

Analysis of Publication Trends, Interaction of Causal Factors, and Traffic Safety Intervention Strategies: Case Studies and Methodology from 2017 to 2024

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Abstract- The increasing use of vehicles due to urbanization and technological advances increases the risk of traffic accidents, with significant social and economic impacts. Data from Indonesia shows more than 100,000 accident cases in 2023, causing losses of up to IDR 50 trillion per year. This study aims to explore several important aspects related to road traffic accidents. First, how do publication trends from 2017 to 2024 affect sustainable transport research and policy, highlighting the contribution of key journals and the role of productive countries in publication? Second, how do interactions between driver behavior, road conditions, and vehicles affect the risk and severity of road traffic accidents, and how can the Health Belief Model be used to understand driver behavior in the context of road safety? Finally, how can factor mapping of each article related to transportation mode, methodology, scientific contribution, and clustering of weaknesses of findings help design study dominance factors, identify weaknesses in current research, and provide a basis for further study development in the field of road traffic accidents. The search strategy for road traffic accident studies involved using the Scopus database from 2017-2024, resulting in 5,035 documents. After filtering duplicates and irrelevant records, 35 studies met the inclusion criteria. Data were collected and analyzed to understand the causal factors of road traffic accidents. The Health Belief Model is important for traffic safety interventions with a focus on risk perception. The contribution of this research is as input for stakeholders in developing regulations in the field of transportation safety.

Keywords: traffic accident risk; transportation; safety intervention; risk perception

I. INTRODUCTION

Population growth, technological advances and urban development have led to increased use of vehicles, which in turn increases the potential for traffic accidents.[1], [2]. Traffic accidents are short, sudden, and unexpected events that can result in negative impacts such as fatalities, injuries, near misses, and damage. However, based on a report from the World Health Organization (WHO), the accident rate is still very high, contrary to WHO's goal of reducing the number of traffic

accidents by 50%[3]. With 1.35 million people dying from traffic accidents and ranking 8th as a cause of global death, its economic impact reaches around \$600 billion, equivalent to the combined GDP of almost all developing countries. Traffic accidents cause losses in social, economic, health, justice, and security dimensions.[4], [5], [6].

This problem is increasingly prominent in urban areas. Especially Surakarta Indonesia along with the increasing number of residents and vehicles, where road safety does not only include reducing the risk of injury and death, but also the comfort and safety of road users.[7], [8]. Road traffic accidents are a serious problem that has a significant impact in Indonesia. According to data from the Indonesian National Police Traffic Corps, traffic accidents in Indonesia are often caused by various factors, including excessive speeding, poor road conditions, and unsafe driver behavior. In 2023, there were more than 100,000 cases of traffic accidents throughout Indonesia, with the number of fatalities reaching around 30,000 people and injuries reaching more than 50,000 people[9], [10]. The impact of traffic accidents in Indonesia is very broad and covers various aspects, from social to economic. Socially, traffic accidents often result in the loss of family members, which can cause trauma and psychological impacts for the families left behind. In addition, these accidents often cause additional economic burdens, both for victims who are injured and for their families who must bear the costs of treatment and rehabilitation. From an economic perspective, traffic accidents cause significant losses.

According to a report from the Research and Development Agency of the Ministry of Transportation[11], economic losses caused by traffic accidents reach around IDR 50 trillion per year. These losses include medical treatment costs, vehicle damage, and losses due to work absence from accident victims. These losses also have an impact on national economic productivity because accidents often involve active workers who contribute to the economic sector. In addition, traffic accidents also add to the burden on the health system. Hospitals and health facilities often face a surge in cases due to traffic accidents, which require intensive medical attention. This can result in a decrease in the

quality of health services for other patients and increase pressure on limited medical resources. To overcome this problem, the government and related parties need to increase efforts in terms of traffic law enforcement, road infrastructure improvements, and driving safety campaigns. With more integrated and systematic steps, it is hoped that the number of traffic accidents in Indonesia can be reduced significantly in the future.

Research Question 1: How will publication trends of documents related to transport topics from 2017 to 2024 affect the development of sustainable transport research and policies, with a focus on the contribution of key journals and the role of productive countries in publication?

Research Question 2: How do the interaction effects between driver behavior, road conditions, and vehicles affect the risk and severity of traffic accidents according to the latest bibliometric analysis, and how can the Health Belief Model be used to understand driver behavior in the context of traffic safety?

Research Question 3: How is the mapping of factors from each article based on transportation mode, methodology used, scientific contribution and clustering of weaknesses of findings to design the dominance factors of existing studies?

II. MATERIALS AND METHODS

A. Search Strategy

The search strategy began by using the Scopus.com database to identify relevant papers on the causal factors of road traffic accidents. The keywords used were "Road Traffic Accident Driver," with a search time span from 2019 to 2024. This search process resulted in a total of 5,035 documents.[2], [12]. The initial steps involve an initial screening to remove duplicates, and using automated tools to flag records that appear irrelevant. The remaining records are then further filtered based on relevance to the topic and inclusion criteria.

B. Inclusion Criteria

Inclusion criteria for this study included papers published between 2019 and 2024, which discussed the causal factors of traffic accidents with a focus on driver behavior, road conditions, or vehicle factors. Only studies published in English and available in full-text format were included.[13]. Articles meeting these criteria must be original research or systematic reviews that present empirical data relevant to the topic of road traffic accidents.

C. Exclusion Criteria

Exclusion criteria included papers that were not in accordance with the main topic, such as studies that did not discuss the factors causing traffic accidents or were not relevant to the keywords used. Rejected articles included technical reports, papers that were not fully accessible, and studies published outside the specified time frame (2019-2024). In addition, papers that were not in abstract form or did not meet the established methodological criteria were also excluded from this review.

D. Study Selection

The study selection process began by identifying 5,035 records from the database using the keyword "Road Traffic

Accident Driver." After removing 510 duplicate records and 204 records marked as irrelevant by the automated tool, as well as 3,616 records removed for other reasons, 705 records were further screened. Of these, 205 records were excluded because they did not meet the inclusion criteria. A total of 500 reports were requested for retrieval, but 103 were not retrieved. The available reports, 407, were evaluated for eligibility. Of the 407 reports reviewed, 200 were rejected because they did not have an abstract, and 207 were rejected because they were not relevant to the keywords used. Finally, 35 studies were included in the literature review as primary sources.

E. Outcome Measures

The outcomes measured in this literature review include the identification and analysis of causal factors of road traffic accidents based on predetermined inclusion and exclusion criteria. These factors include variables such as driver behavior, road conditions, and vehicle factors. This study aims to assess the quality and relevance of the selected studies, and determine their contribution to the overall understanding of road traffic accident causes.

F. Data Extraction

Data extraction was conducted by collecting key information from the 35 selected studies. This process involved collecting data related to the research design, methodology, causal factors of the accidents studied, and the main findings of each study. The extracted data included aspects such as accident types, variables studied, and research results. These data were analyzed to identify patterns, gaps, and contributions of each study to the understanding of road traffic accidents, as well as to formulate recommendations for further research.

G. Quality Assessment

The PRISMA 2020 flowchart shows the selection process for a systematic review of road traffic accident causal factors. From a database search with the keyword "Road Traffic Accident Driver," 5,035 records were identified. After removing 510 duplicates and 204 records marked as irrelevant by the automated tool, as well as 3,616 records for other reasons, 705 records were screened. Of these, 205 records were excluded, and 500 reports were requested for retrieval. A total of 103 reports were not successfully retrieved, and 407 reports were assessed for eligibility. However, 200 reports were rejected due to missing abstracts and 207 due to not matching keywords. Finally, 35 studies were included in the literature review to answer RQ1, RQ2 and RQ3 Figure 1.

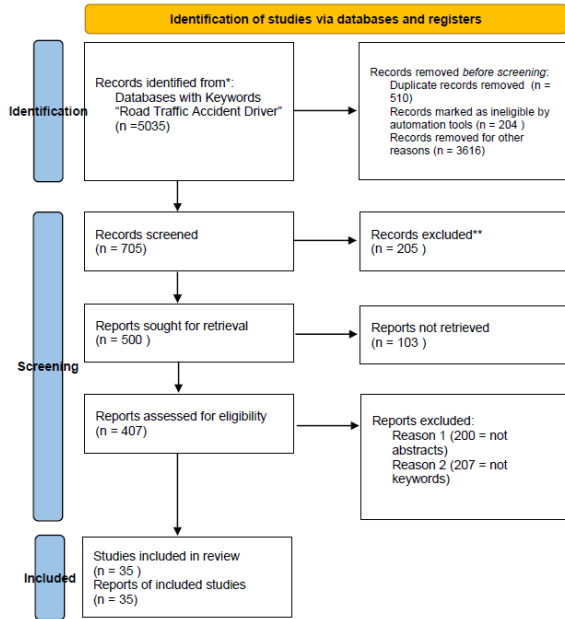


Fig. 1. PRISMA Model

Source:[13]

III. RESULTS AND DISCUSSION

A. Result

Answer to RQ1: The publication trend of documents related to transport topics from 2017 to 2024 influences the development of sustainable transport research and policies, with a focus on the contribution of key journals and the role of productive countries in publication.

Study of the number of documents published on transportation topics from 2017 to 2024, with a total of 35 documents. In 2023, there was a significant spike with 9 documents (25.71%), indicating an increase in attention to transportation issues. In 2020 and 2022, there were 6 documents (17.14%) each, indicating a steady growth. This trend is very urgent because it reflects the increase in research related to sustainable transportation, especially towards 2023 and 2024, when this topic will increasingly become an important concern in global scientific studies Figure 2.

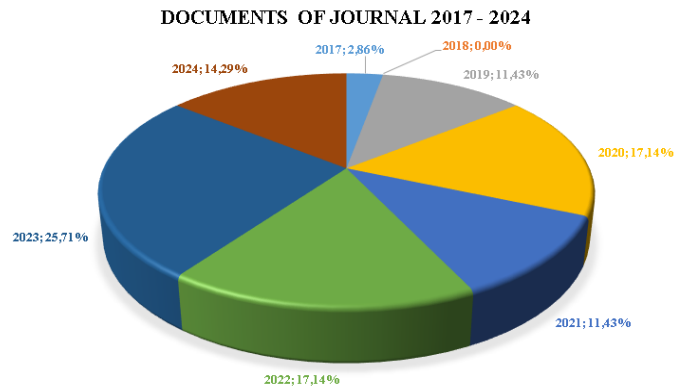


Fig. 2. Descriptive Study

Answer to RQ 2: The interaction effects between driver behavior, road conditions, and vehicles affect the risk and severity of traffic accidents according to a recent bibliometric analysis, and how the Health Belief Model can be used to understand driver behavior in the context of traffic safety.

This meta-analysis study uses VOS Viewer, where the bibliometric visualization of VOSviewer software shows the development of research topics related to traffic accidents and related risk factors. The visualization indicates topics that have begun to develop in recent years (2022–2024) related to interaction effects, drivers, and health belief models. Interaction Effects is one of the important topics, showing that in the context of traffic accidents, there is a mutually influencing relationship between various variables such as driver behavior, road conditions, and vehicles. Drivers are the main focus of this study, with various aspects studied, including behavioral, psychological, and ability factors in influencing accident risk. The Health Belief Model is used to analyze driver behavior based on their risk perceptions of accidents and how health beliefs influence their decisions while driving. This is a psychological approach that is starting to get more attention in traffic safety analysis Figure 3.

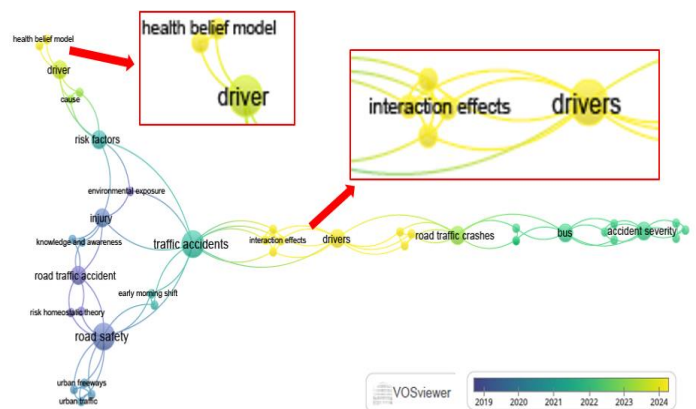


Fig. 3. Bibliometrics

The study in 2019-2023 revealed that the Risk Factors studied include aspects such as the environment, exposure to risk, driver knowledge, and the physical condition of the road infrastructure. These are the main variables that influence the occurrence of traffic accidents. Traffic Accidents and Road Traffic Accidents as the main topics in traffic safety, research on traffic accidents highlights the occurrence of accidents and the factors that cause them, such as vehicle type, accident time, and type of driver involved. Urban Traffic focuses on urban traffic, describing how traffic conditions in large cities affect accident rates, with attention to factors such as traffic density and road governance in urban areas. Buses as public transportation, emerge as an important theme. This involves accidents involving large vehicles and the complexity of handling safety for passengers and drivers. Accident Severity is the severity of the accident (severity) is also an important variable studied, measuring the impact of accidents on physical damage, injury, and death. There has been significant development in topics related to traffic safety, especially in studying driver behavior through the Health Belief Model approach. On the other hand, more traditional topics, such as risk factors, traffic accidents, and urban traffic, are still the main focus of traffic safety research, with attention to bus accidents and analysis of crash severity. This meta-analysis study emphasizes and understands the interaction effects between variables in predicting and reducing traffic accidents, which is an increasingly relevant research topic along with the development of technology and transportation systems.

Answer to RQ 3: Mapping factors of each article based on transportation mode, methodology used, scientific contribution and clustering of weaknesses of findings to design dominant factors of existing studies..

Studies on traffic accidents have different methods, findings, and contributions. Factors that influence traffic accidents include individual factors, such as age, education, and driving experience, as well as environmental factors, such as road conditions, weather, and traffic density. Several studies have also found that improving road infrastructure, driver training, and traffic supervision can help reduce the severity of accidents Table 1.

TABLE I. MAPPING FINDINGS

Author and Year	Methodology	Findings	Contribution	Weakness
[14]	Cross-sectional	Of 369 drivers, the response rate was 94.1%, risk 1.74 (SD ± 0.36); risk factors: perceived severity, benefits, barriers, self-efficacy.	Perceptions of severity, benefits, barriers, and self-efficacy influence risky driving behavior; improve perceptions to reduce risk.	Unable to identify the root cause of the cause-effect relationship between the variables studied

Author and Year	Methodology	Findings	Contribution	Weakness
[15]	Refraction examination and questionnaire.	Of the 700 participants, 18% had visual acuity below the Bangladeshi bus driver standard. The majority of drivers (70.3%) experienced near or far refractive errors.	Facilities for glasses or cataract surgery, as well as making driving licenses	Independent data collection is less accurate
[16]	AHP based on spherical fuzzy Kendall's Test	differences in priority of road safety factors between driver groups, with a focus on 'Lapses,' 'Errors,' 'Violations,' aggressive violations, and drunk driving.	This study concludes that there are differences in the priority of driver behavioral factors between different driver groups in Budapest.	This study was only conducted in Budapest, so the results may not be generalizable to other areas or different situations.
[17]	Negative binomial regression	Traffic volume, median type, and number of lanes are related to fatal crashes, injuries, and property damage.	Road geometry, curves, and slopes are important for predicting and anticipating property damage accidents; gender is not significant.	does not take into account driver demographic factors, such as age, experience, and health.
[18]	Structural Equation Model.	Drivers' perceptions of social disapproval and safety awareness influence their refusal to drive at risk. Personal disapproval is closely related to support for laws prohibiting risky driving behavior.	Public awareness and driver education about the risks of dangerous driving improves traffic safety culture in Canada.	The questionnaire measures driver perceptions, but can be affected by social bias, making the results not completely accurate.
[19]	(Principal Component Analysis (PCA) Socioeconomic status (SES)	PCA developed indices of SES, health, and lifestyle, explaining 56.3%-67.9% of the variance. High SES is associated with more frequent crashes for drivers and pedestrians.	High SES and healthy lifestyle are associated with crashes in young Colombian road users.	Cannot establish a cause-and-effect relationship between observed variables.
[20]	Mediation model via online questionnaire on driving anger, deviant behavior, and accidents.	Aberrant driving behavior mediates the effect of anger on crash risk, so the focus of interventions should be on aberrant behavior.	Deviant behavior is a complete mediator between anger and crash risk; interventions need to be targeted.	Subscales measuring anger and aberrant behavior may not capture the full complexity of risky driver behavior.

Author and Year	Methodology	Findings	Contribution	Weakness
[21]	Chi-square.	Accidents increased with altitude; there was a significant difference ($p < 0.05$) between altitude groups. The chi-square test showed significant differences ($p < 0.05$) in road class and crash patterns.	Improvements in road safety facilities, speed restrictions, and increased medical care at accident sites are needed.	physical and behavioral factors, ignoring social, economic, or policy factors related to road safety.
[22]	Mixed logit model 10-year period, from 2012 to 2022	The accident occurred between midnight and 6 am. Collisions involving pick-up trucks or heavy trucks.	Improve visibility at night at railroad crossings. Develop targeted education and training programs for pick-up and truck drivers.	Not examining all relevant variables, such as weather conditions or more specific driver behavior, that could affect the results.
[23]	Descriptive study	Collisions are the most common type of traffic accident, accounting for 64.6% of all accidents that occur. Traffic accidents occur more frequently with pick-up trucks, taxis and motorbikes than with private cars.	The factors of excessive speed, young age, and alcohol consumption were found to be strongly associated with accident occurrence, especially among drivers aged 19-33 years.	There may be improvements in road design, law enforcement, or environmental conditions that may play a role in the accident.
[24]	A cross-sectional study was conducted on 800 drivers in Hamadan, Iran, selected through multistage cluster sampling technique.	Unintentional violations had the highest average percentage (19.13%) with the lowest average percentage (16.44%). Relationship Age, gender, education level, driving experience, and daytime driving hours were significantly associated with DBQ dimensions and traffic injury severity.	Developing driving behavior interventions among drivers.	Measuring driving behavior with a scale may not capture the full complexity of driving behavior and other contextual factors that may influence traffic crashes.
[25]	A cross-sectional study was conducted in Hargeisa, Somaliland, between January and March 2022.	Traffic accident trends in Somaliland over the past 11 years (2011–2021). The prevalence of traffic accidents reached 28.17% (CI: 23.67, 32.63).	Driver and pedestrian awareness of traffic accidents needs to be increased. Regular vehicle inspections can reduce the risk of traffic accidents.	Not fully considering all factors that can influence traffic accidents, such as road conditions,

Author and Year	Methodology	Findings	Contribution	Weakness
[8]	Random Forest-SHapley Additive exPlanations	The main risk factors that influence traffic accident severity are: functional zone, shopping POI density, service POI density, accident cause, travel mode, collision type, season, road type, driver age, and physical isolation.	This combination of accident risk factors shows a strong influence of the built environment on accident severity.	weather, or traffic density. Testing demographic variables on traffic accident severity.
[26]	Domino Theory	The number of road accidents in India is on the rise, with an increase of 2.5% from 2014 to 2015. This shows a worrying trend regarding road safety in India.	Road safety in India and emphasized the need for implementing better safety measures.	The need for a 5-year span of data observation verification with domino theory
[27]	survey approach with Odds ratio (OR) and adjusted odds ratio (aOR) assessment	A total of 55.5% of drivers reported that they had been involved in at least one traffic accident, which is quite high.	The need to minimize violations to reduce accidents from 2.84 times	Wider gender and age differences .
[28]	The Epworth Sleepiness Scale (ESS) is used to measure the level of daytime sleepiness (Excessive Daytime Sleepiness, EDS).	The prevalence of EDS is quite high among informal drivers of interprovincial transport on the Lima-Huancayo highway, with obesity as the main factor associated with EDS, followed by overweight and long driving experience.	Interventions to address obesity and overweight and consider driving habits.	Driver sleep behavior and habits are based on self-reports and measurements that may not be completely accurate.
[29]	Chi-Square Test and Logistic Regression	The highest number of accidents occurred during the day (72.3%), while the lowest occurred at sunrise (0.83%). Most accidents occur in July and September. Accidents occur most frequently on sunny days (91.7%), while the least occur on cloudy days (3.5%).	Improvements in road construction standards, road development, and driver education to adapt driving behavior to environmental and road conditions.	The need to assess vehicle conditions, driver behavior, or specific geographic influences is not included in this analysis.
[30]	Descriptive study	The type of accident is the most critical factor influencing	Solutions that can reduce the impact of factors that influence	Vehicle mechanics and type of vehicle

Author and Year	Methodology	Findings	Contribution	Weakness
		the severity of an accident. The fatality rate depends on the type of accident that occurs..	accidents with injuries and fatalities on rural highways	involved in the accident.
[31]	Ordered Logit Model. Bias-Reduced Binomial Regression Model.	Traffic control variables did not have a significant impact on injuries in single-crash crashes. Guardrails are associated with higher severity in both single- and multi-vehicle crashes at intersections. Centerline impacts vary between intersections and non-intersections for multi-vehicle crashes.	Guidelines for road infrastructure improvements and transportation controls that may affect accident severity. Emphasis on the design and use of guardrails and assessment of centerline effectiveness based on crash location (intersection vs. non-intersection).	Consideration of weather conditions, driver behavior, or vehicle conditions that may affect the severity of an accident.
[32]	Multinomial logit model.	Factors that influence accident types include geographic characteristics, meteorological characteristics, time of day, driver characteristics, vehicle features, and road characteristics.	Knowledge of traffic accident types and showing that class balancing techniques such as ROSE can improve model performance in predicting accident types.	Consideration of more specific driver behavior analysis or more detailed road conditions.
[6]	Cross sectional.	There is a 26% chance of a collision, which is a 63% increase from the initial estimate.	Speed and brake failure significantly affect the likelihood of a collision and its severity.	Consideration of road conditions, weather, and the behavior of other drivers may not be fully recorded.
[33]	Logistic regression	Only 4% reported serious or minor injuries, while 96% experienced only property damage.	The contribution of RTCs among novice female drivers is relatively high, but most accidents only cause <u>property damage</u> .	the need to generalize to other groups of drivers or to other countries.
[34]	Cross-sectional	Drivers with sleep duration of less than 5 hours showed a tendency to have a higher odds ratio (OR) (2.87, 95% CI = 0.87–9.45, p = 0.08) for sudden braking compared to the group with 6 hours of sleep.	Improve sleep quality so that the risk score of 2.5–5.1 can be reduced.	Generalization of findings to a larger population of truck drivers.

Author and Year	Methodology	Findings	Contribution	Weakness
[35]	A questionnaire survey designed based on the Norm-Activation Model (NAM) theory	Individual personality characteristics have a significant relationship with speed behavior. Driving culture and traffic exposure are also significantly related to speeding behavior. Various situational constraints influence driver speed behavior.	The NAM theory shows a significant relationship with speed behavior, confirming that social norms and attitude factors influence driver behavior.	Self-reported data may be affected by reporting bias, where drivers may not be completely honest or accurate in reporting their behavior.
[36]	Secondary data obtained from the Addis Ababa Police Commission Office.	vehicle type, driver education level, type of accident, conditions at the time of the accident, and day of the accident are related to severity. Factors that reduce severity include longer driving experience, the presence of vehicle passengers, two-lane roads, and crashes occurring in the afternoon.	Strict law enforcement, driver training, and attention to road conditions and the time of the accident are steps that can help reduce the severity of accidents.	The need for more detailed improvements to road conditions, weather, or driver behavior may not be taken into account.
[37]	Cross-sectional survey-based.	42% of Novice Drivers are under 25 years old, and 79% are under 35 years old. History of RTC: 39.8% of the sample reported a history of RTC. Driving Habits: 47.1% of them were not wearing seat belts when the accident occurred.	A guide for younger drivers to be less distracted, while older drivers are more likely to have higher depression scores.	the need to evaluate other factors such as road or weather conditions that may also affect involvement in RTC.
[38]	Cross-sectional survey-based.	General Roads: One-third (33.0%) of rear seat passengers “always” wear seat belts. Highway: Three-quarters (73.2%) of rear seat passengers “always” wear seat belts.	The prevalence of rear seat belt use is higher on toll roads than on public roads.	The need for generalization on respondent demographics

Author and Year	Methodology	Findings	Contribution	Weakness
[39]	Chi-Square Cramer's Correlation	Respondents under 30 years old were more aware of traffic regulations (OR = 2.019). Rural respondents were less aware of traffic regulations than urban respondents (OR = 0.288). Educated respondents know more about traffic regulations than uneducated respondents (OR = 5.064). Drivers and passengers are more aware of traffic regulations (OR: 2.731 & 1.869).	Violation of traffic rules is a major factor contributing to accidents.	the need for knowledge and awareness of traffic regulations, such as the influence of the media
[40]	Logistic regression	Vehicle ownership, khat chewing habit while driving, driver age, having own residence, and punishment from traffic police were significantly associated with the risk of traffic accidents among taxi drivers in Jigjiga Town.	Better awareness campaigns about traffic rules and strict enforcement can help reduce the risk of accidents.	The need for awareness to minimize traffic accidents, such as road conditions or weather conditions.
[41]	Exploratory study	Accidents occurred outside the city in poor lighting conditions (OR = 6.87, P < 0.001). Age over 65 years (OR = 2.97, P < 0.001). Crashes occurred in residential areas with light vehicles, and pedestrians were in safety zones or on undivided two-way roads (OR = 0.14, P < 0.001).	The risk of death decreases if the driver is not injured.	The data only covers a specific period and location, so it may not be generalizable to other areas or different time periods.
[42]	Haddon Matrix	Road surface conditions, quality of traffic signs, and lighting can affect the likelihood of an accident. The condition of the vehicle, including maintenance and safety features, can be an important factor. Factors such as driver fatigue,	Formulate a more comprehensive prevention strategy.	There is a need to develop and test practical solutions that can be applied directly in the field.

Author and Year	Methodology	Findings	Contribution	Weakness
[43]	Cross-sectional	Other Drivers and Self: Positively related to aggressive violations. Fate: Shows positive association with aggressive and negligent violations. Other Drivers: Positively related to errors. Vehicle/Environment: Positively related to negligence.	Improving road safety by targeting changes in driver perceptions of responsibility and risk.	Only involving drivers in Lebanon
[5]	Multinomial Logit Model	Driving on Uphill Roads: RRR 3.03, 95% CI 1.73 to 5.30 Driving in Drowsiness: RRR 2.60, 95% CI 1.71 to 3.96 Driving in the Wrong Direction: RRR 2.37, 95% CI 1.77 to 3.1	The need to reduce the risk of accidents occurring in northern Thailand also shows a higher risk of fatalities.	accident severity identification not identified
[44]	Observational study	Driving for about 2.5 hours did not cause significant fatigue.	Eye blink parameters can be used as objective indicators of fatigue, with eye blink duration showing the most consistent changes.	All participants were male and may not represent differences in fatigue experiences based on gender or age.
[45]	Multivariate regression analysis	Drivers working 40–60 hours have a three times greater risk of fatigue than those working less than 40 hours. Poor sleep increased the risk of high fatigue sevenfold (95% CI: 2.26–21.67, p = 0.001). Drivers who reported feeling lonely were twice as likely to experience high fatigue.	Scheduling work schedules, providing quality bedding, and increasing social connections can help reduce driver fatigue.	This study was conducted in Australia, so the results may not be entirely applicable to truck drivers in other countries with different working conditions and cultures.

In compiling the research factors, we referred to the weaknesses identified in previous research. The process of reviewing the existing weaknesses has provided valuable insights to form key factors that need to be considered in further research. Identifying the root cause, accuracy of data collection,

and generalization of research results are some of the main elements that need to be improved. In addition, it is important to consider demographic factors, reduce social bias, and include relevant variables such as weather conditions and vehicle conditions.

TABLE II. DOMINANT FACTORS OF THE STUDY

No	Dominant Factors of the Study	Description	Source
1	Identify Root Causes	Research should include in-depth analysis to understand the cause-and-effect relationships between variables in traffic accident occurrence, driver error and accident factors.	[35], [43]
3	Location Generalization	Results should be tested and applied across multiple locations to increase generalizability.	[29], [32]
4	Demographic Factors Consideration	Must consider driver demographic factors such as age, experience and health.	[24]
5	Social Bias	Using methods that minimize social bias in measuring driver perceptions.	[19]
6	Compliance with Behavioral Complexity	Subscales should measure behaviors comprehensively to encompass the full complexity of driver behavior.	[6], [14]
7	Consideration of Social and Economic Factors	Incorporate social, economic and policy factors related to road safety.	[6], [18]
8	Relevant Variables	Incorporate all relevant variables, including weather conditions, specific driver behavior, road conditions, weather and driver behavior and environmental factors.	[8]
9	Infrastructure Improvement	Reviewing road design improvements, law enforcement, and environmental conditions that influence accidents.	[15]
10	Long Term Verification	Verify observational data over a wider time span and with relevant theories.	[28]
11	Gender and Age Differences	Involving differences in gender and age of riders to get a more representative picture.	[16]
12	Validity of Self-Report	Using additional methods to verify the accuracy of driver self-reports.	[37]
13	Vehicle and Geographical Conditions	Taking into account vehicle condition, vehicle type, and geographical influences.	[23]
14	Population Generalization	Ensuring findings can be generalized to a wider population of drivers, including in other countries.	[31]

15	Awareness and Knowledge	Incorporate knowledge and awareness of traffic regulations and media influences.	[43]
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Root Cause Identification is a crucial dominant factor. This study should include an in-depth analysis to understand the cause-and-effect relationships between the various variables that contribute to the accident occurrence, including driver error and other relevant causal factors. This analysis aims to identify the root causes of the accidents, thus allowing for the implementation of more effective prevention strategies Table 2. Studies that do not investigate the cause-and-effect relationships in depth may overlook key factors that influence accidents, resulting in less effective solutions. Therefore, it is important to conduct comprehensive research in order to produce valid and applicable findings in an effort to improve road safety.

B. Discussion

RQ1: Publication trends of documents related to transport topics from 2017 to 2024 influence the development of sustainable transport research and policies, with a focus on the contribution of key journals and the role of productive countries in publications.

The study of publications on transport topics from 2017 to 2024 shows an interesting trend in scientific attention. With a total of 35 papers, there was a significant spike in 2023 with 9 papers (25.71%), indicating an increased focus on transport issues. The periods of 2020 and 2022 each recorded 6 papers (17.14%), indicating a steady and consistent growth. Journals such as Sustainability (Switzerland), PLoS ONE, and the International Journal of Environmental Research and Public Health were the main contributors, with 8.57% to 11.43% of the total publications respectively. Countries such as Switzerland and the Netherlands, with 4 publishers each, and the United States with 3, played a significant role in these publications, indicating strong support for sustainable transport research and global policy. Dominant journals included Sustainability, which focuses on sustainability, and PLoS ONE, which covers a variety of multidisciplinary fields. These journals are important as references in sustainable transport studies, covering aspects such as economics, environment, and public health. Contributions from various disciplines show that the topic of transport is gaining increasing attention in the context of sustainability and public policy

RQ2: The interaction effects between driver behavior, road conditions, and vehicles affect the risk and severity of traffic accidents according to the latest bibliometric analysis, and how the Health Belief Model can be used to understand driver behavior in the context of traffic safety.

The Health Belief Model offers an effective framework for understanding how individual factors influence health behaviors, particularly in the context of driving safety. [14], [46]. In this study, the main focus is on the role of the driver—as an individual factor that plays an important role in traffic safety—

and the interaction effects between health beliefs and driving behavior. Drivers who have high beliefs about the risks and negative consequences of risky behaviors, such as drunk driving or not wearing a seat belt, tend to show safer behaviors.[47]. The effectiveness of this model lies in its ability to identify key variables such as perceived susceptibility, severity, benefits of preventive measures, and perceived barriers. Interaction effects, on the other hand, refer to how these factors influence each other and may strengthen or weaken each other's influence. Perceived susceptibility to a crash may interact with beliefs about the benefits of seat belt use, which in turn influences driving decisions.[1], [48], [49], [50]. Research suggests that the interaction between these factors can provide deeper insights into how health beliefs shape driving behavior and can be used to design more effective interventions to improve traffic safety.[16], [51], [52]. By understanding the interaction of these effects, traffic safety policies can be more precisely targeted to address the multiple factors that influence driver behavior and improve compliance with safety rules.

The Health Belief Model was designed based on existing findings, as shows in Figure 4.

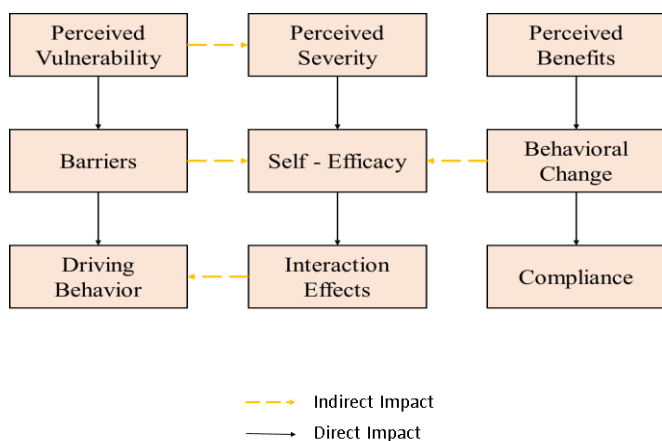


Fig. 4. Health Belief Model in Vehicle Drivers

Adoption Development From literature by [14], [46], [53], [54]. Where this development is a contribution to the sustainability of transportation use, namely in the Health Belief Model methodology offers a framework for understanding driving behavior from a psychological and social perspective. Perceived Vulnerability describes the extent to which individuals feel threatened by the risk of an accident, influencing their motivation to take preventive action. Perceived Severity indicates the extent to which an accident is considered serious and has a major impact, which can strengthen the drive to prevent it. Perceived Benefits refer to the belief that preventive measures, such as seat belt use, can effectively reduce risk, while Barriers include obstacles such as costs or inconveniences that may prevent the implementation of such measures. Conversational Control reflects an individual's belief in their ability to implement preventive measures successfully. Action Influence describes how these beliefs influence safer driving behavior, while Compliance measures the level of compliance

with safety rules. Interaction Effect explains how the combination of perceptions of vulnerability, severity, benefits, and barriers interact to influence overall driving behavior, forming a complex picture of how individuals respond to risk and implement safety measures in everyday life.

RQ3: Mapping of factors from each article based on transportation mode, methodology used, scientific contribution and clustering of weaknesses of findings to design dominant factors of existing studies.

Motor vehicles encompassing cars, trucks, buses, and motorcycles are dominant as subjects, given their significant role in traffic accidents. Data analysis shows that motor vehicles are often the main focus, with emphasis on factors contributing to accidents. For future research, several important decisions can be made. First, the development of a more effective and accurate accident monitoring system is essential to detect and prevent accidents more efficiently. Second, improving driver awareness and skills through more effective and frequent training should be a priority to improve safety. Third, improving the quality of road infrastructure and reducing hazardous environmental conditions can reduce risks for drivers. Fourth, the development of a better traffic control system will help regulate traffic flow and reduce the likelihood of accidents. The role of companies and governments in supervising and regulating traffic needs to be strengthened to reduce the frequency of accidents and ensure better road safety. Traffic accidents show that various factors can influence the occurrence of accidents, including behavioral, social, economic, and environmental factors. Factors such as excessive speed, seat belt use, and driving habits can affect the risk of accidents. However, some studies also found that weaknesses in methodology and sampling can affect the results of the study. For example, studies that only use online questionnaires may not capture the full complexity of risky driver behavior. Existing studies that only consider demographic factors and do not consider other factors such as road conditions or weather may not provide an accurate picture of crash incidence. In some studies, factors such as driver and pedestrian awareness of traffic accidents and regular vehicle inspections can reduce the risk of crashes. However, some studies have also found that other factors such as sleep quality and geographic characteristics can affect crash risk. Factors affecting traffic accidents and the need for an integrated approach. Traffic accidents are a global problem that requires an integrated approach to overcome them. Various factors can affect the occurrence of accidents, including behavioral, social, economic, and environmental factors. In the table above, there are 15 dominant factors that need to be considered in the study of traffic accidents. Identification of the root cause is a dominant factor that needs to be considered in the study of traffic accidents. The study should include an in-depth analysis to understand the causal relationship between variables in the occurrence of traffic accidents, driver error, and accident factors. This is in accordance with the study[35], who found that systematic

analysis of factors affecting traffic accidents can help improve driver awareness and safety. Location generalization is a dominant factor that needs to be considered in traffic accident studies. The results of the study should be tested and applied in various locations to improve generalization. This is in accordance with the study[32], who found that research conducted in various locations can help increase the generalizability of findings. Consideration of demographic factors is a dominant factor that needs to be considered in traffic accident studies. Demographic factors such as age, experience, and driver health can affect the risk of accidents. This is in accordance with research[24], who found that demographic factors can influence crash risk. Social bias is a dominant factor that needs to be considered in traffic crash studies. Using methods that minimize social bias in measuring driver perceptions can help improve the accuracy of the findings. This is in accordance with research[19], who found that methods that minimize social bias can help improve the accuracy of findings. Further research that considers multiple factors and uses appropriate methodology is needed to improve driver and pedestrian awareness and safety.

IV CONCLUSION

Publication studies on transportation (2017-2024) showed a surge in interest in 2023 with 9 papers (25.71%). Journals such as Sustainability and PLoS ONE, as well as countries such as Switzerland and the Netherlands, contributed significantly, indicating a focus on sustainability and public policy. The Health Belief Model helps understand how individual beliefs about risks and benefits influence driving behavior, focusing on perceived susceptibility, severity, benefits, and barriers to design effective traffic safety interventions. Motor vehicles, including cars and motorcycles, are the main focus of traffic crash studies. Future research should focus on monitoring systems, driver training, road infrastructure, and traffic management to reduce risk. Factors such as speed, seat belt use, and road conditions need to be considered, with an integrated approach to understand and effectively address crash causes.

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