SOCIAL SECURITY MANAGEMENT JOURNAL
https://e-journal.uum.edu.my/index.php/ssmj

How to cite this article:
Radzi, E. M., Hassan, Z., (2026). Mapping the landscape of driving behavior and road safety research: A Scientometric perspective (2000–2025). *Social Security Management Journal, 3*(1), 1-17. https://doi.org/10.32890/ssmj2026.3.1.1

# MAPPING THE LANDSCAPE OF DRIVING BEHAVIOR AND ROAD SAFETY RESEARCH: A SCIENTOMETRIC PERSPECTIVE (2000–2025)

**[1]Elias Md Radzi, [2]Zuraida Hassan**
[1]PhD Student, Occupational Safety and Health Management Program,
[2]School of Business Management,
Universiti Utara Malaysia, Malaysia

*[1]Corresponding author: eliasmdradzi9@gmail.com*

Received: 30/1/2026 Revised: 23/3/2026 Accepted: 31/3/2026 Published: 30/4/2026

## ABSTRACT

This study conducts a scientometric analysis of global research output pertaining to driving behaviour and road safety from 2000 to 2025, with the objective of delineating thematic evolution, impactful contributions, and institutional productivity. Bibliographic metadata were extracted from the Scopus and Web of Science databases and subjected to analysis to examine publication trends, keyword co-occurrence networks, citation patterns, and research productivity metrics. A total of 2,211 publications were retained for analysis following pre-processing and duplicate removal procedures. The results demonstrate a discernible increase in scholarly output post-2010, with publication activity in Scopus increasing from fewer than 50 documents annually prior to 2010 to approximately 175 by 2025, indicate a substantial growth within the field. Journal articles constitute the predominant publication type, followed by conference papers and review articles, thereby underscoring the central role of peer-reviewed dissemination. Prominent publication venues include *Accident Analysis & Prevention*, *Transportation Research Part F: Traffic Psychology and Behaviour*, and *Traffic Injury Prevention*, while emerging trends are evident in technology-oriented sources. Keyword analysis reveals that established themes such as distraction, risk perception, and driving performance continue to exert influence on the field, alongside increasing emphasis on machine learning, autonomous driving, and decision making. Highly cited works by Anstey et al. (2005), Fuller (2005), and Ulleberg and Rundmo (2003) remain foundational to the intellectual structure of the domain. Institutional analysis identifies Tsinghua University, Tongji University, and Changan University as leading contributors, with augmented contributions from other Chinese, European, and Australian institutions. In summary, the findings suggest a maturing and increasingly interdisciplinary research landscape, characterized by enhanced integration of behavioral science, intelligent transportation systems, and data-driven safety modelling approaches.

**Keywords:** driving behavior, road safety, Scientometric analysis, machine learning, autonomous driving

## INTRODUCTION

Driving behavior constitutes a multifaceted construct encompassing the actions and decisions executed by vehicle operators, which exert direct ramifications for road safety. This encompasses adherence to traffic regulations, responses to prevailing road conditions, and interactions with other road users. Safe driving behavior is conventionally defined by established road rules intended to promote efficiency and minimize harm within transportation systems (Bin-Nun et al., 2022; Radzi et al., 2025). Conversely, aberrant driving behaviors, including violations, lapses, and other unsafe responses, have been consistently associated with an increased incidence of road traffic injuries (Rezapur-Shahkolai et al., 2020). Further research has demonstrated the feasibility of detecting driver intention and behavior through advanced analytical approaches such as electroencephalography (EEG)-based recognition systems, facilitating earlier identification of potentially hazardous actions (Li et al., 2022).

Driving behavior also exhibits variance contingent upon experience level, with novice drivers demonstrating greater difficulty in managing complex manoeuvres and emergency situations compared to experienced drivers, who typically exhibit superior coordination of steering and braking to avert collisions (Xu et al., 2022a). Concurrently, modelling studies on car-following behavior indicate that varying safety thresholds influence both traffic flow dynamics and crash risk, while intelligent connected technologies may reduce reaction times and enhance safety outcomes (Li & Lee, 2023). Collectively, these findings underscore that the enhancement of driving behavior necessitates an integrated perspective encompassing behavioral insights, technological support, education, and regulatory frameworks.

Road traffic accidents remain a salient global public health and developmental concern. Initial estimates indicate that these incidents result in approximately 1.24 million fatalities annually worldwide (Dutta, 2020), while more recent burden analyses reported 103.2 million road injuries in 2019, despite observed declines in death and disability-adjusted life year rates over time (Xu et al., 2022b). The burden is particularly pronounced in low- and middle-income countries, with young adults aged 20–24 constituting one of the most affected demographic groups (Xu et al., 2022b). In Malaysia, 5.6% of adults were reported to have experienced non-fatal injuries resulting from road traffic accidents - male, lower educational attainment, and overweight status identified as associated factors (Isa et al., 2022). These patterns reflect the complex interplay of behavioral, psychological, and social determinants underpinning road traffic harm (Kochetova, 2022). Risky behaviors such as speeding, aggressive driving, and red-light violations remain central contributing factors, although their manifestation and enforcement vary across jurisdictions (Toriumi et al., 2022). Consequently, effective prevention necessitates multifaceted interventions that integrate enforcement, education, infrastructure planning, and context-sensitive policy design.

Against this backdrop, a comprehensive understanding of the evolution of research pertaining to driving behavior and road safety is paramount. Existing studies have addressed regional disparities in research coverage, including the relative paucity of scholarly work originating from Africa, despite its disproportionately high road traffic fatality burden (Luke, 2023). Additional scholarship has examined motorcyclist behavior within intelligent transportation systems, deterrence-based safety strategies, psychological and socioeconomic determinants of risky driving, and the historical development of driver and pedestrian behavior models (Abdulwahid et al., 2022; Babojelić & Novačko, 2020; Davey & Freeman, 2011; Jafarpour & Rahimi-Movaghar, 2014). While these contributions are valuable, they remain dispersed across diverse disciplines and thematic areas. Consequently, the field lacks a consolidated overview of its publication growth, principal outlets, thematic structure, influential works, and institutional contributions. A scientometric perspective is therefore well suited to delineate the intellectual landscape of this domain and to elucidate the trajectory of its development over time.

This study addresses this exigency by conducting a scientometric analysis of research on driving behavior and road safety spanning the period from 2000 to 2025. Scientometric analysis facilitates the systematic examination of scholarly output through the analysis of publication patterns, citation structures, keyword relationships, and collaboration networks, thereby elucidating the intellectual structure and thematic evolution of a given research area. Within the context of driving behaviour and road safety, such an approach can identify influential contributors, dominant and emerging themes, and knowledge gaps that warrant further investigation. By extension, this provides a more robust evidentiary foundation for future research directions and for policy development in road safety.

Accordingly, this study is guided by the following research questions:
1. What trends and patterns can be discerned in the volume and characteristics of publications pertaining to driving behavior and road safety from 2000 to 2025?
2. Which academic journals and sources have demonstrated the highest productivity in disseminating research on driving behavior and road safety?
3. What are the prevailing research themes, emerging topics, and subject areas that have exerted influence on the field of driving behavior and road safety over the past two decades?
4. Which publications have exhibited the most substantial academic impact within this research domain, as indicated by citation metrics and co-citation analysis?
5. Which research institutions and countries have made noteworthy contributions to the advancement of knowledge in driving behavior and road safety?

## MATERIALS AND METHODS

This study reviews and analyses the applications, trends, thematic evolution, and scholarly impact of research pertaining to driving behavior and road safety across diverse contexts. To achieve this objective, scientometric techniques were employed, integrating trend measurement via ScientoPy with science mapping utilizing VOSviewer. Relevant bibliographic records were retrieved from Scopus and Web of Science (WoS) using the search queries presented in Table 1. The search was conducted up to 26 October 2025. Scopus and WoS were selected due to their recognized academic credibility, comprehensive disciplinary coverage, and robust bibliographic metadata, rendering them appropriate sources for scientometric analysis (Abdullah & Sofyan, 2023; Radzi et al., 2024).

ScientoPy, a Python-based open-source tool for scientometric analysis, was employed to preprocess the datasets and identify leading topics, influential authors, productive countries, and highly cited publications (Ruiz-Rosero et al., 2019). Its preprocessing functionalities enhance data consistency and mitigate redundancy, thereby bolstering the reliability and interpretability of the results. VOSviewer was utilized to generate co-occurrence maps based on author keywords, facilitating visual examination of the conceptual structure of research on driving behavior and road safety. Collectively, these tools facilitate a comprehensive assessment of publication patterns, thematic development, and scholarly influence within the field (Abdullah, 2022).

**Table 1**
*Search strategy for Extracting Data from the Web of Science and Scopus Databases*

| Database | Search Strategy | Records |
|---|---|---|
| Web of Science | Topic: ("driving behavior" OR "driving performance" OR "driving patterns" OR "driver decision-making" OR "driving style" OR "on-road behaviour" OR "driving habits" OR "Driving ethics") AND ( "traffic" OR "road" OR "vehicle" OR "transportation") AND ("accident" OR "collision" OR "crash" OR "incident") AND ("psychology" OR "attitude" OR "decision" OR "reaction") AND ("safety" OR "risk" OR "hazard" OR "security") | 466 |
| Scopus | Article Title, Abstract, Keywords: ("driving behavior" OR "driving performance" OR "driving patterns" OR "driver decision-making" OR "driving style" OR "on-road behaviour" OR "driving habits" OR "Driving ethics") AND ("traffic" OR "road" OR "vehicle" OR "transportation") AND ("accident" OR "collision" OR "crash" OR "incident") AND ("psychology" OR "attitude" OR "decision" OR "reaction") AND ("safety" OR "risk" OR "hazard" OR "security") | 2110 |

**Search Strategy and Eligibility Criteria**

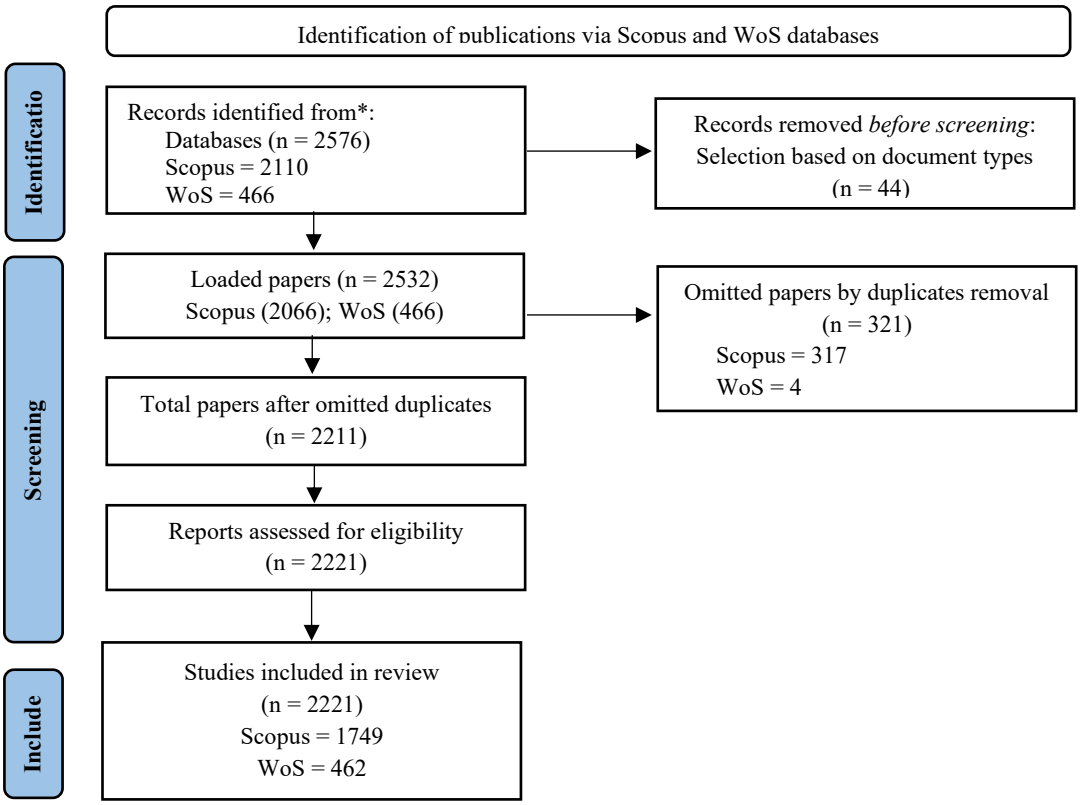
The search strategy was designed to capture publications addressing driving behavior and road safety through combinations of behavioral, transport, crash-related, psychological, and safety-related terms in Scopus and WoS, as detailed in Table 1. Following retrieval, records underwent screening through a structured preprocessing procedure. Initially, automatic document-type filtering was applied to exclude records unsuitable for the scientometric review. Subsequently, duplicate records across the two databases were identified and removed using ScientoPy. Publications were retained if they aligned with the search scope, contained sufficient bibliographic metadata for analysis, and remained after duplicate removal. Records were excluded if they fell outside the thematic scope of driving behavior and road safety, lacked usable metadata, represented duplicate entries, or were removed during document-type filtering.

**Pre-processing of Retrieved Datasets**

The retrieved datasets were pre-processed to eliminate duplicate entries and consolidate valid bibliographic information prior to analysis. As illustrated in Diagram 1, the initial search yielded 2,576 records from Scopus and WoS combined, comprising 2,110 records from Scopus and 466 from WoS. Following automatic document-type filtering, 44 records were excluded, resulting in 2,532 records for screening. Duplicate removal then identified 321 overlapping records, including 317 from Scopus and 4 from WoS. After this process, the final dataset consisted of 2,211 unique publications eligible for scientometric analysis. Of these, 1,749 publications (79.10%) were from Scopus and 462 publications (20.90%) were from WoS.

To ensure internal consistency, the total number of records reported in the text, Diagram 1, and subsequent figures should be standardised to 2,211 rather than 2,221. Likewise, the PRISMA-style flow diagram should report 2,211 for both "reports assessed for eligibility" and "studies included in review," so that all counts align with the documented subtraction sequence: 2,576 - 44 - 321 = 2,211. This correction enhances transparency and methodological consistency throughout the manuscript.

**Diagram 1**.
*Flow Diagram of Research of Databases and Registers*




## RESULTS

The results of the present investigation sufficiently answer each of the research inquiries delineated in the methodology segment. The results are also presented using graphical visualisations generated by ScientoPy and VOSviewer.

### Trends and Patterns in Publishing

Figure 1 illustrates the publication trend in driving behavior and road safety research from 1990 to 2025, based on data extracted from Scopus and Web of Science (WoS). The number of publications in both databases exhibited a gradual increase from the early 2000s, with a marked acceleration occurring post-2010, indicative of growing academic and institutional interest in this domain. Scopus consistently yielded a higher volume of publications compared to WoS, demonstrating a pronounced surge after 2015 and reaching a peak of approximately 175 documents in 2025. WoS displayed a similar, albeit more moderate, trajectory, peaking at approximately 55 publications in 2025. Cumulatively, these trends reflect the increasing salience of this research area in relation to road safety policy, behavioral science, and intelligent transportation systems.

**Figure 1**

*The Evolution of Publication Growth*

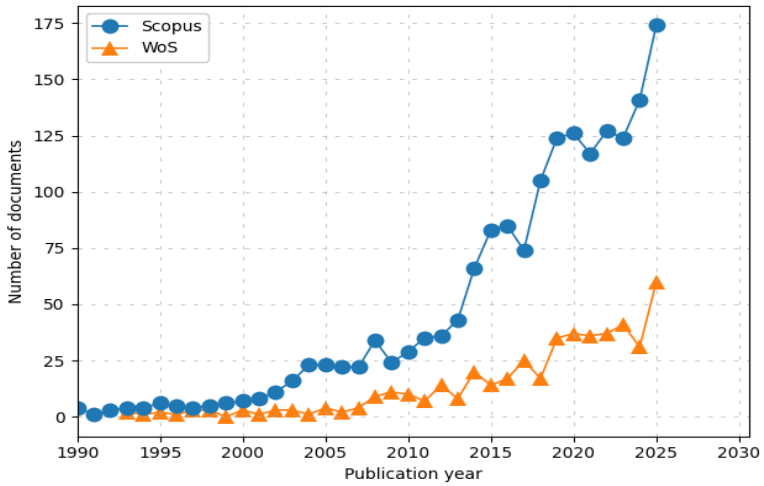
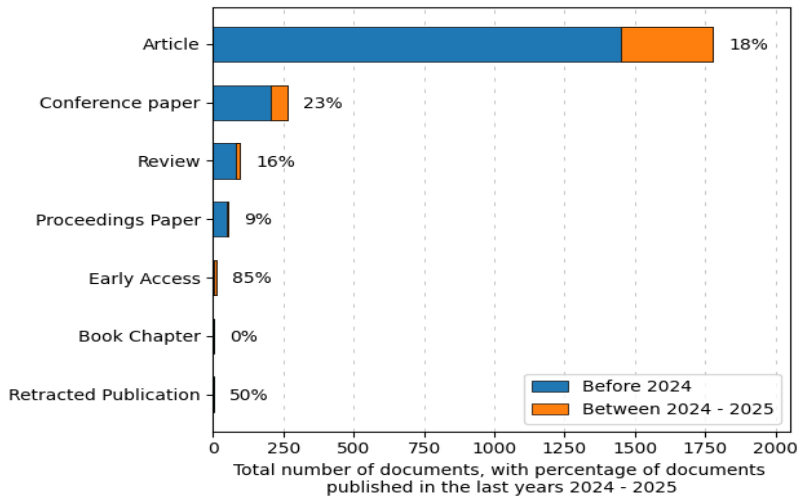



Figure 2 illustrates the distribution of document types within the dataset, delineated by total output and the percentage published between 2024 and 2025. Journal articles represent the predominant publication type, with 18% of these appearing in the specified two-year period, thereby affirming that peer-reviewed journals continue to serve as the primary conduit for knowledge dissemination in this discipline. Conference papers constitute the second most prevalent category, with 23% published in 2024–2025, indicative of ongoing engagement with academic forums for the presentation of nascent research. Review articles, while less numerous, maintain a salient role in knowledge synthesis, with 16% appearing during the same period. Early access publications exhibit the highest recent activity, with 85% published in 2024–2025, reflecting the expedited circulation of newly accepted scholarly work. Retracted publications account for a minimal proportion of the dataset; however, 50% of these fall within the recent period, while book chapters are not represented. Collectively, these trends suggest a field characterized by established journal-based scholarship, complemented by active conference dissemination and an accelerated early publication trajectory.

**Figure 2**

*Bar-trend Graph of the Document Types*

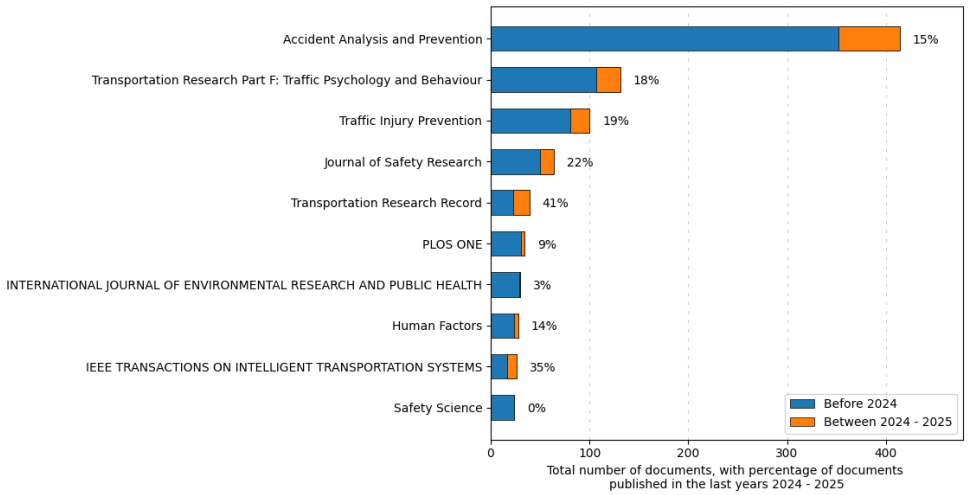


### Prominent Publishing Titles

Figure 3 identifies the most productive publication outlets in the domain of driving behavior and road safety research. Accident Analysis & Prevention demonstrates leadership in total output, with 15% of its publications appearing in the 2024–2025 period, indicating sustained and stable influence. Other prominent behavioral and safety-focused journals include Transportation Research Part F: Traffic Psychology and Behavior (18%), Traffic Injury Prevention (19%), and the Journal of Safety Research (22%), reflecting the field's strong grounding in behavioral and injury-prevention perspectives. Recent publication intensity is particularly notable in Transportation Research Record (41%) and IEEE Transactions on Intelligent Transportation Systems (35%), suggesting growing momentum in applied, technical, and AI-related approaches. Conversely, PLOS ONE (9%), the International Journal of Environmental Research and Public Health (3%), Human Factors (14%), and Safety Science (0%) demonstrate either more modest or less recent contributions within this dataset. These patterns suggest that the field is sustained by a core of established behavioral-safety journals while exhibiting increasing expansion into technology-oriented and interdisciplinary venues.

**Figure 3**

*The Prolific Source Titles*

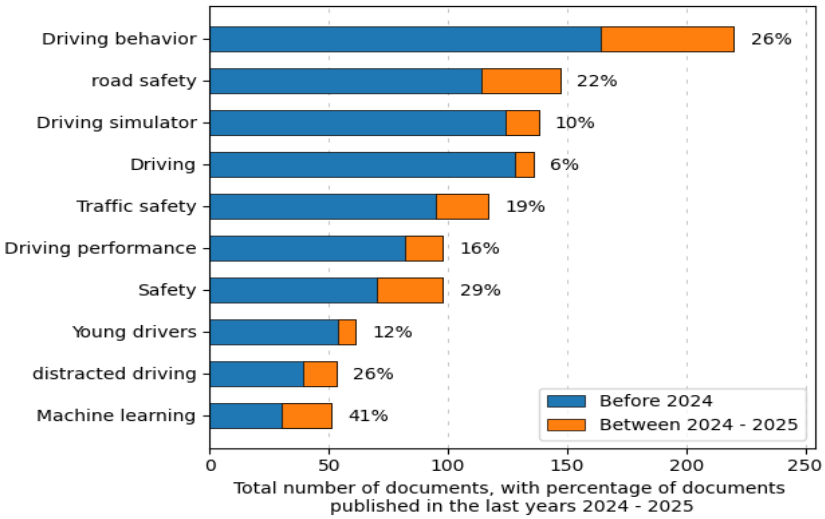



### Emerging Topics or Themes in Research

Figure 4 highlights the primary and emergent research themes within the field, based on total scholarly output and the percentage of publications appearing in 2024–2025. "Driving behavior" remains the most prevalent keyword, representing 26% of publications in the recent period, followed by "road safety" at 22%, thereby confirming their continued centrality within the literature. Other sustained themes include "traffic safety" (19%) and "driving performance" (16%), both of which maintain considerable visibility. Concurrently, "machine learning" exhibits the most substantial recent growth at 41%, indicative of a salient methodological and thematic shift towards AI-enabled analytics, prediction, and driver-state monitoring. Additional active themes include "safety" (29%), "distracted driving" (26%), and "young drivers" (12%), suggesting an ongoing concern with high-risk behaviors and targeted intervention strategies. Conversely, "driving simulator" (10%) and the broader term "driving" (6%) appear more mature and demonstrate less dynamic recent growth. Overall, the field is evolving from traditional behavioral analysis towards increasingly data-driven and technology-supported research paradigms.

**Figure 4**

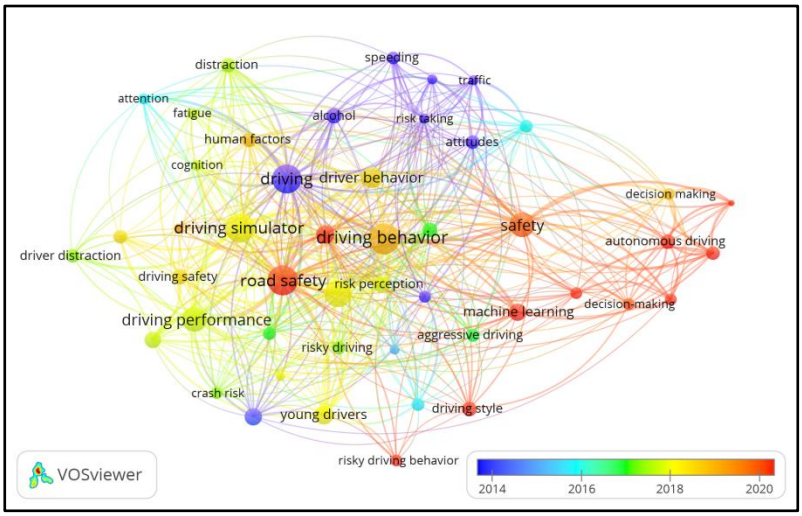
*The Bar-trend Graph of the Research Themes and Topics Emerging*




Keyword co-occurrence mapping, as illustrated in Figure 5, elucidates the conceptual architecture of the field. Central nodes, including "driving behavior," "road safety," and "driving simulator," link established human-factors domains, such as distraction, attention, fatigue, and cognition, with risk-related constructs like aggressive driving, risk perception, and crash risk. Furthermore, temporal analysis reveals the increasing prominence of emergent themes, notably "machine learning," "autonomous driving," and "decision making." This trend indicates a discernible shift from traditional risk-factor analysis toward predictive, AI-assisted, and automation-oriented research in road safety.

**Figure 5**

*The Visualization of the Overlapping Keywords Co-used by Authors*




**The Most Influential Academic Works**

Table 2 presents the most frequently cited publications within the dataset, each accruing a minimum of 371 citations. These works constitute the intellectual bedrock of the field, addressing salient themes such

as driver capability, psychosocial predictors of risky driving behavior, the impact of distraction, and theoretical frameworks of general driver behavior. Key studies include Anstey et al. (2005) with 813 citations, Ulleberg and Rundmo (2003) with 712 citations, and Fuller (2005) with 679 citations. These are followed by Elander et al. (1993) with 626 citations, Strayer et al. (2006) with 454 citations, Strayer and Drews (2004) with 382 citations, Ranney (1994) with 375 citations, Simons-Morton et al. (2005) with 372 citations, and Caird et al. (2004) with 371 citations. Cumulatively, these highly cited works suggest that the field's development has been predicated on three enduring pillars: driver-related individual factors, situational risk mechanisms, and conceptual frameworks for explaining and predicting driving behavior.

**Table 2**
*The Most Cited Paper*

| No | Source | Title | Citation count | Document type |
|---|---|---|---|---|
| 1. | (Anstey et al, 2005) | "Cognitive, sensory and physical factors enabling driving safety in older adults" | 813 | Articles |
| 2. | (Ulleberg & Rundmo, 2003) | "Personality, attitudes and risk perception as predictors of risky driving behaviour among young drivers" | 712 | Articles |
| 3. | (Fuller, 2005) | "Towards a general theory of driver behaviour" | 679 | Articles |
| 4. | (Elander et al, 1993) | "Behavioral correlates of individual differences in road-traffic crash risk: An examination of methods and findings" | 626 | Articles |
| 5. | (Strayer et al, 2006) | "A comparison of the cell phone driver and the drunk driver" | 454 | Articles |
| 6. | (Strayer &Drews, 2004) | "Profiles in driver distraction: Effects of cell phone conversations on younger and older drivers" | 382 | Articles |
| 7. | (Ranney, 1994) | "Models of driving behavior - a review of their evolution" | 375 | Review |
| 8. | (Simons-Morton et al., 2005) | "The observed effects of teenage passengers on the risky driving behavior of teenage drivers" | 372 | Articles |
| 9. | (Caird et al., 2004) | "A meta-analysis of the effects of texting on driving" | 371 | Articles |

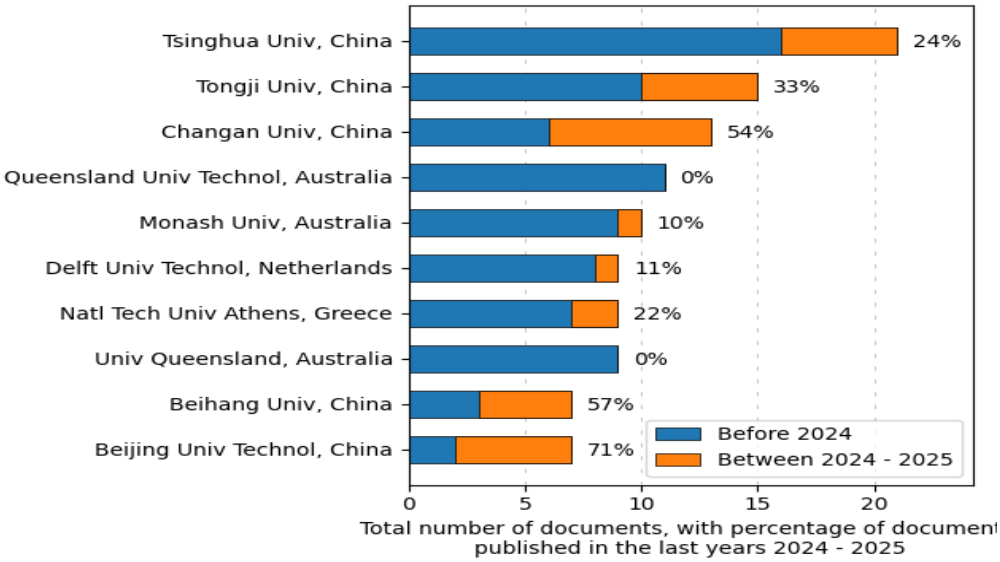
**Productive Institutions**

Figure 6 illustrates the most productive institutions in the field, including the proportion of publications contributed during the 2024–2025 period. Tsinghua University exhibits the highest total publication volume, with 24% of its output occurring in the most recent period, followed by Tongji University (33%) and Changan University (54%), suggesting sustained and expanding research capacity in driving behaviour and road safety. Other Chinese institutions, including Beihang University (57%) and Beijing University of Technology (71%), demonstrate particularly strong recent activity, indicative of emerging momentum in AI- and intelligent transportation system-oriented work. Australian institutions such as Queensland University of Technology (0%) and the University of Queensland (0%) reflect significant historical contributions, but limited recent output in this period, while Monash University (10%) maintains continued

visibility. European institutions, including Delft University of Technology (11%) and the National Technical University of Athens (22%), demonstrate ongoing participation. Overall, the institutional distribution reveals both established centres of excellence and more recent high-growth contributors, underscoring the increasingly international and geographically diversified nature of the field.

**Figure 6**

*The Ten Leading Institutions in Terms of Productivity*




## DISCUSSION

Due to limited synthesis of scholarship on driving behavior and road safety using scientometric methods, a comprehensive analysis of the existing literature employing advanced scientometric techniques is imperative. This study maps the global landscape of driving behavior and road safety research from 2000 to 2025, examining publication trends, collaboration networks, and thematic structures while visualising the relationships among key studies, authors, and institutions. Furthermore, we identify and analyze the most highly cited papers to underscore foundational contributions and emerging areas of research.

Scientometric investigations provide a rigorous, data-driven perspective of a field by analysing publication growth, thematic patterns, source venues, document types, and collaboration networks. When applied to driving behavior and road safety, these methodologies illuminate the evolution of research output from 2000 to 2025, highlight dominant and emerging topics such as distraction, driver performance, machine learning, and young drivers, and identify leading journals, institutions, and countries in the discourse. They also reveal influential authors and co-authorship clusters that shape the intellectual framework of the field. By mapping these dynamics and pinpointing high-impact works and research fronts, the present study clarifies the current state of the field, identifies gaps and opportunities, and provides actionable guidance for researchers seeking innovative contributions, stronger collaborations, and evidence-based directions for future work.

The findings of this study regarding the concentration of research in driving behavior and road safety yield valuable insights into publishing patterns and temporal trends within this domain, encompassing the distribution of outputs across academic journals, institutions, and thematic areas. Figure 1 depicts a consistent increase in publications concerning driving behavior within the context of road safety from 1990

to 2025, as evidenced by both Scopus and WoS, with an acceleration observed from the early 2000s and intensifying post-2010. Notably, Scopus consistently surpasses WoS in terms of publication output, reaching a peak of approximately 175 items by 2025, compared to around 55 items documented in WoS. This disparity indicates either a broader coverage or a higher output captured in Scopus. The recent proliferation of publications correlates with heightened global policy attention and technological advancements, such as the development of autonomous vehicles and driver monitoring systems, thereby underscoring the maturation of the field and its increasing relevance to public health and transport decision-making.

Autonomous vehicles are poised to redefine transportation networks, with significant implications for public health. These implications encompass potential benefits such as improved road safety and reduced emissions, alongside challenges including decreased physical activity and uncertain impacts on land use and emissions (Crayton & Meier, 2017; Singleton et al., 2020). The rapid development of AV technology is driven by advancements in artificial intelligence and pervasive sensing, which are integral to broader technological shifts in transport, including mobility as a service and unmanned aerial vehicle (Cohen & Jones, 2020). However, despite the optimism surrounding these technologies, regulatory frameworks are lagging, as legal systems struggle to keep pace with innovations (Othman, 2022). The rising number of publications, particularly from Asia and Europe, underscores the global interest and research efforts in smart transportation policy, with China and Italy leading in contributions (Fitriani, 2023). This expanding body of research is essential for shaping policies that align with public health objectives and sustainable development, ensuring that the deployment of AVs supports healthy lives and sustainable cities (Crayton & Meier, 2017). As AVs continue to evolve, they present promising tools for enhancing mobility and public health, particularly in scenarios such as pandemics, where they can facilitate safe transportation (Othman, 2022). Overall, the intersection of AV technology and public health presents both opportunities and challenges that necessitate careful policy consideration and ongoing research.

Figure 2 illustrates that journal articles are the predominant document type in research on driving behavior and road safety, surpassing both conference papers and reviews, with a significant increase anticipated in 2024-2025. This trend suggests that the advancement of knowledge and practice in the field is heavily reliant on original, peer-reviewed research and academic discourse. The prevalence of journal and conference papers reflects ongoing institutional interest and active debates within university and professional conference settings. The Global Status Report on Road Safety highlights the persistent challenges associated with road safety, identifying multifactorial causes such as alcohol consumption, speeding, and fatigue as significant contributors to road accidents (Mignot, 2017). A bibliometric analysis of accident prevention research elucidates the importance of system analysis, the establishment of accident models, and the cultivation of a safety culture as foundational elements in this domain (Huang et al., 2022). Furthermore, research on driving attitudes and behaviors indicates variations in risk perception and concern among young drivers, which have practical implications for road safety training courses (Cordellieri et al., 2019; Radzi et al., 2026). The Safe System approach, which originated from the Swedish Vision Zero and Dutch Sustainable Safety philosophies, signifies a paradigm shift in road safety by focusing on the elimination of severe road trauma through the system-based design and management of kinetic energy (Corben et al., 2022). Additionally, road safety education programs, exemplified by a case study from Slovenia, demonstrate the potential to reduce traffic violations and accidents, thereby underscoring the critical role of education in enhancing traffic safety (Topolšek et al., 2019). Collectively, these studies highlight the ongoing institutional focus and active discourse within the field, driven by a commitment to reducing road accidents and improving safety outcomes through rigorous research and innovative solutions.

Figure 3 illustrates that esteemed scholarly publications and conference proceedings play a crucial role in effectively disseminating cutting-edge research on driving behavior and road safety, spanning behavioral insights and injury-prevention evidence to data-driven, AI- and sensor-enabled methods and applications. Noteworthy sources include reputable journals such as Accident Analysis & Prevention, Transportation Research Part F: Traffic Psychology and Behaviour. The substantial impact factors and publication volumes of leading outlets in driving behavior and road safety underscore the growing significance and relevance of this field, sustaining interest among researchers and practitioners. This visibility is further reinforced by the tendency for articles published in prestigious, influential journals to garner a higher number of citations, thereby facilitating knowledge diffusion, shaping best practices, and informing policy.

This trend is exemplified in the systematic review by Stefanidis et al. (2022), which highlights the influence of social media on road rule compliance and emphasises the necessity for further research to comprehend its impact on driving behaviors. The bibliometric analysis by Huang et al. (2022) corroborates this by identifying road accident prevention as a central area within accident prevention studies, with key journals such as Safety Science and Accident Analysis and Prevention playing pivotal roles in shaping the field. Antonakis et al. (2014) provide insights into citation dynamics, noting that articles employing robust quantitative methods and theoretical frameworks tend to receive more citations, thereby facilitating knowledge dissemination and influencing best practices. Additionally, Stephens et al. (2022) discuss the perceived increase in aggressive driving, particularly during the COVID-19 pandemic, highlighting the evolving challenges in road safety and the necessity for targeted interventions. Shah et al. (2018) contribute to this discourse by analysing road safety risk assessment in Asian countries, employing advanced methodologies such as DEA and SEM to evaluate and enhance transport management systems. Collectively, these studies illustrate the dynamic interplay between research visibility, citation impact, and the development of effective road safety policies and practices.

Figure 4 illustrates the primary domains of investigation and emerging concerns related to driving behaviour within road safety. The term "Driving Behavior" is notably prominent as the most frequently utilised keyword, highlighting the importance of raising awareness regarding environmental sustainability (i.e., the environmental impacts of driving practices). The extensive use of the term "Driving Behavior" in contemporary studies within road safety contexts suggests that scholars and practitioners recognize the necessity of employing evidence-based, data-driven, behaviorally informed methods to assess risk and design effective road safety interventions. Research underscores the critical role of driving behavior in road safety, with various studies employing advanced methodologies to evaluate and mitigate risks. For instance, Chen et al. (2023) developed a comprehensive model using vehicle trajectory data to categorize driving behaviors into risk types such as dangerous and aggressive, which can inform real-time safety interventions. Similarly, Farooq and Moslem (2019) applied the Analytic Network Process to rank risky driving behaviors, identifying factors such as alcohol use and speed limits as significant for road safety, thereby guiding targeted interventions. In Saudi Arabia, Rahman et al. (2022) employed a Bayesian belief network to explore the complex relationships between driving behaviors and accident causes, demonstrating the model's efficacy in predicting collision likelihoods based on behaviors such as speeding. Furthermore, Bian et al. (2019) proposed a deep learning model to assess driving risk, emphasizing the need to consider temporal and environmental factors in evaluating aggressive driving behaviors. Ameksa et al. (2020) highlighted the importance of diverse data sources, such as in-vehicle and IoT sensors, in capturing comprehensive driving behaviour data, advocating for an integrated approach that considers driver, vehicle, and environmental dimensions. Collectively, these studies illustrate the critical need for data-driven approaches in understanding and improving driving behavior to enhance road safety.

Additionally, the analysis of the co-occurrence of keywords by means of VOSviewer, as illustrated in Figure 5, provides clarification regarding the interconnection between different research topics and concepts. The increasing prominence of terms such as "machine learning," "autonomous driving," and "decision making" underscores a significant shift in road safety research—from reactive approaches to proactive, AI-enabled strategies that anticipate and mitigate risks more effectively. This evolution engenders debates regarding AI's potential to enhance safety, particularly under dynamic and uncertain traffic conditions. On one hand, machine learning empowers autonomous vehicles to better predict and respond to human behavior such as during lane changes or pedestrian crossings, thereby improving both safety and efficiency (Kothuri et al., 2023; Lv et al., 2022; Münst, 2020). However, these systems encounter significant challenges, such as managing epistemic uncertainty and decision risks in rare or unpredictable scenarios, including unsignalized intersections (Yang et al., 2023; Yang et al., 2025). Despite these limitations, the integration of reinforcement learning, probabilistic modelling, and real-time sensor fusion in autonomous vehicles facilitates adaptive decision-making frameworks that closely mimic human driving patterns while prioritizing safety (Mechernene et al., 2022; Zhou et al., 2024). This shift towards evidence-based, data-driven road safety policy reflects a deeper integration of predictive analytics and automation in transport systems, ultimately supporting more intelligent and preventative road safety interventions rather than merely reactive ones.

The results in Figures 4 and 5, marked by frequent machine-learning terms, underscore the evolving focus and emphasize the importance of AI-enabled, data-driven analytics for proactive risk prediction and targeted road-safety interventions. Examining keyword co-occurrence reveals how topics cluster and connect, thereby enhancing understanding of the level of thematic integration and the field’s underlying intellectual structure in driving behavior and road safety research.

Table 2 presents an aggregation of significant academic articles, arranged according to the number of citations each article has received. These highly cited works provide valuable insights into the current state of the field, specifically pertaining to the core theories, dominant risk mechanisms, methodological approaches, and evidence base that inform policy and interventions in driving behavior and road safety. The publication titled "Cognitive, Sensory and Physical Factors Enabling Driving Safety in Older Adults" by Anstey et al. (2005) has garnered the highest number of citations, underscoring its substantial impact within the field. Articles that achieve a considerable number of citations demonstrate widespread utilization and recognition within the academic community. Consequently, these notable publications serve as essential resources for scholars seeking to ground new studies in validated theories and methodologies, identify significant gaps, and design effective, policy-relevant interventions. They contribute to shaping the direction of research agendas in driving behaviour and road safety, as well as influencing methodological standards and evidence-based policy and practice.

The analysis of productive institutions (Figure 6) underscores the substantial contributions of universities from various countries to behavior and road safety research. Notably, Tsinghua University, Tongji University, and Changan University each publish twelve or more articles in this field, reflecting their sustained institutional capacity and strategic emphasis on behaviorally informed road safety science, which includes human factors, exposure and risk modelling, and data-driven/intelligent transportation system approaches. This consistent output highlights their role as regional and global centers for scholarship and collaboration, influencing research agendas, training talent, and facilitating the translation of empirical findings into policy-relevant interventions and safer mobility systems.

## CONCLUSION

This study employed scientometric techniques using ScientoPy and VOSviewer to analyze global trends, thematic evolution, and collaboration networks in driving behaviour and road safety research from 2000 to 2025, based on data from Scopus and WoS. The results revealed a significant rise in scholarly output after 2010, reflecting growing academic and policy interest, with journal articles emerging as the dominant publication type and Accident Analysis & Prevention, Transportation Research Part F, and Traffic Injury Prevention identified as the most productive outlets. Keyword mapping highlighted the increasing prominence of terms such as machine learning, autonomous driving, and decision making, demonstrating a paradigm shift from traditional behavioral analyses toward AI-driven, data-centric safety models. Co-occurrence analysis further indicated strong interconnections between behavioral constructs (distraction, cognition, risk perception) and intelligent system research, signifying deeper integration between human factors and technology. Citation analysis showed that influential works by Anstey et al. (2005), Fuller (2005), and Ulleberg and Rundmo (2003) continue to anchor the field's theoretical and empirical foundations, while institutional analysis positioned Tsinghua University, Tongji University, and Changan University as global leaders in productivity. Overall, the findings reveal a dynamic and maturing discipline increasingly shaped by interdisciplinary collaboration, technological innovation, and evidence-based approaches that collectively guide the future trajectory of driving behaviour and road safety research.

## ACKNOWLEDGMENT

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## REFERENCES

Abdullah, K. H. (2022). Publication trends in biology education: A bibliometric review of 63 years. *Journal of Turkish Science Education, 19*(2), 465-480. https://doi.org/10.36681/tused.2022.131

Abdullah, K. H., & Sofyan, D. (2023). Machine learning in safety and health research: A scientometric analysis. *International Journal of Information Science and Management (IJISM), 21*(1), 17-37. https://doi.org/10.22034/ijism.2022.1977763.0

Abdulwahid, S. N., Mahmoud, M. A., Zaidan, B. B., Alamoodi, A. H., Garfan, S., Talal, M., & Zaidan, A. A. (2022). A comprehensive review on the behaviour of motorcyclists: Motivations, issues, challenges, substantial analysis and recommendations. *International Journal of Environmental Research and Public Health, 19*(6), 3552. https://doi.org/10.3390/ijerph19063552

Ameksa, M., Mousannif, H., Al Moatassime, H., & Elamrani Abou Elassad, Z. (2020). Toward flexible data collection of driving behaviour. *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 4443, 33–43. https://doi.org/10.5194/ISPRS-ARCHIVES-XLIV-4-W3-2020-33-2020

Antonakis, J., Bastardoz, N., Liu, Y., & Schriesheim, C. A. (2014). What makes articles highly cited. *Leadership Quarterly, 25*(1), 152–179. https://doi.org/10.1016/J.LEAQUA.2013.10.014

Babojelić, K., & Novačko, L. (2020). Modelling of driver and pedestrian behaviour – A historical review. *Promet-Traffic & Transportation, 32*(5), 727–745. https://doi.org/10.7307/PTT.V32I5.3524

Bian, Y., Lee, C. H., Zhao, J. L., & Wan, Y. (2019). A deep learning based model for driving risk assessment. Hawaii *International Conference on System Sciences*, 1–10. https://doi.org/10.24251/HICSS.2019.158

Bin-Nun, A. Y., Derler, P., Mehdipour, N., & Duintjer Tebbens, R. J. (2022). How should autonomous vehicles drive? Policy, methodological, and social considerations for designing a driver. *Humanities & Social Sciences Communications, 9*(1), 1–13. https://doi.org/10.1057/s41599-022-01286-2

Chen, S., Cheng, K.-T., Yang, J., Zhang, X., & Luo, Q. (2023). Driving behavior risk measurement and cluster analysis driven by vehicle trajectory data. *Applied Sciences, 13*(9), 5675. https://doi.org/10.3390/app13095675

Cohen, T., & Jones, P. B. (2020). Technological advances relevant to transport – understanding what drives them. *Transportation Research Part A-Policy and Practice*, 135, 80–95. https://doi.org/10.1016/J.TRA.2020.03.002

Corben, B., Peiris, S., & Mishra, S. (2022). The importance of adopting a safe system approach—Translation of principles into practical solutions. *Sustainability, 14*(5), 2559. https://doi.org/10.3390/su14052559

Cordellieri, P., Sdoia, S., Ferlazzo, F., Sgalla, R., & Giannini, A. M. (2019). Driving attitudes, behaviours, risk perception and risk concern among young student car-drivers, motorcyclists and pedestrians in various EU countries. *Transportation Research Part F-Traffic Psychology and Behaviour, 65*, 56–67. https://doi.org/10.1016/J.TRF.2019.07.012

Crayton, T., & Meier, B. M. (2017). Autonomous vehicles: Developing a public health research agenda to frame the future of transportation policy. *Journal of Transport and Health, 6*, 245–252. https://doi.org/10.1016/J.JTH.2017.04.004

Davey, J. D., & Freeman, J. E. (2011). Improving road safety through deterrence-based initiatives: A review of research. *Sultan Qaboos University Medical Journal, 11*(1), 29–37. https://journals.squ.edu.om/index.php/squmj/article/download/1543/1495

Dutta, U. (2020). A data driven approach to identify the contributing factors of traffic death in low, middle, and high-income countries. *Global Journal of Engineering Sciences, 5*(3), 1-2. https://doi.org/10.33552/GJES.2020.05.000613

Farooq, D., & Moslem, S. (2019). Evaluation and ranking of driver behavior factors related to road safety by applying analytic network process. *Periodica Polytechnica Transportation Engineering, 48*(2), 189–195. https://doi.org/10.3311/PPTR.13037

Fitriani. (2023). Research trends on smart transportation policy in Asia and Europe: A biblioetric analysis. *Jurnal Studi Pemerintahan, 14*(2), 215–232. https://doi.org/10.18196/jsp.v14i2.316

Huang, R., Liu, H., Ma, H., Qiang, Y., Pan, K., Gou, X., Wang, X., Ye, D., Wang, H., & Glowacz, A. (2022). Accident prevention analysis: Exploring the intellectual structure of a research field. *Sustainability, 14*(14), 8784. https://doi.org/10.3390/su14148784

Huang, R., Liu, H., Ma, H., Qiang, Y., Pan, K., Gou, X., Wang, X., Ye, D., Wang, H., & Glowacz, A. (2022). Accident prevention analysis: Exploring the intellectual structure of a research field. *Sustainability, 14*(14), 8784. https://doi.org/10.3390/su14148784

Jafarpour, S., & Rahimi-Movaghar, V. (2014). Determinants of risky driving behavior: A narrative review. *The Medical Journal of The Islamic Republic of Iran, 28*(1), 142. https://dash.harvard.edu/bitstream/handle/1/14065490/4322337.pdf?sequence=1

Kochetova, T. (2022). The Patterns of Drivers' Traffic Behavior: Evidence from three countries. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.869029

Kothuri, S., Nivedita, V., P, P., Dharmateja, M., Chinnaraj, A., & Sachidananda, K. (2023). Enhancing pedestrian safety in autonomous vehicles through machine learning. *2023 International Conference on Sustainable Communication Networks and Application (ICSCNA)*, 1587-1592. https://doi.org/10.1109/icscna58489.2023.10370173.

Li, M., & Lee, J. (2023). Modeling car-following behavior with different acceptable safety levels. *Sustainability, 15*(7), 6282. https://doi.org/10.3390/su15076282

Li, M., Wang, W., Liu, Z., Qiu, M., & Qu, D. (2022). Driver behavior and intention recognition based on wavelet denoising and bayesian theory. *Sustainability, 14*(11), 6901. https://doi.org/10.3390/su14116901

Luke, R. (2023). Current and future trends in driver behaviour and traffic safety scholarship: An African research agenda. *International Journal of Environmental Research and Public Health, 20*(5), 4290. https://doi.org/10.3390/ijerph20054290

Lv, K., Pei, X., Chen, C., & Xu, J. (2022). A safe and efficient lane change decision-making strategy of autonomous driving based on deep reinforcement learning. *Mathematics, 10*(9), 1551. https://doi.org/10.3390/math10091551.

Md Isa, Z., Ismail, N. H., Ismail, R., Mohd Tamil, A., Jaafar, M. H., Mat Nasir, N., Miskan, M., Zainol Abidin, N., Ab Razak, N. H., & Yusof, K. H. (2022). Assessing factors associated with non-fatal injuries from road traffic accidents among Malaysian adults: A cross-sectional analysis of the PURE Malaysia study. *International Journal of Environmental Research and Public Health, 19*(14), 8246. https://doi.org/10.3390/ijerph19148246

Mechernene, A., Judalet, V., Chaibet, A., & Boukhnifer, M. (2022). Detection and risk analysis with lane-changing decision algorithms for autonomous vehicles. *Sensors*, *22*(21), 8148. https://doi.org/10.3390/s22218148.

Mignot, D. (2017). Topical collection on human factors and safety. *European Transport Research Review, 9*(3), 1–3. https://doi.org/10.1007/S12544-017-0261-9

Münst, W. (2020). Prediction of driver behavior and decision strategies for autonomous driving: Using machine learning and decision theory [Dissertation, FernUniversität in Hagen]. https://ub-deposit.fernuni-hagen.de/servlets/MCRFileNodeServlet/mir_derivate_00002080/Diss_Muenst_Prediction_2020.pdf

Othman, K. (2022). Exploring the implications of autonomous vehicles: A comprehensive review. *Innovative Infrastructure Solutions, 7*(165), 1-32. https://doi.org/10.1007/s41062-022-00763-6

Radzi, E. M., Abd Aziz, F. S., & Abdullah, K. H. (2024). The interrelation between happiness and workplace safety: A bibliometric review. *Multidisciplinary Reviews, 7*(7), 2024145-2024145. https://doi.org/10.31893/multirev.2024145

Radzi, E. M., Hassan, Z., Ismail, M. A., Abdul Wahab, M. S., Armawai, M.A., Razak, W.Z.W.A (2025). Understanding sensation seeking in driving and its impact on road safety: An integrated scientometric and scoping review. *Social Security Management Journal, 2* (2), 11-33. https://doi.org/10.32890/ssmj2025.2.2.2

Radzi, E. M., Hassan, Z., Ismail, M. I., Rahmat. A. K (2026). Understanding military driving behaviour: A scientometric and scoping review of global research trends and gaps. *Journal of Technology and Operations Management, 21*(1), 55-75.https://doi.org/10.32890/jtom2026.21.1.5

Rahman, M. M., Islam, Md. K., & Al-Shayeb, A. (2022). Towards sustainable road safety in Saudi Arabia: Exploring traffic accident causes associated with driving behavior using a bayesian belief network. *Sustainability, 14*(10), 6315. https://doi.org/10.3390/su14106315

Rezapur-Shahkolai, F., Taheri, M., Etesamifard, T., Roshanaei, G., & Shirahmadi, S. (2020). Dimensions of aberrant driving behaviors and their association with road traffic injuries among drivers. *PLOS ONE, 15*(9). https://doi.org/10.1371/JOURNAL.PONE.0238728

Ruiz-Rosero, J., Ramirez-Gonzalez, G., Williams, J. M., Liu, H., Khanna, R., & Pisharody, G. (2017). Internet of things: A scientometric review. *Symmetry, 9*(12), 1-32. https://doi.org/10.3390/sym9120301

Shah, S. A. R., Ahmad, N., Shen, Y., Pirdavani, A., Basheer, M. A., & Brijs, T. (2018). Road safety risk assessment: An analysis of transport policy and management for low-, middle-, and high-income Asian countries. *Sustainability, 10*(2), 389. https://doi.org/10.3390/SU10020389

Singleton, P. A., De Vos, J., Heinen, E., & Pudane, B. (2020). Potential health and well-being implications of autonomous vehicles. *Advances in Transport Policy and Planning, 5*, 163–190. https://doi.org/10.1016/BS.ATPP.2020.02.002

Stefanidis, K. B., Davey, B., Truelove, V., Schiemer, C., & Freeman, J. E. (2022). Does exposure to social media content influence attitudes towards, and engagement in, road rule violations? A systematic review. *PLOS ONE, 17*(9), e0275335. https://doi.org/10.1371/journal.pone.0275335

Stephens, A. N., Trawley, S., Ispanovic, J., & Lowrie, S. (2022). Self-reported changes in aggressive driving within the past five years, and during COVID-19. *PLOS ONE, 17*(8), e0272422. https://doi.org/10.1371/journal.pone.0272422

Topolšek, D., Babić, D., & Fiolić, M. (2019). The effect of road safety education on the relationship between driver's errors, violations and accidents: Slovenian case study. *European Transport Research Review, 11*(1), 1–8. https://doi.org/10.1186/S12544-019-0351-Y

Toriumi, A., Abu-Lebdeh, G., Alhajyaseen, W. K. M., Christie, N., Gehlert, T., Mehran, B., Mussone, L., Shawky, A., Tang, K., & Nakamura, H. (2022). A multi-country survey for collecting and analyzing facts related to road traffic safety: Legislation, enforcement, and education for safer drivers. *Iatss Research, 46*(1), 14–25. https://doi.org/10.1016/j.iatssr.2022.01.004

Xu, J., Guo, K., & Sun, P. Z. H. (2022a). Driving performance under violations of traffic rules: Novice vs. experienced drivers. *IEEE Transactions on Intelligent Vehicles, 7*(4), 908–917. https://doi.org/10.1109/tiv.2022.3200592

Xu, Y., Chen, M., Yang, R., Wumaierjiang, M., & Huang, S. (2022b). Global, regional, and national burden of road injuries from 1990 to 2019. *International Journal of Environmental Research and Public Health, 19*(24), 16479. https://doi.org/10.3390/ijerph192416479

Yang, K., Li, B., Shao, W., Tang, X., Liu, X., & Wang, H. (2023). Prediction failure risk-aware decision-making for autonomous vehicles on signalized intersections. *IEEE Transactions on Intelligent Transportation Systems, 24*, 12806-12820. https://doi.org/10.1109/tits.2023.3288507.

Yang, K., Li, S., Chen, Y., Cao, D., & Tang, X. (2025). Towards safe decision-making for autonomous vehicles at unsignalized intersections. *IEEE Transactions on Vehicular Technology, 74*, 3830-3842. https://doi.org/10.1109/tvt.2024.3488749.

Zhou, Z., Huang, H., Li, B., Zhao, S., Mu, Y., & Wang, J. (2024). SafeDrive: Knowledge- and data-driven risk-sensitive decision-making for autonomous vehicles with large language models. *Accident Analysis Prevention, 224*, 108299. https://doi.org/10.1016/j.aap.2025.108299