bartlett's Test

In the process of factor analysis, it is necessary to ensure whether the obtained data can be scientifically used for examination or not. In other words, whether the sample size is

adequate for conducting factor analysis. For this purpose, Bartlett's test and the KMO index were used in this study. According to these tests, the adequacy of the data for factor analysis is confirmed when the KMO index is greater than 0.7 and the significance level of Bartlett's test is less than 0.05. If these conditions are met, the sample size is sufficient for exploratory factor analysis. The results of these tests for the researcher-made questionnaire derived from the qualitative phase are presented in Table 7.

Table 7. KMO and Bartlett's Test for the Researcher-Made Questionnaire Data

Statistic	Expert Panel on Traffic Accidents and Technical Affairs
KMO Test	0.843
Bartlett's Test	-
Chi-square (χ^2)	1325.684
Degrees of Freedom (df)	9222
Significance Level (p)	0.002

Based on the data in Table 3, the values of the KMO and Bartlett's test and the significance level for the researcher-made questionnaire have been reported. Therefore, the selected sample size for factor analysis is sufficient. It is worth mentioning that since the significance level of Bartlett's test is less than 0.05, this indicates that factor analysis is adequate and appropriate for identifying the model structure.

In the present study, the KMO index for the experts' questionnaires is 0.841, and all obtained values are greater than 0.7, which shows that the selected samples are sufficient for performing factor analysis. Exploratory Factor Analysis: Table 8 presents the convergence and validity of the multi-institutional prevention model of motorcycle accidents.

Table 8. Validity and Convergence of the Multilateral Prevention Model of Motorcycle Accidents

Selected Code	Axial Code	Composite Reliability	Average Variance Extracted (AVE)
Organizational Structure	Smart Road Governance	0.933	0.823
	Shared Infrastructure	0.819	0.602
	Institutional Responsibility in Upstream Documents	0.790	0.559

Selected Code	Axial Code	Composite Reliability	Average Variance Extracted (AVE)
Multi-institutional Communications	Legal-Financial Support	0.794	0.566
	Feedback and Increasing Institutional Competition	0.750	0.505
	Comprehensive Communication Network	0.800	0.574
	Defining Multi-institutional Cooperation Protocol	0.775	0.538
	Smart Management Based on Data Governance	0.580	0.521
Multi-faceted Cultural Development	Social Cultural Development	0.839	0.641
	Artistic-Literary Cultural Development	0.770	0.539
	Targeted Law Enforcement	0.669	0.518
Technical Factors	Connected Smart Plate	0.821	0.605
	Safe Traffic Environment, Securing Motorcyclists' Traffic	0.844	0.645
	Dedicated Safety Equipment for Motorcycles	0.887	0.723
Comprehensive Education	Attitudinal Innovation	0.845	0.651
	Specialized Training	0.873	0.634
	Education from Childhood	0.800	0.573

The output of the Smart PLS software shows that the composite reliability of the measurement model for the main constructs of the research for the multilateral motorcycle accident prevention model in the organizational structure dimension includes: smart road governance with a value of 0.933, shared infrastructure with 0.819, institutional responsibility determination in upstream documents with 0.790, legal-financial backing with 0.794, and feedback and increased institutional competition with 0.750. The highest composite reliability belongs to the smart road governance dimension, and the lowest composite reliability belongs to the feedback dimension. Also, for the multilateral communications dimension, it includes: comprehensive communications network with 0.800, multilateral cooperation protocol determination with 0.755, and smart management based on data governance with 0.580. The highest composite reliability belongs to the comprehensive communications network dimension, and the lowest composite

reliability belongs to the smart management based on data governance dimension. On the other hand, for the multifaceted cultural promotion dimension, it includes: social culture promotion with 0.839, artistic-literary culture promotion with 0.770, and targeted law enforcement with 0.669. The highest composite reliability belongs to the social culture promotion dimension, and the lowest composite reliability belongs to the targeted law enforcement dimension. Moreover, for the technical factors dimension, it includes: connected smart plate with 0.821, safe traffic environment with 0.844, and specialized motorcycle safety equipment with 0.887. The highest composite reliability belongs to the safe traffic environment dimension, and the lowest composite reliability belongs to the connected smart plate dimension.

It is worth noting that for the comprehensive education dimension, it includes: attitudinal innovation with 0.845, specialized training with 0.873, and education from childhood with 0.800. The highest composite reliability

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belongs to the attitudinal innovation dimension, and the lowest composite reliability belongs to the education from childhood dimension. Also, to accurately examine the convergent validity of the measurement model for the main constructs related to each dimension, the average variance extracted (AVE) was used, which for the organizational structure dimension includes: smart road governance with 0.823, shared infrastructure with 0.602, institutional responsibility determination in upstream documents with 0.559, legal-financial backing with 0.566, and feedback and increased institutional competition with 0.505. The highest average variance extracted belongs to the smart road governance dimension, and the lowest average variance extracted belongs to the feedback and increased institutional competition dimension.

Also, for the multilateral communications dimension, it includes: comprehensive communications network with 0.574, multilateral cooperation protocol determination with 0.538, and smart management based on data governance with 0.521. The highest average variance extracted belongs to the comprehensive communications network dimension, and the lowest average variance extracted belongs to the smart management dimension. Moreover, for the multifaceted cultural promotion dimension, it includes: social culture promotion with 0.641, artistic-literary culture promotion with 0.539, and

targeted law enforcement with 0.518. The highest average variance extracted belongs to the social culture promotion dimension, and the lowest average variance extracted belongs to the targeted law enforcement dimension.

Also, for the technical factors dimension, it includes: connected smart plate with 0.605, safe traffic environment with 0.645, and specialized motorcycle safety equipment with 0.723. The highest average variance extracted belongs to the specialized motorcycle safety equipment dimension, and the lowest average variance extracted belongs to the connected smart plate dimension. It is worth noting that for the comprehensive education dimension, it includes: attitudinal innovation with 0.651, specialized training with 0.634, and education from childhood with 0.573. The highest average variance extracted belongs to the attitudinal innovation dimension, and the lowest average variance extracted belongs to the education from childhood dimension.

According to the above, in Table (9) and Figure (3), no value below 0.50 is observed, meaning the model obtained qualitatively has been confirmed quantitatively based on the opinions of the relevant experts, all selected and core codes have been approved, and as a result, there is a direct correlation between the codes extracted from interviews with experts in the qualitative phase and the multilateral motorcycle accident prevention model.

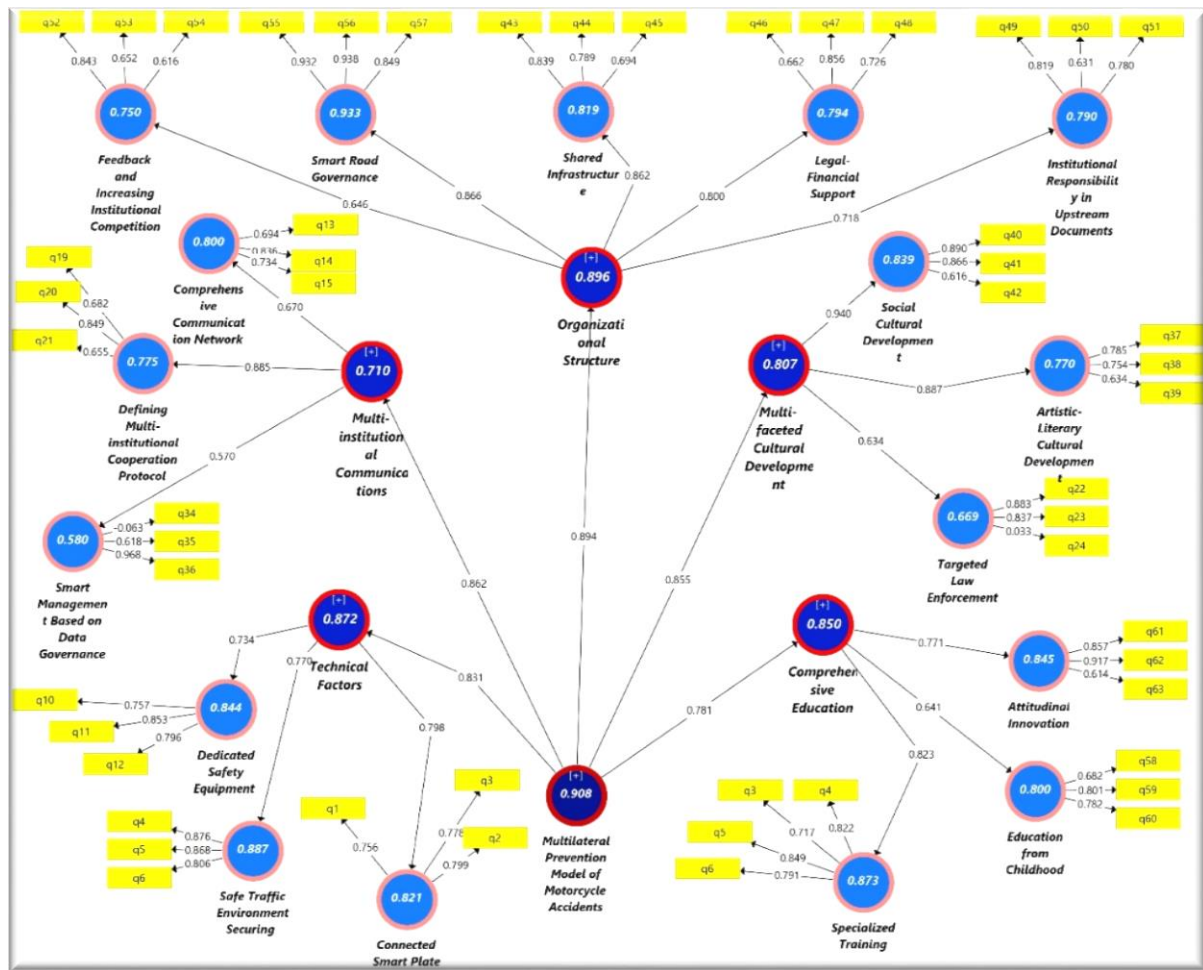


Figure 3. Regression Coefficients of the Multilateral Motorcycle Accident Prevention Model

Table 9. Coefficients and T-Statistics of Model Variables

Dimension/Pathway	Beta Coefficient	T-Statistic	Significance Level
Multilateral Motorcycle Accident Prevention Model → Organizational Structure	0.894	26.894	0.000
Road Governance Model in Multilateral Motorcycle Accident Prevention → Multilateral Communications	0.862	25.251	0.000
Multilateral Motorcycle Accident Prevention Model → Multidimensional Culture Building	0.855	25.392	0.000
Multilateral Motorcycle Accident Prevention Model → Technical Factors	0.831	12.436	0.000
Multilateral Motorcycle Accident Prevention Model → Comprehensive Education	0.781	10.281	0.000
Organizational Structure → Smart Road Governance	0.866	28.566	0.000
Organizational Structure → Shared Infrastructure	0.862	22.714	0.000
Organizational Structure → Assignment of Institutional Responsibility in Policy Documents	0.718	11.782	0.000
Organizational Structure → Legal-Financial Support	0.800	11.627	0.000
Organizational Structure → Feedback and Institutional Competition Enhancement	0.646	6.451	0.000

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Dimension/Pathway	Beta Coefficient	T-Statistic	Significance Level
Multilateral Communications → Integrated Communications Network	0.670	9.035	0.000
Multilateral Communications → Establishment of Interagency Cooperation Protocols	0.885	41.462	0.000
Multilateral Communications → Smart Management Based on Data Governance	0.570	8.894	0.000
Multidimensional Culture Building → Social Culture Building	0.940	66.137	0.000
Multidimensional Culture Building → Artistic-Literary Culture Building	0.887	28.047	0.000
Multidimensional Culture Building → Targeted Law Enforcement	0.634	9.403	0.000
Technical Factors → Smart Connected License Plate	0.798	15.000	0.000
Technical Factors → Safe Riding Environment	0.734	10.487	0.000
Technical Factors → Motorcycle-Specific Safety Equipment	0.770	13.473	0.000
Comprehensive Education → Attitudinal Innovation	0.771	12.532	0.000
Comprehensive Education → Specialized education	0.823	11.779	0.000
Comprehensive Education → childhood education	0.641	5.990	0.000

In Table 7, it is observed that the factor loadings for organizational structure (0.894), multi-institutional communications (0.862), multifaceted cultural development (0.855), technical factors (0.831), and comprehensive education (0.781) are all greater than 0.5, indicating that all factor loadings are statistically significant at the 95% confidence level. Furthermore, all components under the organizational structure dimension in the results of the researcher-made questionnaire show correlation. The highest correlation coefficient belongs to smart road governance (0.866), followed by shared infrastructure (0.862), legal-financial support (0.800), and institutional responsibility in upstream documents (0.718). All these components demonstrate strong correlations. Under the multi-institutional communications dimension, the component establishing protocols for inter-agency cooperation has the highest correlation coefficient (0.885), followed by comprehensive communication network (0.670), and feedback

and institutional competition enhancement (0.646). All components show strong correlations. Similarly, all components under the multifaceted cultural development dimension show correlations, with social cultural development having the highest correlation coefficient (0.940), followed by artistic-literary cultural development (0.887), and targeted law enforcement (0.634). All components under the technical factors dimension also show strong correlations: smart connected license plate (0.798) with the highest correlation, followed by dedicated safety equipment for motorcycles (0.773), and safe traffic environment (0.734). Under the comprehensive education dimension, specialized training shows the highest correlation coefficient (0.823), followed by attitudinal innovation (0.771), and childhood education (0.641). All components demonstrate strong correlations. The final factor analysis of the multi-institutional motorcycle accident prevention model is presented in Figure 4.

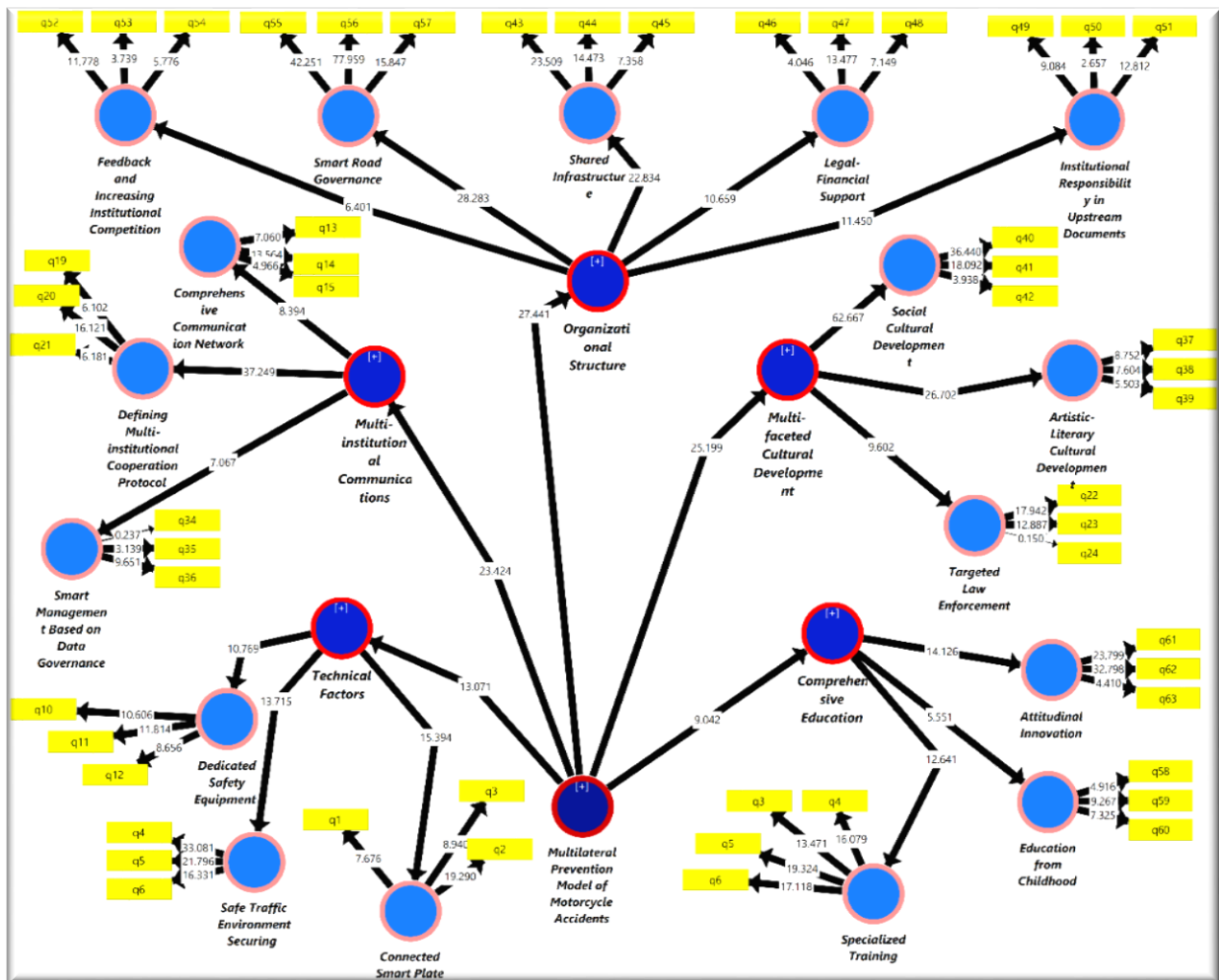


Figure 4. T-values of the Multi-Institutional Motorcycle Accident Prevention Model

According to Figures 3 and 4, the values of the factor loadings between the dimensions and components related to the multi-institutional motorcycle accident prevention model have been presented. In relation to the R^2 coefficient, this value should be more than 0.05 at a 95% significance level. Therefore, based on the overall proposed model, it is observed that at the 95% level, relatively strong relationships exist between the studied dimensions and components with the multi-institutional motorcycle accident prevention model, and the relationships are significant. Moreover, the most influential dimension in the multi-institutional motorcycle accident prevention model is related to the **organizational structure** dimension with a value of **26.894 – very strong relationship** – followed by the

multi-faceted cultural development dimension with a value of **25.392 – strong relationship** – and then the **multi-institutional communication** dimension with a value of **25.251**, followed by the **technical factors** dimension with a value of **12.436**, and finally the least influential is the **comprehensive education** dimension with a value of **10.281** in the multi-institutional motorcycle accident prevention model.

Also, according to the factor analysis diagram (T-value) for the examined dimensions and components including: organizational structure, multi-institutional communication, multi-faceted cultural development, technical factors, and comprehensive education, the calculated T-values are above **1.96**, indicating that the test is significant and that there is a strong relationship

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between all identified dimensions and components in the multi-institutional motorcycle accident prevention model. To evaluate the adequacy of the proposed model,

goodness-of-fit indices were used according to Tables 10 and 11, the results of which are as follows.

Table 10. Results of the adequacy test of the dimensions of the Multi-Institutional Motorcycle Accident Prevention Model

Dimension	MSE Index	RMSE Index	Q ² Index
Organizational Structure	0.096	0.042	0.487
Multi-Institutional Communication	0.112	0.085	0.463
Multi-Faceted Cultural Development	0.167	0.131	0.357
Technical Factors	0.185	0.173	0.319
Comprehensive Education	0.196	0.187	0.298

Table 11. Results of the Adequacy Test of the Components of the Road Governance Model in Multi-Institutional Motorcycle Accident Prevention

Dimension	Components	MSE Index	RMSE Index	Q ² Index
Organizational Structure	Smart Road Governance	0.071	0.020	0.516
	Shared Infrastructure	0.082	0.031	0.502
	Defining Institutional Responsibility in Upstream Documents	0.094	0.034	0.463
	Legal-Financial Support	0.064	0.058	0.447
	Feedback and Increased Institutional Competition	0.121	0.061	0.432
Multi-Institutional Communication	Comprehensive Communication Network	0.103	0.042	0.505
	Defining Multi-Institutional Collaboration Protocols	0.119	0.053	0.454
	Smart Management Based on Data Governance	0.107	0.074	0.439
Multi-Faceted Cultural Development	Social Culture Development	0.117	0.117	0.411
	Artistic-Literary Culture Development	0.164	0.132	0.363
	Purposeful Law Enforcement	0.195	0.147	0.318
Technical Factors	Connected Smart License Plate	0.168	0.153	0.384
	Safe Traffic Environment / Securing Motorcycle Routes	0.189	0.174	0.323
	Dedicated Motorcycle Safety Equipment	0.213	0.182	0.287
Comprehensive Education	Attitudinal Innovation	0.184	0.178	0.302
	Specialized Training	0.202	0.185	0.269
	Education from Early Childhood	0.212	0.193	0.257

6. Discussion and Conclusion

The use of motorcycles in metropolises is an inseparable necessity of transportation, such that many occupational and personal goals are achieved with greater speed and lower cost. Therefore, the safety of vulnerable traffic users holds a significant position in transportation

planning, and any planning aimed at enhancing the safety of motorcyclists becomes possible through recognizing challenges and accurately educating on specialized safety issues. The present study, for the first time in Iran, was conducted with the aim of presenting a multi-institutional prevention model for motorcycle accidents. The results obtained from interviews

in the qualitative section with experts, elites, and faculty members of Amin Police University, Ministry of Roads and Urban Development, Deputy of Civil Affairs of the Ministry of Interior, the headquarters of FARAJA Traffic Police, and experts from the Transport and Traffic Deputy of the 22 districts of Tehran Municipality—who had executive experience and sufficient understanding of interdisciplinary traffic safety management based on multi-institutional prevention of motorcycle traffic accidents—showed that the dimensions of the multi-institutional prevention model for motorcycle accidents include, in order: organizational structure, multi-institutional communication, multi-faceted cultural development, technical factors, and comprehensive education. Also, the impact level of each extracted dimension in the statistical population was evaluated in the quantitative section, and results indicated that these dimensions are closely and continuously interconnected. With the analysis of data obtained from the conducted factor analysis, ultimately **5 dimensions, 17 components, and 414 diverse and closely related indicators** were extracted and served as the basis for designing the tools in both qualitative and quantitative sections. These dimensions are: organizational structure, multi-institutional communication, multi-faceted cultural development, technical factors, and comprehensive education. The main components used for the **organizational structure** dimension include: smart road governance, shared infrastructure, defining institutional responsibility in upstream documents, legal-financial support, and feedback and institutional competition; for the **multi-institutional communication** dimension: comprehensive communication network, defining multi-institutional cooperation protocol, and smart management based on data governance; for the **multi-faceted cultural development** dimension: social culture-building, artistic-literary culture-

building, and purposeful law enforcement; for the **technical factors** dimension: smart connected license plate, securing motorcycle traffic environment, and dedicated motorcycle safety equipment; and finally, for the **comprehensive education** dimension: attitudinal innovation, specialized training, and early childhood education were obtained. It is worth mentioning that the analysis of the results from both the qualitative and quantitative sections of the study revealed that all extracted dimensions from the interviews with specialists, elites, and experts were confirmed by the statistical population in the quantitative section in the same priority order.

By reviewing the research findings, it is observed that multi-institutional prevention of motorcycle accidents is a multifaceted and interdisciplinary subject and cannot be accomplished solely by the traffic police. Therefore, contrary to the current practice in our country where the traffic police alone spearhead the prevention of motorcycle violations through enforcement against offending drivers, alternative punishments, implementation of the MotorYar plan, temporary and physical restrictions on unauthorized travel routes (such as special lanes, tunnel entrances, etc.), motorcycle confiscation, field training of offending drivers, and so forth, prevention of motorcycle accidents is not feasible. In the past two years, 46% of fatalities and 67% of injuries in traffic accidents in the country's metropolises were related to motorcyclists. Currently, due to the lack of a multidimensional approach to traffic safety in the country and consequently the increasing traffic volume in metropolises, the popularity of this mode of transport among traffic users has been rising. Therefore, another issue that gives special research value to the multi-institutional prevention of motorcycle accidents is the attention to the role of effective institutions in motorcyclist traffic safety and the determination of institutional responsibilities in upstream documents based on the third

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component of the organizational structure dimension in this study.

Based on the analysis of interviews conducted in the qualitative section of the research, road governance must, while having a diverse, integrated, interactive, networked, participatory, adaptive, empowered, creative, and innovative system in traffic safety management, seek to fulfill public demands and the common good in the transportation system. On the other hand, considering that wise governance is one of the main scenarios for governments in an era of rapid changes, chaos, complexities, and uncertainties, intelligent road governance and feedback collection aimed at diagnosing performance issues and creating institutional competition based on this dimension can lead to focused and sustainable prevention of motorcyclist traffic accidents within the framework of multi-institutional communications.

Furthermore, collecting feedback from stakeholders to improve the performance of traffic users and managers and to correct traffic behavior in society should be pursued, while creating mutual trust and respect through the component of legal and financial backing, and the payment amount to each institution should be proportional to the quality of work according to the multi-institutional cooperation protocol. Another valuable issue that will be achieved if the proposed model in this research is implemented is the root and multifaceted traffic culture-building. One of the main goals of traffic managers is to promote traffic culture and consequently correct the traffic behavior of users. Through multi-institutional prevention based on the findings in the comprehensive education dimension of this study, in addition to teaching laws and proper traffic behavior from early childhood, attitudinal innovation in educating traffic users is achieved, and at older ages, these individuals will eagerly receive specialized training. Therefore, multi-institutional prevention includes designing, guiding, and evaluating the traffic safety

management system. This guidance and leadership involve coordination and systematization of specific prevention arrangements to purposefully shape the rules and norms of society so that tasks such as data governance, optimal resource allocation, discourse organization, and ultimately feedback collection are executed.

The functions of multi-institutional prevention provide more cohesion and coordination and also facilitate the implementation of practical solutions with participation in decision-making by most traffic users for decision-makers in the field of motorcyclist traffic safety. Thus, addressing specialized and professional topics will weigh more compared to the challenges of single-institution prevention by the traffic police, which in the long term will bring multifaceted benefits to traffic users and subsequently, through holding stakeholders accountable and public demand, lead to the improvement and enhancement of traffic safety. Supporting the results of this research, one can refer to the study by Salimi, Amiri, and Haqshenas (2024) titled "Identification of managerial and executive factors in reducing motorcycle traffic accidents in the country," whose results include managerial and executive factors for motorcycle accident prevention through multi-institutional prevention and the pursuit of a leading organization, leading to practical prevention of motorcycle accidents. This aligns with the organizational structure and multi-institutional communication dimensions. Also, the findings of Ma'roofi and Saqafi (2022) in a study titled "Multi-institutional approach to preventing traffic crimes" including multi-institutional coordination for culture-building and improving traffic safety using participatory models to reduce traffic accidents align with parts of this research's findings, including the organizational structure dimension and the component of defining institutional responsibility in upstream documents and the data governance component. On the other hand, the findings of Hosseini,

Bakhtiari, Fakharz, and Mohibi (2022) in a study titled "Multi-institutional participation model in the crime detection process" include the technology dimension, intelligent participation components, and in the structural dimension, feedback collection and intelligent monitoring components, which align with parts of the present study's findings.

Moreover, the findings of Javadian, Naderpour, Hassanzadeh, and Naderi (2020) titled "Investigating the reasons for citizens' tendency to use motorcycles instead of public transport" align with the multi-institutional participation dimension and components of shared infrastructure and multi-institutional cooperation protocol. Additionally, the findings of Emigun, Sani, Swimy, Fadileh, and Obafunba (2022) titled "Investigation of the main causes of mortality in motorcycle accidents," which include strengthening multi-institutional participation and making widespread significant changes in governmental transportation policies in Nigeria, align with the organizational structure dimension and the component of defining institutional responsibility, as well as the multi-institutional communication dimension.

Also, the findings of Chong, Kento, Hiroto, Tadanori, and Kenji (2022) in a study titled "Evaluation of the effectiveness of sustainable safety education programs aimed at improving motorcyclist traffic culture in Vietnam," which include specialized motorcyclist training, improving children's awareness of motorcycle dangers, and altruistic motivation as key factors to encourage safe riding, align with parts of this study, including the multi-faceted culture-building and comprehensive education dimensions, especially specialized training and early childhood education components.

The findings of this research showed that considering the interdisciplinary nature of traffic management and the necessity of synergy among effective institutions in motorcyclist traffic safety with a focus on transparency, enhanced participation, multi-

institutional oversight, and effective cooperation, direct prevention of motorcycle accidents can be achieved. Also, this research stated that multi-institutional prevention by implementing the principles of the extracted dimensions can play a key role in improving motorcyclist safety. Furthermore, the use of modern technologies such as intelligent systems can enhance the effectiveness of multi-institutional prevention programs for this vulnerable group's accidents. Ultimately, this research shows that motorcycle accident prevention is only possible through combining multi-institutional actions, inter-organizational coordination, and novel approaches in organizational structure, road governance, and data governance. In explaining these findings, it can be stated that special attention must be paid to the multi-institutional prevention model for motorcycle accidents, and all five dimensions—organizational structure, multi-institutional communications, multi-faceted culture-building, technical factors, and comprehensive education—and their components should be considered to witness improved traffic safety and reduced motorcycle traffic accidents.

7. Implications

Based on the findings of this research, the following proposals are offered to improve and strengthen the follow-up and implementation process of the multi-institutional prevention model for motorcycle accidents:

- **Transparency in informing about laws and the duties and authorities of institutions effective in traffic safety:**

Collecting and sharing accident-related data by creating comprehensive platforms, and then transparently and accessibly informing traffic users about the current status of traffic accidents in the country, specific laws, and traffic violations related to motorcyclists.

- **Holding specialized training workshops:**

Organizing specialized workshops for motorcyclists that may include training on safety principles, proper use of modern safety

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equipment such as guards, handlebar warmers, helmets, etc.

- **Improving supervisory and control infrastructure through multi-institutional communications:**

Reviewing the performance of institutions responsible and effective in traffic safety, as well as developing intelligent monitoring systems such as violation recording cameras dedicated to motorcyclists in busy passages and high-risk areas, to increase more precise supervision of managers' performance and motorcyclists' traffic behavior.

- **Multi-institutional supervision:** Defining specific responsibilities for each institution, strengthening interactions among various institutions, creating legal and executive infrastructures aimed at establishing a leading organization as the traffic authority in the country, and then formally and continuously reviewing and evaluating the performance of other organizations involved in motorcyclist traffic safety.

- **Developing insurance systems for motorcyclists:** Creating insurance schemes with appropriate coverage for law-abiding motorcyclists can provide an incentive for obeying laws and using safety equipment among other motorcyclists.

The combination of these measures and multi-institutional approaches can significantly contribute to reducing motorcyclist accidents and improving their traffic safety.

8. Innovation

One innovative aspect of this present research is that, for the first time, while providing an explanation of multi-institutional prevention of traffic accidents, using the opinions of experts and officials and benefiting from senior experts of the Road and Traffic Police, the Road Police Headquarters of FARJA, the Ministry of Roads and Urban Development, and the Ministry of Interior's Deputy of Urban Development, a comprehensive and suitable model was presented to identify the requirements for

focused prevention of motorcyclist accidents based on the multi-institutional prevention model. This model enables the necessary and essential actions to be planned and comprehensively and effectively implemented. The results of this research can serve as a framework for policymaking and planning in the field of prevention of accidents involving this vulnerable group of traffic users.

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