

A Scenario of Road Traffic Safety: A Bibliometric Analysis

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Abstract

In the past decade, road traffic accidents (RTAs) have become increasingly concerning, both as social and health issues. To gain insights into the state of road traffic safety research between 2010 and 2022, we conducted a comprehensive study using Scopus as our primary source for relevant research. This analysis covered various bibliometric indicators, including annual publication and citation trends, prominent authors, journals, institutions, highly cited articles, and keyword co-occurrence. R statistical software and the biblioshiny package were employed for the analysis. The dataset exhibits an annual growth rate of 15.55%, indicating an increasing number of documents over time. On average, the documents are relatively recent, with an average age of 4.8 years, and each document has an average of 10.87 citations, reflecting their scholarly impact. Collaboration among authors is evident, with an average of 3.33 co-authors per document and a notable percentage of international co-authorships (24%). The analysis also reveals fluctuating patterns in publication output and citation impact across different years. Additionally, certain journals, such as "Accident Analysis and Prevention," "Periodic Polytechnic Transportation Engineering," and "IATSS Research," have published a substantial number of articles in the road safety field. Several influential articles and trusted authors have emerged from this dataset, contributing to the body of knowledge in road safety research. This study offers valuable insights into the research landscape of road safety over the past decade, highlighting key contributing factors to accidents and providing a foundation for devising impactful policies and measures to curb road traffic incidents. Overall, these findings provide

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valuable insights into the scholarly landscape, collaborations, and topical coverage within the specified timespan.

Keywords

Bibliometric Analysis, Road Safety, Road Traffic Accidents, Road Traffic Safety, Road Safety.

1. Introduction

The issue of road safety has become a worldwide concern given the diverse and far-reaching impacts of road traffic accidents (RTAs) on contemporary society (Giri et al., 2023). RTAs occur when one or more moving vehicles collide on a public road, resulting in material damage, injuries, or fatalities. Road traffic safety aims to employ various methods and measures to protect road users and prevent serious injuries and deaths on the road (Lukusa et al., 2019). The significant increase in RTAs poses considerable social and economic challenges, particularly in developing countries, leading to a high number of casualties and injuries (Oreko et al., 2017). To address this issue and reduce the associated costs, there is a pressing need to enhance national road safety (Subhan et al., 2021).

Poor transportation infrastructure and unfavorable traffic conditions are among the factors contributing to traffic accidents (Zanne & Groznik, 2018). In recent years, RTAs and traffic offenses have become prominent social and health concerns (Falde-Garrido et al., 2016). Developing countries, in particular, are facing a worsening situation with road accidents due to inadequate and unsuitable road infrastructure for fast-paced urbanization and motorization. To prevent or minimize the impact of road accidents, professionals involved in road safety need to have a comprehensive understanding of the causes of accidents (Banik et al., 2011). By addressing these causes and improving road infrastructure and safety measures, we can work towards reducing the occurrence of RTAs and their consequences.

Reckless driving has been identified as the primary cause of traffic accidents in Pakistan (Batool & Carsten, 2017). In India, speeding accounts for 51% of all road accidents. Notably, a 5% reduction in average speed could lead to a significant 20% decrease in fatalities (Faustino & Sivasubrahmaniyan, 2018). Meanwhile, road traffic accidents continue to be a significant problem in Russia, with dozing behind the wheel (27.9%), careless driving (24.6%), tire bursts (11.7%), and brake failure (7.4%) being the leading contributing factors to these accidents (Iqbal et al., 2020).

Accidents resulting in more severe injuries tend to involve young drivers aged 20 to 30 years, occur in areas with speed limits exceeding 60 mph, take place on weekdays, and happen during sunny weather conditions (Ijaz et al., 2021). Each day, numerous individuals suffer injuries or lose their lives in road accidents, with the majority of these accidents being caused by drivers themselves (Kushchenko et al., 2019). Although road safety has improved in general, young male drivers continue to surpass female drivers in terms of accident involvement in most Western countries (Møller & Haustein, 2013). In India and other parts of the world, road traffic accidents are frequently caused by factors such as extremely sharp curves, lack of skid resistance, and poor visibility (Pathak et al., 2020). Road emergencies account for a significant number of three-car collisions, bus accidents in mountain gorges, and similar incidents (Tollerud and Beaton, 2016).

Based on statistical analysis in India, the majority of vehicles involved in road traffic accidents (RTAs) are heavy trucks (40%) and passenger cars (20.7%), followed by 2-wheelers (7.9%), trailer trucks (7.4%), buses (5.5%), and light trucks (5.3%). Fatalities accounted for 9% of these accidents, with trucks being responsible for the majority of fatalities (77%), serious injuries (41%), and minor injuries (46%) (Singh et al., 2017). Rural road safety is a significant concern, contributing substantially to the overall road safety issue. Rural road fatalities represent a considerable portion, ranging from 28% to 87% of all road fatalities (Cafiso et al., 2010). Moreover, the percentage of major traffic accidents occurring in mountainous areas has increased to 60% in recent years, indicating the lack of an effective mountain road safety system (Jun and Cao, 2021).

To mitigate accidents, several factors such as overcrowding/overloading, speeding, lack of supervision, and fatigued driving require attention and rectification (Zhang et al., 2018). Although Sweden is known for its highly safe traffic environment worldwide, a considerable number of people still experience injuries in road traffic accidents (Berg et al., 2016). The implementation of road safety barriers has been proven effective in decreasing both the occurrence and seriousness of traffic accidents (Butns et al., 2015). In China, there exists a strong linear relationship between road traffic fatalities, Gross Domestic Product (GDP), traffic fines, and the number of severe traffic accidents (Cai et al., 2015). The Spanish government adopted stricter punishment policies to significantly curtail road accidents and fatalities (José et al., 2012). Lithuania has taken several proactive approaches, including road user education, transportation, and engineering initiatives, to create safe and enjoyable traffic experiences across its road network, in line with the broader goals of the European Union. However, despite

advancements made in 2008, Lithuania's traffic safety situation is not on par with many other EU member states. As a result, more efficient and targeted improvement strategies are required, particularly for road segments with high accident rates (Pik & Pumputis, 2010). The Russian regions have witnessed significant improvements in traffic safety due to increased state attention (Petrov & Petrova, 2020). Cost-benefit analysis and black spot treatment have been utilized in Lithuania to enhance road safety. The Penalty Point System (PPS), primarily pioneered in Europe, has been incorporated into road safety legislation worldwide. Implementing road traffic safety strategies has shown a notable 15% to 20% reduction in accidents, fatalities, and injuries (Pulido et al., 2021).

Weather elements, in addition to factors like road design, surface quality, and traffic flow, significantly influence accident prediction (Schlögl, 2020). Child restraint systems (CRSs) in vehicles are designed to protect children and reduce child fatalities and injuries resulting from traffic accidents (Schluter & Paterson, 2010). Driver behavior is closely tied to how they perceive traffic conditions, and considering cultural differences is essential when creating interventions to improve road safety. China has implemented measures to enhance road safety, but cultural factors still pose challenges in ensuring the safety of road users (Xie & Zhang, 2019). Countries worldwide share the common goal of improving road safety and minimizing the impact of traffic accidents. To achieve this, automatic emergency response systems have been developed and deployed to offer real-time accident information and immediate assistance when required (Rembalovic et al., 2020).

In countries that prioritize enhancing road safety, accurately forecasting road traffic accidents is essential for setting effective goals. Making well-informed decisions in road traffic safety management relies on a comprehensive analysis of accident data, including an objective evaluation of their causes and circumstances (Zagidullin & Gabdullin, 2020). The primary factor responsible for road accidents is driver-related errors. These errors, including reckless driving, dangerous overtaking, and excessive speeding, are responsible for approximately 80% of all road traffic accidents (Giri et al. 2023). To tackle these issues, specific legislative or regulatory measures can be tailored to different vehicle types and driver groups, targeting various aspects like driver behavior, vehicle characteristics, road conditions, and the environment to effectively reduce speeding and drunk driving rates (Zhang et al., 2014).

2. Materials and Methods

Figure 1 provides a more detailed overview of the methodology employed in the study. The bibliometric data utilized in this research is sourced from the Scopus database, which is recognized as the largest abstract and citation database for globally peer-reviewed papers, book chapters, and conference reviews. Scopus serves as a comprehensive repository of scholarly information, enabling the extraction of relevant bibliometric information for the study. Scopus offers a comprehensive overview of research output worldwide across various disciplines such as science, technology, medicine, philosophy, and psychology. It provides extensive tracking, analysis, and visualization capabilities, enabling researchers to gain insights into global research trends. Due to the complexity of implementing bibliometric indicators and literature mapping across multiple databases, bibliometric studies often rely on a single database like Scopus. This allows for a more streamlined and focused analysis of bibliometric data, facilitating easier interpretation and meaningful insights. Compared to other databases, Scopus offers distinct advantages, such as a broader array of publications and more accurate data analysis capabilities (Falagas et al., 2008). To conduct a comprehensive search and ensure the inclusion of relevant articles, the study utilizes specific keywords such as "road safety," "road traffic accidents," "traffic accidents," and "highway accidents" in the database search. The search is limited to open-access articles published between 2010 and 2022, specifically within the field of engineering. The keyword "road safety" is a primary focus. After a thorough examination of the abstract and scope, the top 100 relevant articles are selected for the final bibliometric analysis. The extracted data includes information such as the research title, publication year, journal name, author names, keywords, affiliations, and country of origin. The analysis in the study was conducted using R statistical software, which is a widely used programming language and environment for statistical computing and graphics. In addition, the bibloshiny package, a specific package within R, was utilized for the analysis. The bibloshiny package provides functionality for bibliometric analysis, including extracting and processing bibliographic data, generating bibliometric indicators, and visualizing the results. By leveraging R and the bibloshiny package, the study was able to perform robust bibliometric analyses on the gathered data.

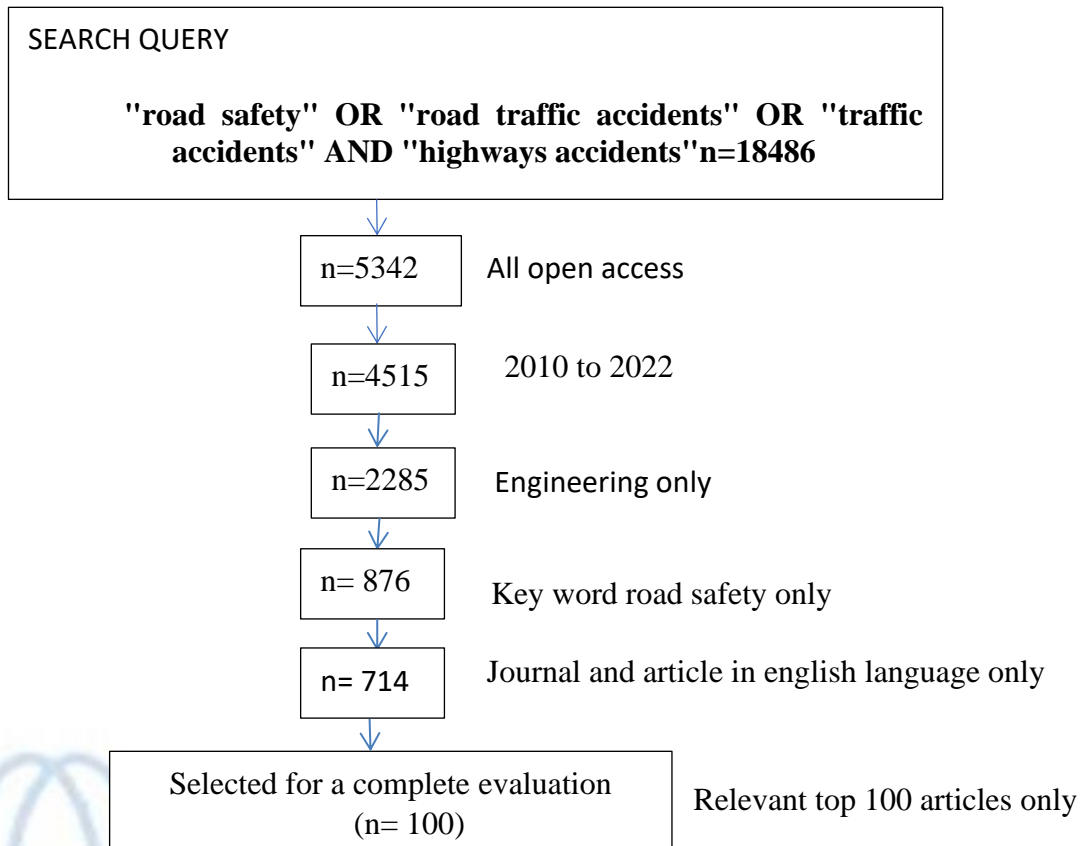


Figure 1: Search Strategy

3. Result and Discussion

3.1 Descriptive Statistics

Table 1 provides information about a dataset comprising 100 documents sourced from 39 different publications. The data spans from 2010 to 2022, covering 12 years. The dataset exhibits an annual growth rate of 15.55%, indicating an increasing number of documents over time. On average, the documents in the dataset are relatively recent, with an average age of 4.8 years. Each document, on average, has 10.87 citations, reflecting the level of scholarly impact. The dataset includes a total of 748 Keywords Plus (ID) and 334 Author's Keywords (DE), indicating the range of topics covered. There are 296 authors associated with the dataset, with 15 of them being the sole authors of their respective documents. Collaboration is also evident, as 17 documents have multiple authors, with an average of 3.33 co-authors per document. The dataset demonstrates international collaboration, with 24% of co-authorships being international. Overall, this dataset provides valuable insights into scholarly contributions, collaborations, and topical coverage within the specified timespan.

Table 1: Key Information

Description	Results
Main Information About The Data	
Timespan	2010:2022
Sources (Journals, Books, etc)	39
Documents	100
Annual Growth Rate %	15.55
Document Average Age	4.8
Average citations per doc	10.87
References	1
Document Contents	
Keywords Plus (ID)	748
Author's Keywords (DE)	334
Authors	
Authors	296
Authors of single-authored docs	15
Authors Collaboration	
Single-authored docs	17
Co-Authors per Doc	3.33
International co-authorships %	24

Source: Author's elaboration

3.2 Publication Trend

Figure 2 summarizes data on the number of articles published and the average number of citations per year for each year from 2010 to 2022. It reveals fluctuating patterns in both the publication output and the citation impact. In 2011 and 2017, fewer articles generated a relatively high average number of citations per year, indicating a significant scholarly impact. Conversely, other years experienced a higher number of articles but with lower average citation rates, suggesting potentially lower influence or visibility. The data highlights the dynamic nature of research output and its varying reception in terms of citations. These trends can serve as indicators of the academic community's response to the published work and its perceived significance within the respective years.

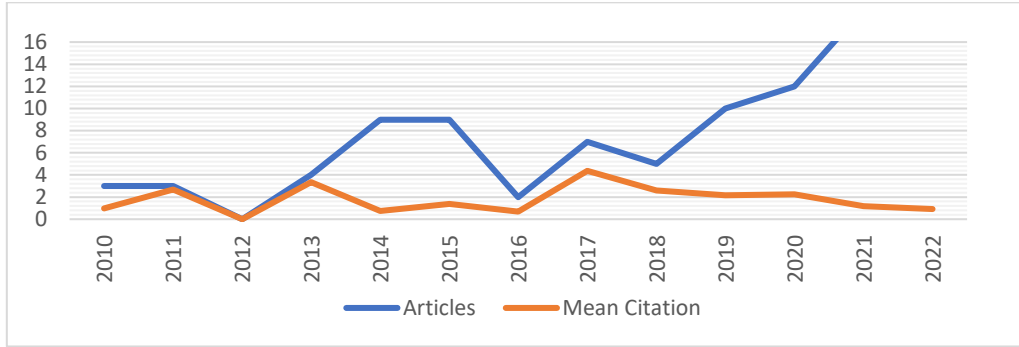


Figure 2: Publication by Year

Figure 3 provides an overview of the distribution of articles among various academic journals in the road safety fields, offering insights into the concentration of research contributions. The majority of the articles are found in "Accident Analysis and Prevention," which has 16 articles, followed closely by "Periodic Polytechnic Transportation Engineering" with 13 articles, and "IATSS Research" with 12 articles. Several other journals also contributed to the dataset, albeit with a smaller number of articles. "Journal Of Road Safety" and "Baltic Journal of Road and Bridge Engineering" each had 5 and 4 articles, respectively. Additionally, "Safety," "Transportation Research Part F: Traffic Psychology and Behaviour," And "CogEngineering" each published 4, 4, and 3 articles, respectively. Finally, "Transport Problems" also had 3 articles.

3.3 Top Ten Publishers on Road Safety

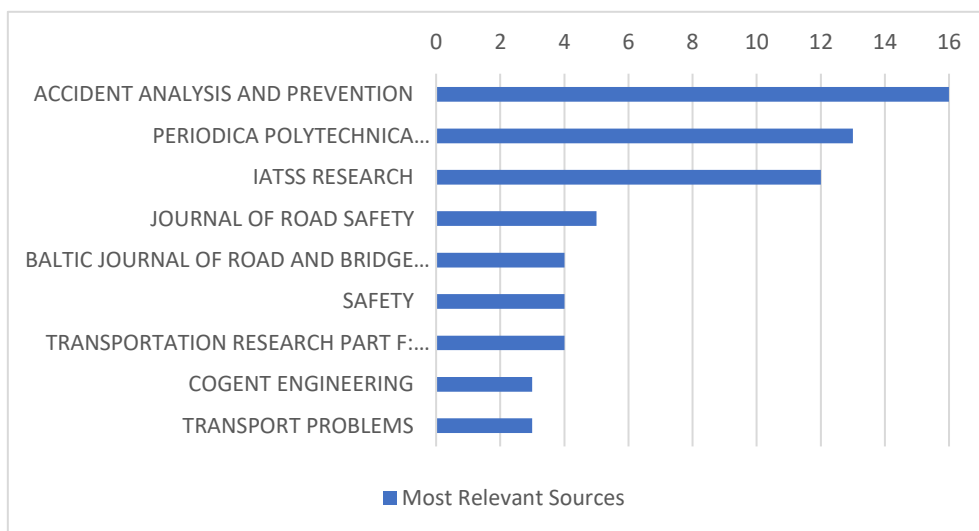


Figure 3: Top Ten Publishers on Road Safety

3.4 Most Trusted Authors

Table 2 provided data presents a list of authors along with the number of articles each author has contributed, and an additional metric called "Articles Fractionalized," which indicates the fraction of articles attributed to each author. Alonso F. and Useche SA are the most prolific authors, with each of them having written five articles, accounting for 1.42 of the total articles. De Oña J, McIlroy RC, Montoro L, and Yannis G have each contributed to three articles, with fractionalized values ranging from 0.81 to 0.92. Several authors, including Amara K, Borucka A, Esteban C, Faus M, Garach L, Kiec M, López G, Moretti L, Oulha R, Nakamura H, Parkin J, Patil LN, Sipos T, and Stanton NA, have each authored two articles, with fractionalized values ranging from 0.31 to 1.50. Notably, Pellegrino O has a fractionalized value of 1.50, indicating a higher contribution compared to the other authors. The data suggests a diverse group of researchers who have contributed to the field, with varying degrees of article output and fractionalized representation. These authors play a significant role in generating knowledge and advancing research in the respective domain.

Table 2: Most Relevant Authors Published Papers more than two

Authors	Articles	Articles Fractionalized
Alonso F	5	1.42
Useche SA	5	1.42
De Oña J	3	0.92
Mcilroy RC	3	0.81
Montoro L	3	0.83
Yannis G	3	0.83
Amara K	2	0.50
Borucka A	2	0.83
Esteban C	2	0.50
Faus M	2	0.58
Garach L	2	0.58
Khairnar HP	2	1.00
Kiec M	2	0.50
López G	2	0.58
Moretti L	2	0.58

Nakamura H	2	0.42
Oulha R	2	0.50
Parkin J	2	0.31
Patil LN	2	1.00
Pellegrino O	2	1.50
Sipos T	2	1.00
Stanton NA	2	0.48

Source: Author's elaboration

3.5 Source Growth Rate

Figure 3 presents the distribution of articles among various journals in the transportation and road safety fields over the years 2010 to 2022. "Accident Analysis and Prevention" consistently published a significant number of articles, increasing from 1 in 2011 to a peak of 16 in 2022. "Periodica Polytechnica Transportation Engineering" maintained a consistent presence, ranging from 7 to 13 articles per year. "IATSS Research" published a varying number of articles, reaching a peak of 12 in 2022. "Journal of Road Safety" and "Baltic Journal of Road and Bridge Engineering" had a smaller number of articles, with "Journal of Road Safety" gradually increasing to 5 articles by 2022. "Safety" and "Transportation Research Part F: Traffic Psychology and Behaviour" remained relatively stable, each publishing a maximum of 4 articles in 2021.

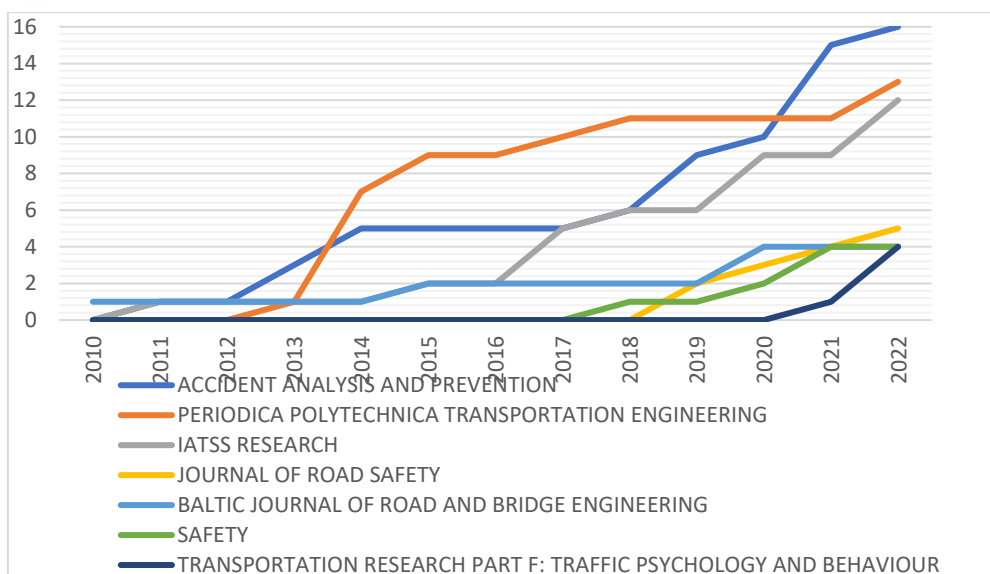


Figure 3: Source Growth

3.6 Most Contributing Institution

Table 3 represents the number of articles associated with different affiliations. It provides a snapshot of the research output or contribution of various universities, research institutes, and centers in terms of published articles. The affiliations listed include prominent institutions from different countries, such as Belgium, the United Kingdom, the Netherlands, Australia, Poland, and Italy. The number of articles ranges from 10 for Hasselt University, followed by 9 for the University of Southampton, and 7 for Delft University of Technology. Several institutions, including the University of Birmingham, Curtin University, Queensland University of Technology, and various research institutes, have contributed 5 articles each. Additionally, there are several affiliations with 4 articles each, showcasing a significant level of research activity.

Table 3: Most Relevant Affiliation

Affiliation	Articles
Hasselt University	10
University of Southampton	9
Delft University of Technology	7
University of Birmingham	6
Curtin University	5
Queensland University of Technology	5
Transportation Research Institute (Imob) - Hasselt University	5
Universidad Autónoma De Baja California	5
Vilnius Gediminas Technical University	5
Łukasiewicz Research Network - Tele And Radio Research Institute	5
Centre for Human Factors and Sociotechnical Systems	4
Motor Transport Institute	4
Sapienza University Of Rome	4
University of Calabria	4
Vias Institute	4

Source: *Author's elaboration*

3.7 Most Contributing Countries

Figure 4 provides an overview of the research output of different countries based on these metrics: the number of Self-Citations (SCP), the number of Multiple Country Publications (MCP), and the Frequency (Freq) of occurrence. The "United Kingdom" has the highest number of Self-Citations with 6 occurrences and also the highest number of Multiple Country Publications with 4 occurrences, making it the most frequent contributor overall (Freq = 0.1). "Belgium" has 1 Self-Citation and 5 Multiple Country Publications (Freq = 0.06), sharing the second position with "Hungary," which has 6 Self-Citations but no Multiple Country Publications (Freq = 0.06). "Australia" and "Poland" both have 3 Self-Citations and 2 and 1 Multiple Country Publications, respectively, resulting in a Frequency of 0.05 and 0.04. Several other countries have lower contribution frequencies, with some having only Self-Citations and no Multiple Country Publications, impacting their overall Frequency score.

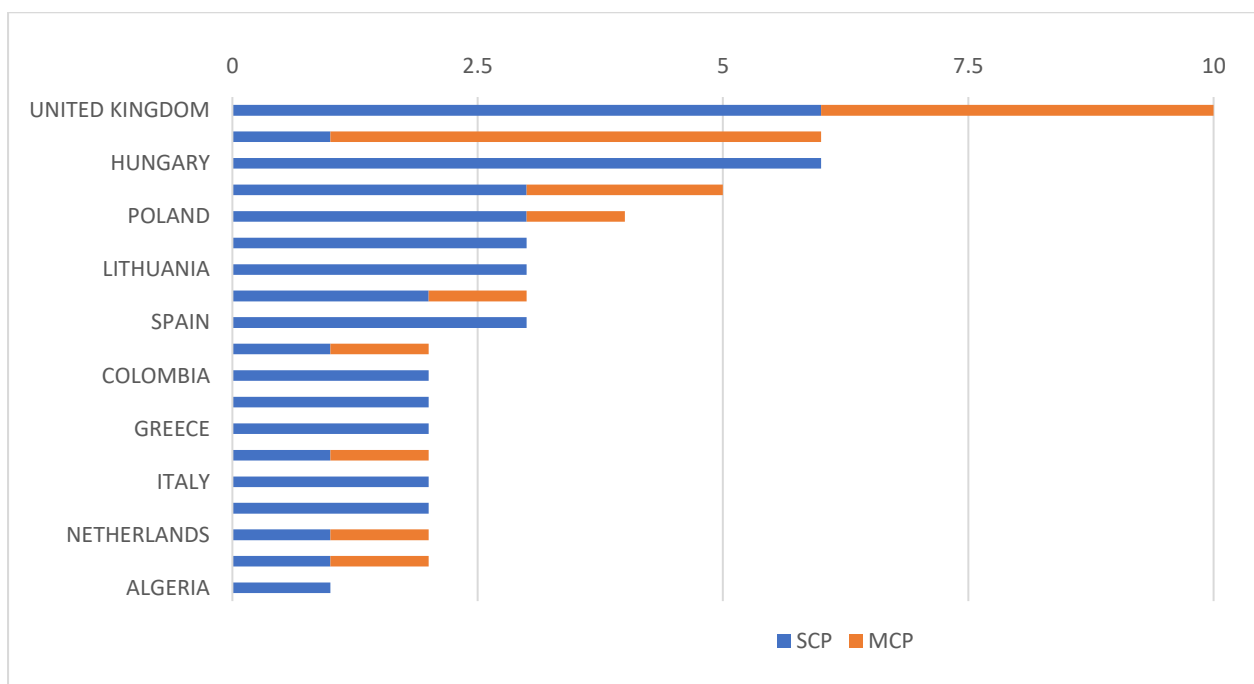


Figure 4: Corresponding Authors' Country

3.8 Most Cited Countries

According to Figure 5, Spain has received the highest number of citations with a total of 113. The United Kingdom closely follows with 109 citations, while Belgium ranks third with 104. Canada and Italy have received 78 and 45 citations respectively, indicating their contribution to the scholarly landscape. Hungary and Poland have received 42 and 40 citations respectively, while the United States and Australia have both received 40 citations. Portugal, Serbia, Latvia,

and Lithuania have also received a notable number of citations, ranging from 32 to 13. Japan, France, and Greece have received 12 and 11 citations respectively, demonstrating their presence in academic discourse. Finally, India, Iran, and Malaysia have each received 10 citations, reflecting their contributions to research in various fields. These numbers suggest that these countries' scientific output has been recognized and cited in academic literature, highlighting their contributions to global knowledge and research efforts.

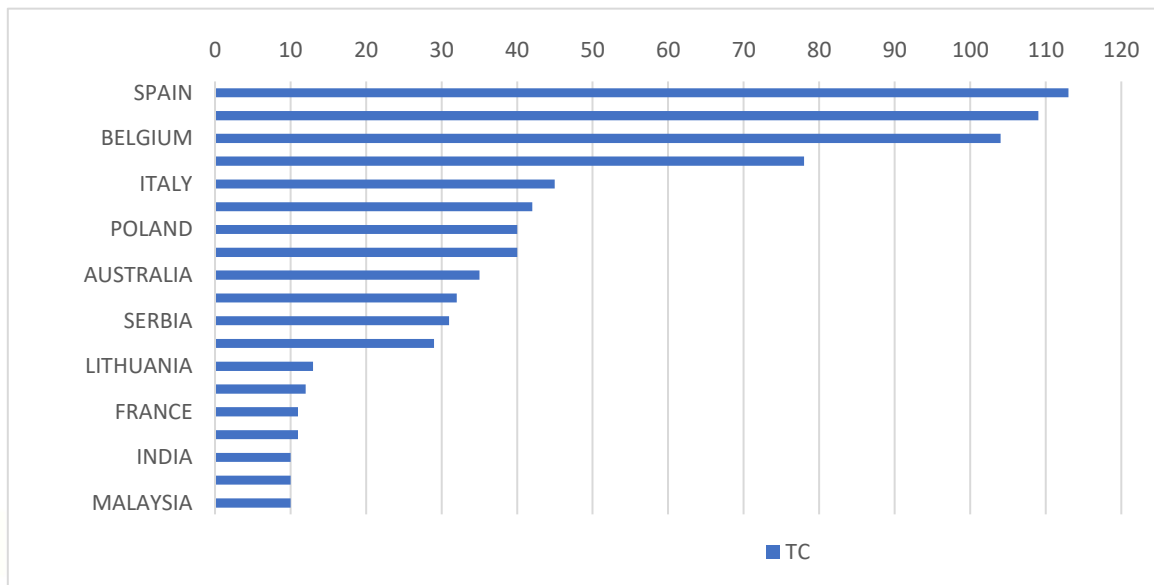


Figure 5: Most Cited Countries

Author's Keywords

Table 4 displays the frequency of specific words within a given context. The term "road safety" appears 63 times, indicating a significant focus on ensuring safety on roadways. Similarly, "accident prevention" is mentioned 62 times, highlighting the importance of proactive measures to reduce accidents. "Motor transportation" is referenced 56 times, emphasizing the relevance of transportation modes involving motor vehicles. The occurrence of "roads and streets" 51 times suggests a specific emphasis on infrastructure elements. The word "safety" is mentioned 30 times, indicating a broader focus on overall safety considerations. "Highway planning" is discussed 20 times, suggesting a particular interest in the planning and design of highways. The terms "human" and "humans" appear 18 and 17 times respectively, signifying the focus on human factors and human-centered approaches in the context of road safety. "Transportation" is mentioned 17 times, reflecting the broader transportation context within which road safety is considered. "Accidents" and "traffic accidents" each occur 15 times,

emphasizing the occurrence and impact of accidents in traffic settings. "Highway accidents" are specifically mentioned 12 times, indicating a more specific subset of accidents. "Risk assessment" is discussed 12 times, highlighting the importance of evaluating potential risks associated with road safety. Overall, the data reveals the frequency of various terms associated with road safety, offering insights into the topics and concerns prevalent within this domain.

Table 4: Author's Keywords in Articles

Words	Occurrences
Road safety	63
Accident prevention	62
Motor transportation	56
Roads and streets	51
Safety	30
Highway planning	20
Human	18
Humans	17
Transportation	17
Accidents traffic	15
Traffic accident	15
Highway accidents	12
Risk assessment	12
Accidents	11

Source: Author's elaboration

3.9 Global Collaboration

Table 5 consists of a list of research papers along with their total citations, citations per year, and normalized total citations. The paper "WEGMAN F, 2017, IATSS RES" has received 99 total citations, with an average of 14.14 citations per year. Its normalized total citations, which take into account the citation rates within the field, are 3.24. Similarly, "DE OÑA J, 2013, ACCID ANAL PREV" has garnered 92 citations, with an average of 8.36 citations per year and a normalized total citation score of 2.50. The paper "HOEKSTRA T, 2011, IATSS RES" has received 68 citations in total, with an average of 5.23 citations per year and a normalized

total citation score of 1.96. The remaining papers in the list also have their respective citation statistics. These numbers provide insights into the impact and influence of these research papers within their respective fields.

Table 5: Global Citation

Paper	Total Citations	TC per Year	Normalized TC
WEGMAN F, 2017, IATSS RES	99	14.14	3.24
DE OÑA J, 2013, ACCID ANAL PREV	92	8.36	2.50
HOEKSTRA T, 2011, IATSS RES	68	5.23	1.96
VINGILIS E, 2020, ACCID ANAL PREV	62	15.50	6.89
MCILROY RC, 2019, ACCID ANAL PREV	44	8.80	4.07
SHEN Y, 2015, TRANSP RES PART C EMERG TECHNOL	35	3.89	2.84
ALIREZAEI M, 2017, SYSTEMS	33	4.71	1.08
SHEN Y, 2013, ACCID ANAL PREV	32	2.91	0.87
TEŠIĆ M, 2018, ACCID ANAL PREV	31	5.17	1.99
SALMON PM, 2019, APPL ERGON	30	6.00	2.78

Source: Author's elaboration

3.10 Cloud Map

Figure 5 showcases a word cloud that visually represents key aspects related to road safety, accident prevention, traffic accidents, roads and streets, and motor transportation.



Figure 5: Cloud Map

The word cloud is designed to highlight the significance of these factors within the context of road safety. The size and placement of each word within the cloud indicate its prominence or frequency of occurrence in the associated literature or discussions surrounding road safety. By presenting these key aspects in a visually engaging manner, the word cloud offers a quick and intuitive understanding of the central themes and focal points in the field of road safety.

Road safety is a pressing concern for developing countries, as the country's road safety situation is considerably worse compared to developed nations (Patil, 2021). The identification of significant factors for assessing road risk levels is a crucial aspect of road safety research, especially for decision-making processes (Shah et al., 2017). The European Union has set the reduction of road accidents as a key objective. Intelligent Transport Systems (ITS) play a vital role in achieving this goal by providing drivers with warnings and support, thereby enhancing road safety (Pauer, 2017). Crash prediction models play a significant role in analyzing highway safety and can be utilized for various purposes, including predicting the number of road crashes and establishing correlations with different factors. Therefore, it is essential to explore alternative functional forms to accurately capture the dynamics of these crashes.

Further research is necessary to develop models that effectively represent the nuanced relationship between traffic flow and run-off-the-road crashes, enabling more precise road safety analysis and interventions (Roqueb & Cardoso, 2014). Coronell et al., 2021 emphasized the integration of speed controls within a comprehensive road safety management system. The analysis of current road safety strategies in Australasia reveals deficiencies in specific aspects of their content, resulting in inadequate addressing of future challenges. To overcome these limitations, the paper proposes enhancements aimed at bolstering the strategies' comprehensiveness and resilience (Hughes et al., 2019). To address the road safety challenges, it is crucial to implement comprehensive measures that encompass enforcement, education, and awareness campaigns, as well as infrastructure improvements (McIlroy et al., 2022). Strengthening enforcement by imposing stricter penalties and increasing police presence can discourage risky behaviors. Education and awareness programs targeted at different road user groups can equip individuals with the knowledge and skills to make safe choices. Investing in infrastructure improvements, such as traffic calming measures and improved signage, can create safer road environments. Achieving significant improvements in road safety requires collaboration and commitment from various stakeholders (Yannis et al., 2014).

Despite global, regional, and national efforts to reduce road crashes, the number of fatalities resulting from these crashes is increasing globally, including in Asia. Currently, the Asia-

Pacific region accounts for 60% of global road fatalities. There are significant variations in the number of road fatalities among regions, subregions, and countries within Asia. South and South-West Asia subregion has the highest fatality rate, with 20.3 fatalities per 100,000 population, followed by South-East Asia with a fatality rate of 17.8 per 100,000 population (Regmi, 2021). As technology continues to evolve, the integration of autonomous vehicles has the potential to revolutionize road safety and significantly reduce the number of accidents and injuries on our roadways (Pędzierska et al., 2020). When planning actions and measures to improve road safety, it is crucial for the police and local authorities to consider specific accident circumstances, as well as the historical, current, and predicted trends of accidents. Often, combinations of accident circumstances that are not captured in existing police statistics are overlooked, even though they may be relevant, especially if their frequency is increasing (Meißner & Rieck 2022).

4. Conclusion

The bibliometric study on road traffic safety research using Scopus as the main data source provides valuable insights into the field. It reveals that *most authors and collaborations come from developed countries, with a recent increase in research focusing on road safety in developing countries*. This emphasizes the need for more studies in these areas. The study's findings are beneficial for new academics, helping them understand international trends and contributors to road safety research. It highlights *driver error as the primary cause of accidents and underscores the importance of promoting responsible driving through education and awareness campaigns*. The study also emphasizes the *urgent attention required for road safety, particularly in developing countries* facing increasing accident rates. Factors such as poor transportation infrastructure, unfavorable traffic conditions, and reckless driving significantly contribute to accidents. Recognizing these challenges and conducting further research can pave the way for targeted interventions to improve road safety globally.

Countries worldwide have taken various measures and implemented strategies to enhance road safety. These efforts include improving national road safety management, installing road safety barriers, and enforcing stricter punishment policies. Additionally, specific challenges related to road safety in different regions have been recognized and addressed, such as rural road safety and mountain road safety. Cultural factors that influence road user behavior have also been considered in interventions. Research has examined the effectiveness of measures such as *mandatory safety device usage, road infrastructure enhancements, and interventions*

targeting specific road user groups. The integration of ITS and vehicles shows promise in improving road safety outcomes. It is important to note that road traffic safety challenges vary across regions, with developing countries facing additional issues due to **inadequate and unsuitable road infrastructure, leading to higher rates of casualties and injuries.** Understanding these regional disparities is crucial in designing tailored interventions to address the specific challenges faced by different countries.

To effectively address road safety, a comprehensive approach is needed, which *involves improving infrastructure, enforcing regulations, raising awareness through education campaigns, and leveraging technological advancements.* Stakeholders such as policymakers, researchers, and the public must collaborate and work together towards this common goal. Ongoing research, data analysis, and evaluation of interventions are vital in developing evidence-based strategies and implementing effective measures. By tackling the root causes of accidents and implementing targeted solutions, we can make significant progress in reducing the frequency of road accidents and minimizing their impact. This requires a collective effort to create a safe and secure road environment for all users. By identifying the key factors contributing to accidents and assessing the effectiveness of safety strategies, policymakers can make informed decisions and implement measures that effectively prevent road traffic incidents and promote road safety globally.

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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