Analysis of Risk Factor Traffic Crashes and Implementation of Road Safety: A Systematic Literature Review

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Article Information	ABSTRACT
	Introduction: Every year, RTA (Road Traffic Accident) kills roughly 1.19 million people globally and injures between 20 and 50 million people. The projected financial impact of these accidents is \$518 billion per year, and numerous households suffer lifetime physical disability and mental trauma as a result of these fatal road accidents. This study aims to assess risk factors for traffic crashes and the implementation of road safety. **Method**: This research technique is a systematic literature review that examines 27 journal articles published between 2020 and 2024. The author used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020. **Results**: Most countries have established comparable policies, such as punishing illegal activity, regulating speed, increasing driving, helmet use, drinking and driving, and road safety education. The issues that remain include unsafe behavior still being violated by the community and a lack of awareness about the need for road safety implementation **Conclusion**: The government must consider acceptable tactics for educating people about the necessity of following traffic regulations, improving current policies, and utilizing technology to help prevent traffic accidents.

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INTRODUCTION

Every year, around 1.19 million people are killed in traffic accidents globally, with 20 to 50 million individuals suffering nonfatal injuries (WHO, 2023b). The WHO Southeast Asia area caused up to 28% of the fatalities worldwide (WHO, 2023a). The Western Pacific Region comprised up to 25% of deaths (WHO, 2023a). The projected financial impact of these accidents is \$518 billion per year, and numerous households suffer lifetime physical disability and mental trauma as a result of these fatal road accidents (WHO, 2018).

Various methods and activities have been implemented locally and globally to assure road safety and decrease property damage and loss of life; for this purpose, WHO has declared a "Decade of Action for Road Safety 2021-2030", establishing an ambitious target of averting at least 50% of road traffic deaths and injuries by 2030 (WHO, 2021). Traffic and road safety policies have been implemented to save lives by slowing the rise in road traffic deaths in the face of a growing population. Road safety generally results from the interplay of three significant factors: humans, vehicles, and the road. Humans have long been seen as the leading cause of road accidents due to their propensity for error, even though environmental causes frequently lead to human error. Roadway conditions, and the cars and their families, can cause human mistakes and thus be significant causes of accidents. Recent road safety solutions (such as the Safe System Approach) explicitly differentiate components that cause traffic crashes—human, ecological, vehicle-related, etc.—and prioritize a more comprehensive method for fixing the issue (Assailly, 2017; Babić, Babić, Fiolic, & Ferko, 2022).

The development of road safety has lowered the number of deaths from traffic accidents around the world. There were an expected 1.19 million road traffic deaths in 2021, a 5% decrease from the 1.25 million deaths in 2010. Since 2010, death rates in the Western Pacific Region have decreased by 16%, whereas in the Southeast Asia Region, they have decreased by 2% (WHO, 2023a).

Road safety has been a top priority for transportation engineers, legislators, and researchers. Road collisions are caused by a complex combination of circumstances, including transportation infrastructure (e.g., highway surface conditions), vehicle user behaviors (e.g., driver/pedestrian activity), traffic (e.g., congestion), and other environmental problems (e.g., bad weather), among others.

There is an enormous literature on risk factors in crashes and road safety implementation. To strengthen research arguments, a scoping review of the literature on risk factors and traffic safety implementation using VOSviewer software is required to find topic links and state-of-the-art information in this research. Figure 1 displays the initial analysis of theme association data, revealing a highly complex association pattern for road safety implementation. Figure 2 depicts the distribution of publications according to keywords.
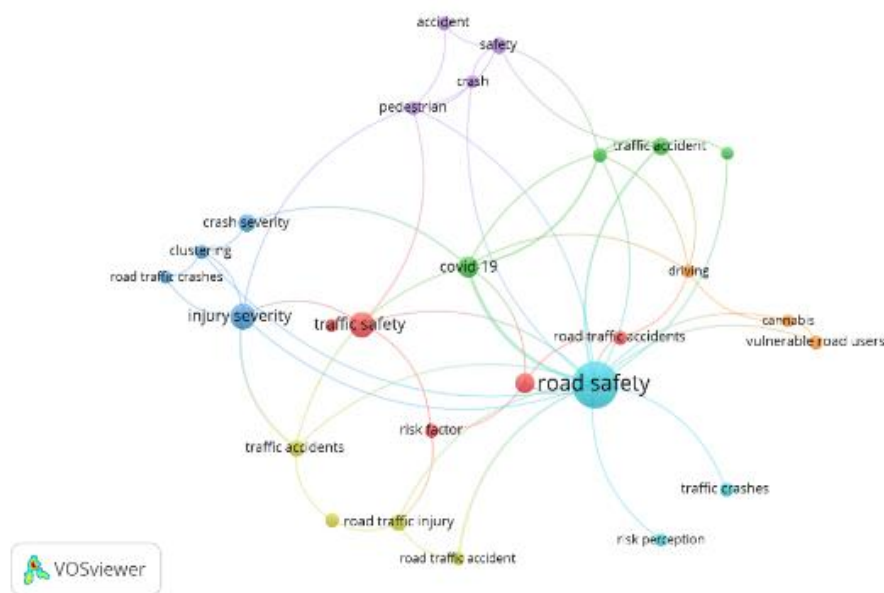

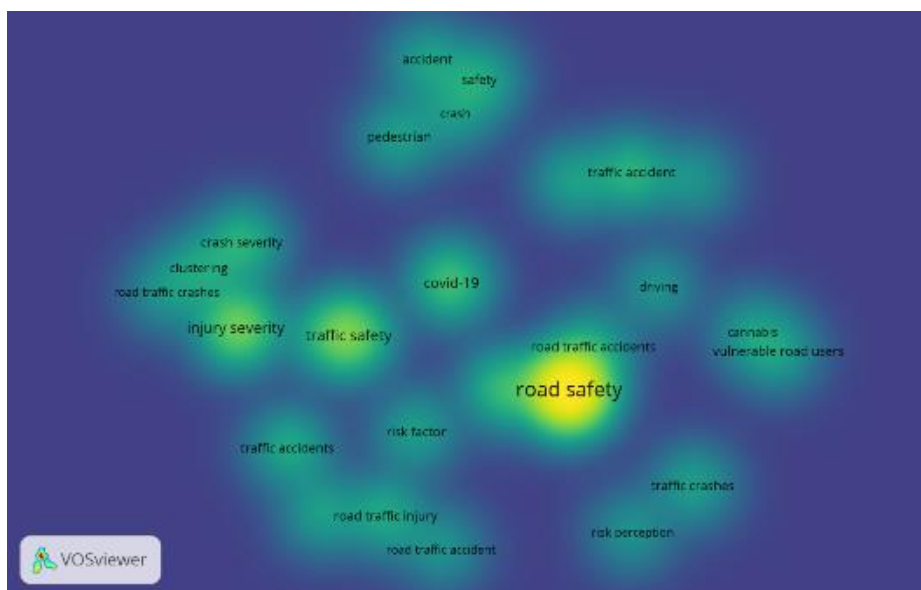Figure 1. Initial network visualization

Figure 2. Visualization of article distribution

Despite knowing that numerous papers try to define, describe, and clarify road safety implementation, with some even trying to foresee and understand the future, no systematic and logical study has combined traffic accident risk factors and road safety implementation. As a result, the novelty of this study is critical for explaining the existing and new principles behind road safety implementation to collect and analyze the perspectives, insights, and expectations of the relevant scientific and practitioner organizations.

Based on the above explanations, the author wants to continue discussing the risk factors of traffic crashes and the implementation of road safety. This research article aims to determine these risk factors and implement road safety.

LITERATURE REVIEW

An accident is defined as an unforeseen and unplanned situation in which the activity and reaction of an object or person result in human harm or property harm. A crash on the roadway is characterized as a malfunction of the vehicle driver's system to conduct one or more actions necessary for the trip to be finished without injury or loss. Vehicle crashes are primarily caused by inadequate roadways and a lack of adequate and systematic enforcement (Ahmed et al., 2023).

Bad roadways, reckless passing, tired driving, somnolence, stupor, illness, the use of mobile phones, drinking and eating in the car, negligence in the event of a street mistake, and the failure of other road users to react appropriately to the situation are the primary causes of traffic accidents (Sun, Liu, Chen, & He, 2019). Regardless of the vehicle, traumatic injuries from traffic accidents can impact any region of the body. The head, chest, abdomen, pelvis, and spine are among the body's most vulnerable areas, with catastrophic effects (Ahmed et al., 2023).

Traffic safety is the most common health determinant in the transportation industry. It refers to the steps taken to guarantee individuals' well-being and prevent accidents. It covers methods for lowering noise pollution, raising knowledge about electric and hybrid vehicles, encouraging micro-mobility, and deploying automated vehicles to reduce driver-related crashes and save lives (Rojas-Rueda, 2020). A well-established interdepartmental and multisectoral partnership administers plans, strategies and responsibilities. It works

with a solid evidence base that is tuned to the insight that professionals can prevent system defects (Elvik & Nævestad, 2023).

METHOD

This research strategy involves conducting a systematic review of the literature. The author used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 to ensure systematic literature reviews that are transparent, reproducible, and scientifically adequate (Page et al., 2021). The author used the Science Direct, Google Scholar, and Web of Science databases to look up journal articles. Multiple combinations of keywords with Boolean operators "AND/OR" (search strings) for each category are utilized to find relevant articles. The journal search used the following keywords: risk factor, road safety, accident, implementation, traffic collisions, and traffic safety. The inclusion criteria for selected journals are (a) English language journal papers published between 2020 and 2024, (b) studies including the implementation of road safety, and (c) Original research. The researcher used the PICO method to analyze the selected articles. Data analysis was performed using content analysis, which helps comprehension by evaluating the text of each article and literature references.
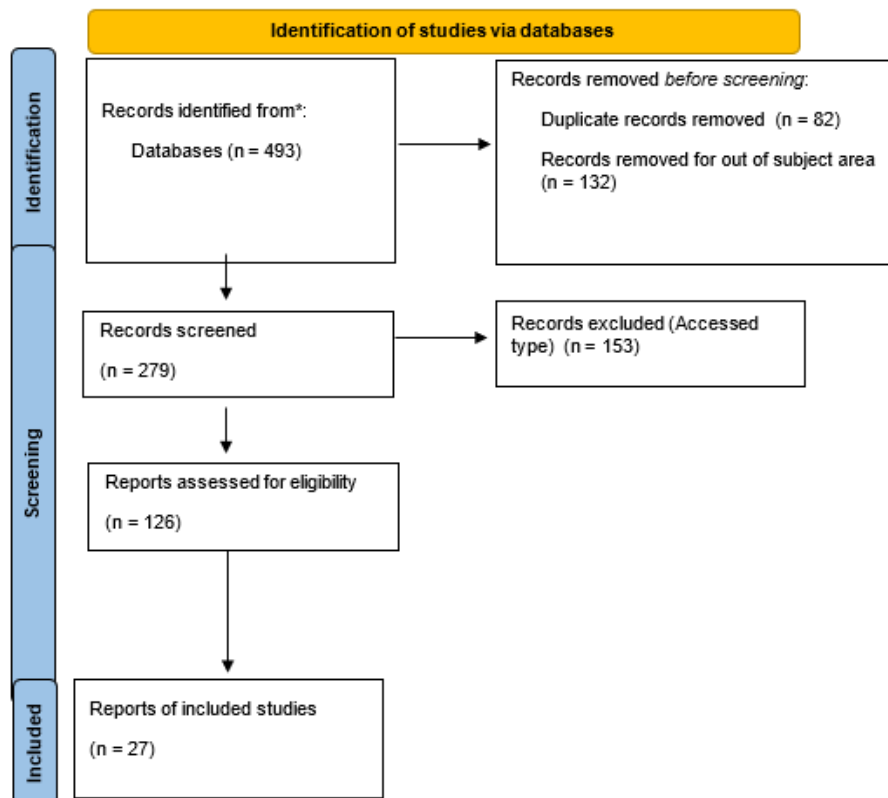

Figure 1. PRISMA Flow Diagram

RESULT AND DISCUSSION

The final number of articles analyzed in this literature review was 27 based on the results of sorting using the PRISMA Method (Figure 1). In detail, the results of the analysis are presented in Table 1.

Table 1. Results of Literature Review Analysis

No	Author and Country	Population	Interven-tion	Comparison	Important Results
1.	(Inada, Tomio, Nakahara, & Ichikawa, 2022) Japan	National police data on the monthly number of roads	Campaign	Impact campaign on road safety	Between 1949 and 2019, 632,577 people died on the road. Deaths decreased when the campaign was carried out in the spring.
2.	(Benlagha & Charfeddine, 2020) China	Four hundred five thousand one hundred seventy-seven ur-wheeled vehicles and motorcycles.	Implementation road safety	Factor affecting injury and new approach road safety in China	The influencing components include vehicle-related factors, driver-related factors, and other factors such as the vehicle's insurance coverage.
3.	(C. Yang, Jiang, Zhou, Hitosug, & Wang, 2023) China	traffic injuries report	Traffic safety	Traffic safety in China	China plans for healthy transportation growth during the "decade of road safety" to project global road traffic injuries by 2030. Improvements in traffic safety connected to public health under China's "National Comprehensive Three-Dimensional Transportation Network Planning Outline" would spur development in the global traffic environment.
4.	(Gu et al., 2021) China	Annual years of life lost (YLLs)	Traffic accident law	The impact of revising the traffic accident law	Traffic accident policy reduces YLLs
5.	(Kang & Wu, 2021) China	China Statistical Yearbook 2008–2017	Road safety productivity	Development of road safety 2007-2016	In 2016, China reported a 1,433-fold boost in road safety productivity over 2007, owing primarily to advances in cutting-edge technologies.
6.	(Satria, Tsoi, Castro, & Loo, 2020) Indonesia	Traffic crash information from 2012 to 2015 in Aceh	Traffic crash	Identify traffic crash solutions.	Proposed urban road safety measures include better monitoring of helmets, seat belts, and mobile phone use and the creation of regular communication and awareness initiatives.
7.	(Khaonuan, 2022) Thailand	100 people of Mohanamai in Nationwide	Mohanamai network	Development of the Mohanamai network for dealing with road accidents	Mohanamai is an organization of primary healthcare physicians that is essential in organizing community-based road safety management.

No	Author and Country	Population	Interven-tion	Comparison	Important Results
8.	(Bhu-Anantanondh, Kanyajit, Suwannanon, & Sinloyma, 2021) Thailand	500 people with driving licence	Traffic system	traffic system problem in Thailand	Drivers' poor impressions of traffic police officers, ineffective law enforcement, and inadequacies in police tactics.
9.	(Chantith, Permpoonwiwat, & Fowles, 2021) Thailand	The Institute of Security and International Studies in 2012-2017	Road safety	Effectiveness road safety	Speed Limit Laws, Helmet Use Laws, Seat Belt Use Laws, and Drunk Driving Laws can reduce traffic accidents.
10.	(Limsoonthrakul et al., 2021) Thailand	Designing a system to enforce traffic violations in Phuket	System design traffic safety	Effectiveness of Traffic Violation Enforcement System Design and Implementation	This system positively impacts road safety in Phuket with a negligible impact.
11.	(Nakao et al., 2022) Japan	280 emergency agencies	Campaign	Differences in traffic-related deaths during a national traffic safety campaign	During Japan's National Traffic Safety Campaign, major traffic injuries and hospital mortality remained constant.
12.	(Ayuningtyas, Grzebieta, Olivier, & Caponecchia, 2024) Indonesia	Literature review	Road safety	Road Safety Challenge in Indonesia	Indonesia has enforced helmets and speed restrictions.
13.	(Chen, Wang, & Huang, 2021) China	traffic safety report in Zheijang	Motorcycle restrictions	The impact of motorcycle restrictions on traffic accidents.	Banning motorbikes reduces traffic deaths
14.	(Kikuchi et al., 2023) Thailand	road traffic accident database in Shipanburi	Road safety information	Implementation of "road safety information sharing measures."	The "Traffic Safety Information Sharing Act" encourages partners in the government, academia, local communities, and corporate sectors to share road safety information based on experiences or near accidents.
15.	(Wang, Ying, & Jiang, 2022) China	Jinding in Shanghai	Traffic control	Efficacy of adaptive traffic control measures	Experimental results suggest that the strategies can enhance They are driving speed below the speed restriction while reducing traffic congestion during peak hours. The results demonstrate that the proposed measure is

No	Author and Country	Population	Interven-tion	Comparison	Important Results
					an effective and new method for traffic calming in large metropolitan complexes.
16.	(Ichikawa, Inada, & Nakahara, 2020) Japan	Using police-reported national data on MVCs	Traffic crashes	Traffic crashes	When the test was introduced in women aged 75–84 and later in men aged ≥80 and women aged ≥85, there was a significant increase in traffic accidents among unprotected road users.
17.	(Klinjun, Kelly, Praditsathaporn, & Petsirasan, 2021) Thailand	Road traffic investigation reports	Traffic injuries	Determine the risk variables for traffic injuries.	In Thailand, A total of 65.8% of the victims were hurt, and 14.5% died. The majority of deaths (66.1%) occurred on the site. Factors linked to mistakes made by humans
18.	(Rachmat et al., 2023) Indonesia	Indonesian Basic Health Research	Helmet usage	Factors influencing helmet use standards (use of helmets meeting national requirements and buckles) among workers in Indonesia.	The greater the worker's degree and social standing, the higher their consciousness of standardized helmet wear while driving.
19.	(J. Yang, Yamamoto, & Ando, 2021) Japan	Vehicle crash records	Elderly driver licence	impact of requiring driving lessons for elderly drivers	As Japan's aging society progresses, older drivers will rise, resulting in more car accidents.
20.	(Ricardianto, Hidayat, Manik, Widiyanto, & Susanto, 2021) Indonesia	Literature review	Traffic law	Traffic law in Indonesia	The following policies have been implemented: (1) Orderly Traffic Areas; (2) Partnership of Related Agencies; (3) Road Safety Education; (4) Traffic Education Program Enters the School Curriculum; (5) Driving School; (6) Increased CCTVs; and (7) Services and Security for Homecoming Flows. Ditlantas plans an online driving license (SIM), Smart SIM, e-Samsat, and Online BPKB.

No	Author and Country	Population	Interven-tion	Comparison	Important Results
21.	(Djalante, 2020) Indonesia	Indonesia Land Transportation Statistics, from 2016-2018,	Road safety	road safety management that effectively reduces traffic accidents.	Macro factors include the amount of cars, road length, and regional road damage conditions. Human error, such as a lack of supervision and monitoring of vehicles, equipment, and the road environment, and ineffective law enforcement are examples of micro variables.
22.	(Kalauov & Usmonov, 2022) Japan	Literature review	Traffic accident	Developed countries' successes in addressing traffic accident issues.	Japan is one of the world's nations to develop to minimize fatalities from traffic accidents.
23.	(Tumiyadi Maulana & Kusriyah, 2021) Indonesia	Literature review	Law	Law enforcement traffic crashes	Challenges to traffic accident justice include coordination among community members, police officers, local governments, and the central government to guarantee a safe and peaceful environment.
24.	(Wahyurudhanto, 2020) Indonesia	Literature review	policy	Analysis of political policy to reduce traffic accident	Policy executioners' behaviors or traits are crucial in achieving policy execution according to the goals.
25.	(Shimizu, Ueda, Ghaznavi, Sakamoto, & Nomura, 2022) Japan	2,934,477 traffic accidents	Traffic accident	Traffic accidents during COVID-19 and before COVID-19	In April-May 2020, road accidents in Japan fell by 30-40% compared to prior years' averages.
26.	(Sari & Yudhistira, 2021) Indonesia	The Central Traffic Control of the Indonesian National Police	Road surface quality	Effect of road lighting and road surface quality on road crash severities in Indonesia	Improved road illumination and surface conditions lead to a 4.2% and 3.4% reduction in traffic crash casualties, respectively.
27.	(Xu, He, Zhou, & He, 2023) China	Literature review	Road traffic safety law	The impact and revolution of road traffic safety laws with autonomous driving	Since 2021, the law governing autonomous vehicles has undergone numerous significant changes. For example, China's Ministry of Public

No	Author and Country	Population	Intervention	Comparison	Important Results
				technology in China.	Security released a proposed modification of Article 155 of the People's Republic of China's Law on Road Traffic Safety, clarifying laws on-road testing and vehicle access for self-driving vehicles. Shenzhen also issued the Smart Network Vehicle Regulations for the Shenzhen Special Economic Zone.

The risk factors of traffic crashes are as follows:

1. Alcohol

   At the community level, time-series analyses demonstrate that variations in per-capita alcohol use are associated with changes in death rates related to road injuries (Chikritzhs & Livingston, 2021). Males were far more likely to consume alcohol while injured. Approximately half of the injured men who walked and one-fourth of the wounded male drivers/riders had consumed alcohol before the incident (Sundet et al., 2020)

2. Seat Belt Used

   People who do not wear a seatbelt are 8.3 times more likely to be killed and 5.2 times more likely to be seriously injured than those who do. In particular, in terms of "gender," male drivers who do not use a seat belt had a higher probability of experiencing a severe and fatal injury, reaching 13.08 percent. Drivers under 25 and over 60 who do not utilize seat belts are more likely to experience severe or fatal injury in a traffic accident, as is the case with "age"(Febres et al., 2020).

3. Helmet Used

   Wearing a helmet at the moment of the crash protected injuries to the head. Helmet use decreased mortality, which aligns with previous research in developed and developing nations (Abdi, Robertson, Petrucka, & Crizzle, 2022).

4. High-speed driving

   Higher speeds were related to more severe crashes, fewer accidents detected during early peaks, and the types of crashes that occur in traffic.(Stiles, Kar, Lee, & Miller, 2023).

5. License driver

   The reasons for driving without a valid license and the risk of causing a traffic accident, particularly for vehicles with suspended licenses and those who have never been licensed. In these driver categories, a significant fraction of the association can be explained by other risk factors, particularly those associated with high-risk driving behaviors (Martín-delosReyes, Martínez-Ruiz, Rivera-Izquierdo, Jiménez-Mejías, & Lardelli-Claret, 2021).

   Helmet use, speed limits, seat belt use, retests for elderly driver's licenses, road safety initiatives, strengthening traffic laws, penalizing illegal behaviors, standardizing warning signs, improving driving license requirements, and enhancing traffic safety publicity and education are some of the road safety regulations that have been

implemented in most countries (Benlagha & Charfeddine, 2020; Chen et al., 2021; Gu et al., 2021; Husnul Khuluqi & Kurniawidjaja, 2021; Ichikawa et al., 2020; Kang & Wu, 2021; Nakao et al., 2022; Qi, Hu, Li, Wang, & Shi, 2022; C. Yang et al., 2023; J. Yang et al., 2021; Yeo, Lee, Cho, Kim, & Jang, 2020).

As Japan's aging population advances, there will be an increase in the number of older drivers, resulting in more car accidents (J. Yang et al., 2021). There was a significant increase in traffic accidents among unsecured drivers in women aged 75-84, men aged ≥80, and women aged ≥85.21. Spring sessions decreased the number of deaths daily deaths by 2.5% during road safety campaigns in Japan (Inada et al., 2022).

China revised its Road Traffic Safety Law in 2011. Following the implementation of the revised law, the average rate of total years of life lost per 100,000 people due to crashes fell from 1,133.14 to 848.87, and the proportion of years of life lost per 100,000 population fell by 30.11, indicating a steeper decline (Gu et al., 2021; Kang & Wu, 2021). In China, technological advancements have lowered the number of accidents. China conducts traffic calming tests in Shanghai (Wang et al., 2022). Autonomous vehicle technology is currently under field testing since it has reached a mature development stage and is predicted to reduce traffic accidents (Xu et al., 2023).

Indonesia has established the use of helmets and vehicle speed limits (Ayuningtyas et al., 2024; Rachmat et al., 2023). 83.1% of workers utilize helmets when riding motorcycles, of which 56.9% do not wear helmets according to standard regulations (Rachmat et al., 2023). Challenges to traffic incident law enforcement involve the engagement of the community, police officers, local governments, and the central government's duty to cooperate to establish a secure, pleasant, and peaceful environment for the community (Tumiyadi Maulana & Kusriyah, 2021). As a result, road safety in Indonesia must be approached from a human, equipment, and vehicle perspective, as well as a road environment, monitoring and supervision, and regulatory and legal perspective (Djalante, 2020). The suggested solutions on urban roads include better monitoring helmets, seat belts, and mobile phones and implementing regular communication and awareness initiatives (Satria et al., 2020).

In Thailand, up to 65.8% of victims were hurt, and 14.5% died. Most deaths (66.1%) happened on the spot (Klinjun et al., 2021). The severity of the outcome was connected with conventional risk factors, such as motorcycle use, alcohol/drug use, nighttime driving, decreased use of seatbelt/helmet, sitting in the cargo area, and overloading (Klinjun et al., 2021; Sapsirisavat, Mahikul, Desapriya, & Okamura, 2021). Thailand has established several initiatives to reduce road accidents. The implemented policies include a speed limit law, a helmet use law, a seat belt use law, and a drunk driving law (Chantith et al., 2021; Sapsirisavat et al., 2021). In Thailand, the general public needs an inadequate awareness and understanding of road traffic law; poor driving conduct is caused by a lack of knowledge of traffic law linked to traffic law infractions. The Road Traffic Law is the primary reason for inadequate law enforcement. This is because the statute contains a loophole that allows traffic cops or police to issue warnings to drivers who violate the Traffic statute rather than imposing harsher penalties (Bhu-Anantanondh et al., 2021). Thailand pioneered Mohanamai. Mohanamai is an association of primary healthcare providers who promote community-based road safety management (Khaonuan, 2022). The "Information Sharing Traffic Safety Act" empowers stakeholders from the government sector, academia, local communities, and the private sector to communicate road safety information based on their personal observations or near misses by recognizing and clarifying specific issues in accident-prone spots and black spots and selecting suitable road safety measures to suit the local circumstances in the target area (Kikuchi et al., 2023).

Around 80% of teenagers have committed a crime. This perspective indicates that Thailand quickly engages in violation behavior and tends to violate it based on adults, close friends, or relatives (Katanararoj et al., 2024).

The layout of driving alerts should be more straightforward, and rider training programs should include instructions to detect traffic circumstances that frequently generate these errors to reduce traffic crashes in Vietnam. In addition, helmet use was implemented in Vietnam (Trung Bui, Saadi, & Cools, 2020). Between rounds 3 and 8, the probability of wearing a strapped standard helmet decreased by 22.4 percentage points, while other covariates remained stable. Adults have an 11.3 percent greater prevalence of accurate use than children (Li et al., 2020). Helmet rules in Vietnam are practical and successful policies to minimize motorcycle deaths (Chantith et al., 2021).

Poor horizontal positioning impacted model outcomes in Malaysia. The chance of a more significant accident severity due to improper horizontal alignment was approximately 0.4 times lower than in a lack of such factors. Local authorities can take preventative actions to prevent catastrophic traffic accidents on segments with standard horizontal alignments (Musa et al., 2020).

The road safety implementation challenge in Thailand, China, and Indonesia requires more understanding and awareness of traffic rules. Indonesia and Thailand still do not comply with helmet use (Chantith et al., 2021; Rachmat et al., 2023). China has set restrictions on license plate numbers on specific days of the week. This even results in purchasing two or more vehicles per family (C. Yang et al., 2023). Japan has made extensive road safety efforts, but they have been ineffectual because serious traffic injury has not changed (Nakao et al., 2022).

CONCLUSION

Most countries have established comparable policies, such as punishing illegal activity, regulating speed, increasing driving, helmet use, drinking and driving, and road safety education. The issues that remain include unsafe behavior still being violated by the community and a lack of awareness about the need for road safety implementation. The government must consider acceptable tactics for educating the people about the necessity of following traffic regulations, improving current policies, and utilizing technology to help prevent traffic accidents.

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