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Road Safety Intervention: Publication Trends and Future Research Directions

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ABSTRACT

Road safety is vital and essential to the community. It is, therefore, crucial to understand the evolving nature of this scientific domain. This study discusses the bibliometric review of scholarly research performed in road safety intervention. The study uses the Scopus database and various bibliometric parameters such as publication trends, citations and authors' keywords. Graphical visualisation of bibliometric indicators using VOSviewer and SciMAT were also presented. This study also scrutinised the content analysis of future research directions through a scoping review. Results show that the number of publications on road safety intervention have fluctuated, with the highest number of publications were 21 in 2019. The field of research on road safety intervention was diverse, with the top three on the list are medicine, social science and engineering. The authors' keywords of "road safety" is grouped in a similar cluster to "speeding", "injury prevention" and "road traffic injuries"; this information provided a substantial impact on road safety interventions in future research directions. The United Kingdom became the top leading country to publish more research on road safety interventions over 26 years. The scoping review depicted that human factors were shown to have a crucial role in improving road safety interventions. The essential motor theme during the first period (2001 - 2010) was "attitude". Other motor themes, such as "pedestrian", "traffic-accident", "human" and "road safety interventions", became the most significant number of publications in the second period (2011 - 2020). These five themes may be beneficial as a benchmark for researchers focusing on the art of road safety intervention. The bibliometric and scoping review in this study could provide an in-depth analysis of road safety interventions that attract the researchers' interest in this area.

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1. Introduction

Road safety is a critical issue for the world and bears significant weight from a personal safety perspective and an economic and public health standpoint. The World Health Organization (2020) estimates about 1.35 million people die each year from road crashes, with 93% of the world's road deaths occurring in low-income countries. Road safety in low-income countries remain grave and persisting due to low safety requirements, inadequate vehicle safety and maintenance, and insufficient implementation of policies and safe transport systems (Heydari et al., 2019). Therefore, at the 3rd Global Ministerial Conference on Road Safety, participating countries committed to reduce road crashes by half in 2030 by making high-income countries a benchmark. According to Bhalla and Gleason (2020), knowing what has operated in high-income countries is relevant and remarkably well to minimise road crashes.

There are several interventions in higher-income countries to manage road crashes, but some factors have more significant effect than others, for example, improvements in vehicle design (Farmer &

Lund, 2015; Teoh & Lund, 2011). However, the high cost of road crashes in low-income countries are very much crippling due to the inclusion of human and social misery, which cannot be quantified in monetary terms alone (Tabunar, 2020). Road safety interventions could significantly reduce the number of road crashes. Despite several road safety interventions being introduced, many drivers are unaware that human error is the leading cause of road crashes (Grace et al., 2020).

Statistical assessment of road safety interventions can be executed using various approaches, typically requiring different causal identification assumptions (Li et al., 2019). In recent years, without improving road safety interventions, more than 50% of the road crashes victims were predominantly intricate pedestrians, bikers and motorcyclists among young adults (Mohan et al., 2020).

In addition, young drivers involved in road crashes have also been a concern in most countries. Hence, the prevention of road crashes among young drivers has focused on strengthening research related to the establishment of road safety policies (Twisk & Stacey, 2007). This is because the level of knowledge among young drivers is significantly

associated with their age and young drivers are most likely to be involved in road crashes (Yunesian & Moradi, 2005). Other factors such as inexperience, lack of skill and risk-taking behaviour have also been allied with young drivers' road crashes (Rolison et al., 2018).

Jafarpour and Rahimi-Movaghar (2014) identified three categories that trigger road crashes, which are (i) environmental factors (weather, traffic conditions, lighting and visibility of objects), (ii) vehicle factors (security devices and safety maintenance) and (iii) human factors (the mental and physical ability of the driver, driving style, violations and errors). Besides, Mohan et al. (2020) outlined seven elements that affect road safety interventions. The seven elements are human factors, vehicle factors, protective devices, road designs, infrastructure and traffic control, post-crash pre-hospital care and legal aspects, and institutional framework factors.

Similar to the rest of the world, Malaysia's road safety interventions have changed from the "5E" model (Engineering, Enforcement, Education, Environment and Evaluation) to a focus on the five based on the Decade on Action 2011 - 2020 (Ishak & Rahim, 2020). The Decade of Action for Road Safety 2011 - 2020 seeks to save millions of lives by building road safety management capacity, improving the safety of road infrastructure, further developing the safety of vehicles, enhancing the behaviour of road users, and improving post-crash response (Mohan et al., 2020).

Comprehensive, up-to-date analysis and the understanding of road safety interventions are crucial for identifying growth in publications. This process can be achieved by employing a bibliometric review. This is because the bibliometric review provides a macroscopic summary of scientific literature and it is critical to make accurate decisions, and has been widely used for evaluating articles, publishing countries and institution performance (De Oliveira et al., 2019; Van Nunen et al., 2018). Bibliometrics is also a valuable research tool and allows scholars to comprehensively consider relevant information (Zhou et al., 2015).

The bibliometric review has been conducted on a wide variety of road safety topics, including motorcycle accident (Ospina-Mateus et al., 2019), road traffic injuries (Sharma et al., 2018), and simulated driving research (Guo et al., 2019). A bibliometric review is seen as an acceptable method to assess and apply research skills on road safety interventions.

Consequently, this study seeks information on the current state of road safety intervention with the following questions identifying the scope of the study:

RQ1: What are the current publication trends in road safety intervention regarding years, sources, authors, countries, research areas and authors' keywords?

RQ2: What are the areas of concern for future research directions?

2. Method

This study is performed using a combination of bibliometric analysis and a scoping review. Bibliometrics, or the measurement of units of publications and citations, are widely used to provide a convenient and non-reactive tool for research collaboration and assessment of scientific publications (Abdullah et al., 2020; Broadus, 1987; Subramanyam, 1983). Bibliometric data is drawn from multiple contacts, establishing objective and valuable information for researchers interested in the field. A scoping review is an ideal tool to assess the overall scope of literature on a given subject and provide a clear indication of the quantity of literature and studies available and an overview of research emphasis (Munn et al., 2018).

2.1. Data Collection

A sample of publication was collected from the Scopus database on December 25, 2020, to compile a detailed road safety intervention. The Scopus database is used due to reliable and high-quality research sources and allows searching for individual researchers and their publications (Montoya et al., 2018). The initial search string for "road safety intervention" was used in this study based on TITLE-ABS-

KEY. The total number of publications returned from the given query was 143. Out of the 143 publications, 127 articles were from various journal sources and less than ten other publications such as conference papers, books and book series. A total of 140 publications were written in English, four in French and one in German and Spanish.

2.2. Software Application

Data in the format of Comma Separated Values (CSV) and Research Information Systems (RIS) including years, authors, the field of study, article sources, countries and languages were exported to Microsoft Excel, Publish or Perish (PoP), VOSviewer and SciMAT for further analysis. In this study, the bibliometric review was conducted using the VOSviewer software developed by Van Eck and Waltman (2010). According to Van Eck and Waltman (2010, 2019), VOSviewer applied visual elements based on mapping techniques, which converts data related to Comma Separated Values (CSV) format into diagrams or clusters. Also, mapping techniques help analyse authors' information, locations, institutions, citations, co-citations, and other refining aspects. In order to analyse the thematic evolution of road safety intervention research, this study applied a bibliometric mapping technique using SciMAT developed by Cobo et al. (2011).

2.3. Content Analysis

The content analysis is conducted to identify the area of concern for future directions on road safety intervention via scoping review. Scoping reviews are a relatively recent evidence synthesis method and analyse the areas of concern in many studies (Munn et al., 2018). Following the procedure suggested by Arksey and O'Malley (2005) and Nyanchoka et al. (2019), the selection criteria were based on 143 publications related to road safety intervention in the Scopus database. The scoping review offers further analysis of included publications with open access articles written in English and published in 2019 and 2020. The articles published in 2019 and 2020 were scrutinised on the areas of concern to determine future research directions. Limiting this study to 2019 and 2020 publications as future work provides the latest research directions and suggestions that need to be concentrated by other researchers for their academic outcomes. Ten articles have drawn up the inclusion criteria. After a thorough reading of the articles, only one article was excluded from this review due to irrelevant information. It provided nine articles available for further consideration of future directions.

2.4. Explore Thematic Evolution

Thematic analysis in this study is scrutinised using SciMAT software to discover thematic and conceptual development of road safety intervention research. The focus of this study was to examine the evolution of road safety intervention from 2001 - 2020. The study was divided into two-time spans; the first period (2001 - 2010) and the second period (2011 - 2020). The evolution description derives from four different themes based on research conducted by Cobo et al. (2011), as shown in Table 1.

Thematic networks in Figure 1 offer the evolution of research themes, whereas, in Figure 2, thematic development represented the connection of different themes through the periods observed. Figure 1 shows that the strategic diagram uses a horizontal axis to measure centrality and a vertical axis to display network density. According to Cobo et al. (2011), centrality refers to the metric that measures the relationship between networks, which means that higher centrality correlates with other network themes and plays a critical role in developing study fields. In contrast, the measurement of intra-network relationships with an evident and robust internal relationship to a subject is called a density (Moral-Munoz et al., 2018).

Table 1: The simplified of four themes in the strategic diagram

Themes	Position	Explanation
Motor themes	Upper-right quadrant	<ul style="list-style-type: none"> Well established and essential for the organisation of a field of research Centrality and density is very high These themes are related to each other in a similarly broad scope
Highly developed and isolated themes	Upper-left quadrant	<ul style="list-style-type: none"> Well developed internal ties but inconsequential external ties Only marginal importance for the field These themes emphasise the necessary specialist and peripheral role
Emerging or declining themes	Lower-left quadrant	<ul style="list-style-type: none"> Weakly developed and marginal Being low density and low centrality These themes representing either emerging or disappearing
Basic and transversal themes	Lower-right quadrant	<ul style="list-style-type: none"> Essential for a research field but are not developed These themes depict transversal, general and basic

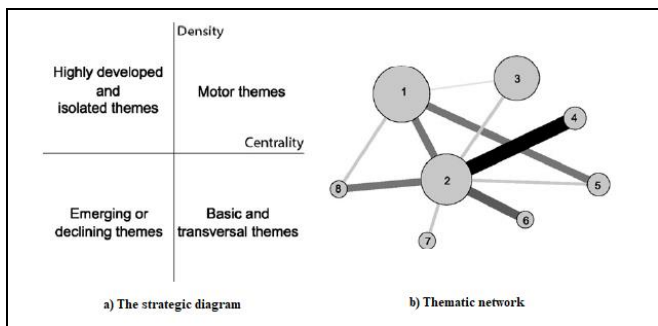


Figure 1: The strategic diagram and thematic network

A thematic network complemented the strategic diagram by showing the relationships between themes. The nodes are sized by frequency or the number of documents, and the thickness of the link is proportional to the equivalence index of documents (Cobo et al., 2019). As shown in Figure 2, the evolution map indicated the thematic field evolution is linked over the study period. The nodes' size is reflected in the number of documents within a given theme, and links between nodes are proportional to the similarity in a topic. The themes shared identical labels are allied by a solid line and themes that share similar keywords but have separate tags attached by a dotted line (Cobo et al., 2011; Moral-Munoz et al., 2018). Thru overlapping map, the data's stability over time can easily be determined by the researchers (Cobo et al., 2011). Cobo et al. (2011) specified that the horizontal line provides a measure of equivalency. It means that the forward-pointing arrow shows the number of words missing during the first period, and the inward-pointing arrow indicates the number of recent entries that would be found (Moral-Munoz et al., 2018).

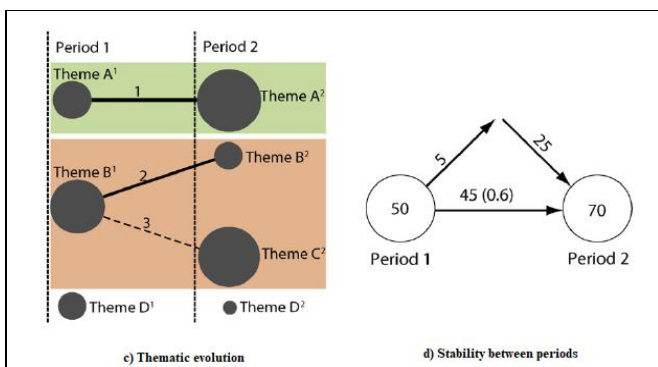


Figure 2: The evolution map and stability between periods

3. Results and Discussion

3.1. Publication Growth Trend

The number of publications is an essential element for developing any research field. Figure 3 indicates the number of road safety intervention publications from 1994 to 2020. The number of publications was stagnant between 1994 and 2007, with below five papers per year and slackened off during the phase. The reason was that the advancement of road safety intervention was still at an earlier stage, and most scholars were new to road safety intervention. The number of publications fluctuated for over 26 years. However, the number of publications rose steadily to more than five post-2012 publications. In 2019, 21 road safety intervention publications were successfully published and recorded as the prime number in the last 26 years of publications.

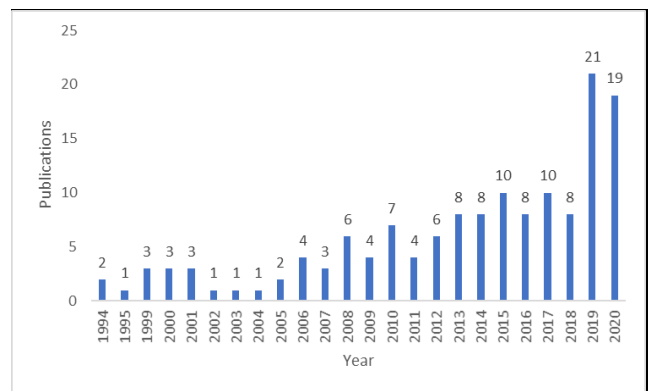


Figure 3: Research trend of 26 years on road safety intervention

3.2. The Publication Sources

Table 2 reflects information on the published sources of road safety interventions. It is ranked based on the number of publications. The Accident Analysis and Prevention is the most influential source in this field, with 31 publications. The second ranked goes to the Transportation Research Part F: Traffic Psychology and Behaviour with 14 publications. Injury Prevention is established in the third place. Based on this finding, it is proposed that these sources have contributed helpful information that will allow prospective researchers to draw on them and will be helpful in their future road safety intervention. It also conveys a message that the sources make it easier for the readers to locate and exploit the information they need (Abdullah et al., 2021).

Table 2: The publication sources

Publication Sources	Publications
Accident Analysis and Prevention	31
Transportation Research Part F: Traffic Psychology and Behaviour	14
Injury Prevention	5
Injury	4
Traffic Injury Prevention	4
Transportation Research Record	4
Journal of Safety Research	3
Safety Science	3
Advances in Intelligent Systems and Computing	2
BMC Public Health	2

Continued on next page.

Table 2 – Continued from previous page.

Publication Sources	Publications
Case Studies on Transport Policy	2
Ergonomics	2
International Journal of Injury Control and Safety Promotion	2
Journal of Public Economics	2
Plos One	2
Proceedings of The International Conference on Industrial Engineering and Operations Management	2
Revue Europeenne De Psychologie Appliquee	2
2013 Tac Conference and Exhibition Transportation Better Faster Safer Tac Atc 2013	1
ANZ Journal of Surgery	1
Advances in Human Aspects of Road and Rail Transportation	1
Advances in Transportation Studies	1
African Journal of Emergency Medicine	1
Analytic Methods in Accident Research	1
Annales Pharmaceutiques Francaises	1
Applied Ergonomics	1
Arpn Journal of Engineering and Applied Sciences	1
Asia Pacific Journal of Public Health	1
Australian Journal of Public Health	1
BMC Emergency Medicine	1
BMJ Global Health	1
BMJ Paediatrics Open	1
British Journal of Educational Psychology	1
Bulletin of The World Health Organization	1
Campbell Systematic Reviews	1
Canadian Journal of Civil Engineering	1
Chinese Journal of Traumatology English Edition	1
East African Medical Journal	1
Ecological Psychology	1
Energy Institute 19th World Petroleum Congress 2008 A World in Transition Delivering Energy for Sustainable Growth	1
Environmental Economics and Policy Studies	1
Fast and The Furious Drivers Speed Cameras and Control in A Risk Society	1
Frontiers in Psychology	1
Gaceta Sanitaria	1
Global Public Health	1
Health Disparities and Inequalities in The United States Selected Reports	1
IEEE Conference on Intelligent Transportation Systems Proceedings ITSC	1
Injury Control and Safety Promotion	1
International Journal of Drug Policy	1
Irish Journal of Psychology	1

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Table 2 – Continued from previous column.

Publication Sources	Publications
Journal of Applied Psychology	1
Journal of Experimental Psychology Applied	1
Journal of Public Health Germany	1
Journal of Social Sciences Research	1
Journal of The International Neuropsychological Society	1
Journal of Transport and Health	1
Journal of Transportation Safety and Security	1
Journal of Trauma and Acute Care Surgery	1
Journal of Urban Health	1
Lancet Global Health	1
Lancet Public Health	1
Methods of Information in Medicine	1
Morbidity and Mortality Weekly Report Surveillance Summaries Washington D C 2002	1
National Medical Journal of India	1
Proceedings 2010 IEEE 17th International Conference on Industrial Engineering and Engineering Management Ie And Em2010	1
Risk Analysis	1
South African Medical Journal	1
Spanish Journal of Psychology	1
Technology and Culture	1
Traffic Engineering and Control	1
Traffic Psychology an International Perspective	1
Transport Reviews	1
Transportation Research Interdisciplinary Perspectives	1
Transportation Research Procedia	1
Unfallchirurg	1

3.3. Prominent Authors

Table 3 indicates six authors who have published at least four publications on road safety intervention over the last 26 years (1994 - 2020). The information was based on the number of articles, H-index, affiliation and country. Based on prominent authors, Hyder A. A. was ranked first with seven articles and an H-index of 41. Stanton N. A. was ranked second with five articles. Bhalla K., Elliott M. A., McIlroy R. C. and Watson B. were rank third with four articles.

Table 3: Prominent authors in road safety intervention

Authors	Publications	H-Index	Countries
Hyder A. A.	7	41	United States
Stanton N. A.	5	59	United Kingdom
Bhalla K.	4	18	United States
Elliott M. A.	4	14	United Kingdom
McIlroy R. C.	4	10	United Kingdom
Watson B.	4	33	Australia

Based on Table 3, the most prominent authors have resided in developed countries. It is suggested that developed countries aim to reduce traffic fatalities by 27% over the period 2000 to 2020 (Jadaan et al., 2018). Also, researchers from these countries are the principal investigators with grants, and their research could be primarily carried

out with co-researchers in other countries (Heydari et al., 2019). Moreover, in the United Kingdom, more grants have been allocated to public and professional associations, registered charities, and universities for practical measures, research and education on road safety (Gaines, 2013).

3.4. Active Countries

Researchers from nine countries have contributed publishing road safety intervention with at least five documents, as depicted in Figure 4. The top three on the list are the United Kingdom, with 38 publications, followed by Australia (26 publications) and the United States (23 publications). The results showed that developed countries had dominated the publication of road safety interventions for over 26 years. This phenomenon has occurred in these countries, which are affected continuously by increased travel, motorisation and population. Therefore, there have been more interventions in those countries to reduce road crashes (Bhalla & Gleason, 2020).

The map of the top-ranked countries is shown in Figure 5. The size of the node indicates the number of publications to be published. As shown in the map, the United Kingdom, China, the United States and Australia have been the world's leading countries in the field of road safety intervention. Lines were linking the countries indicated by the co-authorship. When the two countries linked each other on a single line, they collaborated on the article's publication. The line's thickness was a high level of cooperation between countries (Abdullah et al., 2021). The United Kingdom and Australia had the most scientific collaboration with other countries.

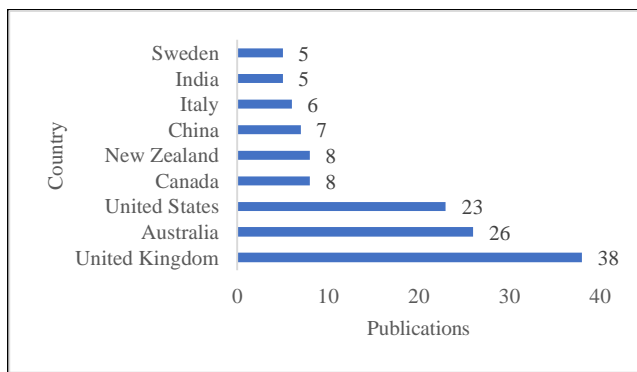


Figure 4: Active countries with five publications on road safety intervention

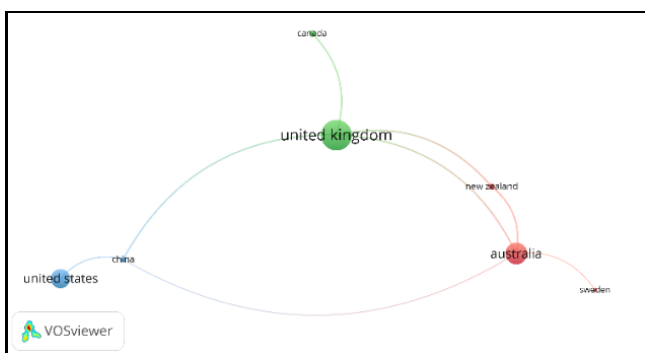


Figure 5: The co-authorship map of the top countries publishing road safety intervention

3.5. Research Areas

The review of research articles on a specific area is also essential. This method facilitates the recognition of the critical disciplines under which road safety intervention has been performed. Figure 6 provides four study areas with more than 20 publications on road safety intervention. "Medicine" is the most researched area, with 79 publications. It is suggested that road safety intervention concerns

public health, as it has significant consequences for medicine. Another field of study that stands out is "Social Sciences," with 76 publications, "Engineering" with 71 publications, and "Psychology" with 25 publications.

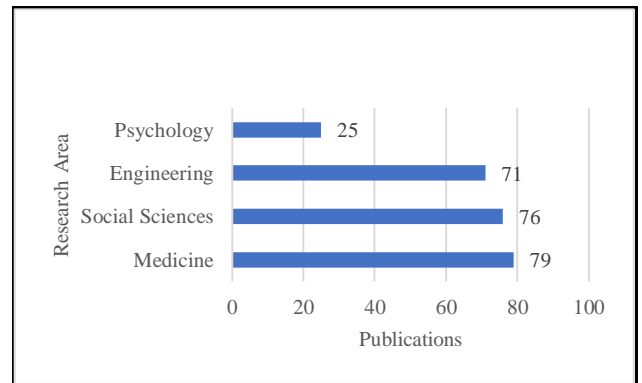


Figure 6: Four most research areas in road safety intervention

3.6. Authors' Keywords

Keywords aid to imitate research hotspots and help researchers to identify new frontier issues. In this analysis, VOSviewer had mapped the keywords of the authors. Figure 7 provided a network diagram of the author's keywords in which colour, node size, font size and thickness of the connecting lines illustrated the relationship with other keywords. There were two clusters to build a network with keywords of red and green nodes.

The closeness in a distance between keywords indicates the higher the relationship between keywords. The distance between the keywords of "road safety", "speeding", "injury prevention" and "road traffic injuries" is close and grouped in a similar cluster; provided a substantial impact. The co-occurrence map offered helpful information that road safety intervention is related to the "young drivers" and "risky driving". These two keywords are related to human factors. Driver's behaviour is responsible for most road crashes, such as drunk driving, over speeding, overtaking, sudden moves, making abrupt turns and stop sign violation (Tabunar, 2020).

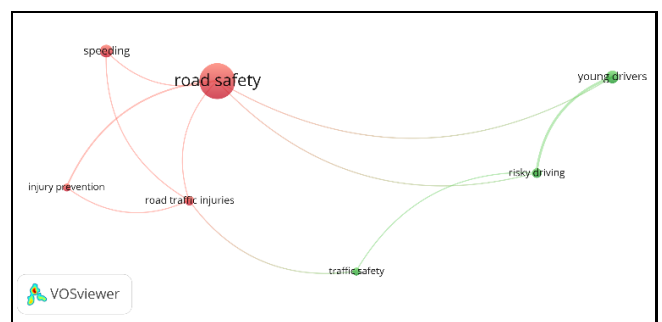


Figure 7: The co-occurrence map of the author's keywords

3.7. Scoping Review: Future Research Directions

Scoping reviews typically analyse what is not studied or reported and identify gaps in the study. There is no standard definition of the term research gap, and its meaning can vary depending on the research context. According to Robinson et al. (2011), the research gap is characterised as a subject or field for which the absence or lack of knowledge limits the ability to conclude a question. The scoping review results enabled the researchers to recognise several research gaps, including lack of previous road safety intervention studies.

Table 4 presents an overview of the 2019 and 2020 articles to determine future research directions. It is indicated that the types of studies on road safety intervention in 2019 and 2020 were based on

counterfactual analysis, review, observation, design and development research, and cross-sectional study.

The most types of studies that have been favour by the researchers are the review and the cross-sectional study. It is important to note that future research may focus on grounded theory, ethnography, narrative analysis, historical studies, case studies and phenomenology to explore relevant information for road safety intervention. This study found that road safety intervention centred primarily on vehicle factors, human factors and the institutional framework. Human factors were the most exciting research subject among researchers in 2019 and 2020.

The results were also closely related to the co-occurrence map of the author’s keywords showing “young drivers”, “risk driving”, “speeding”, and “injury prevention”, as the keywords derived from human factors. This information helps future researchers review authors’ keywords to understand the human factors linked to road safety more thoroughly. Besides, based on future research direction in the 2019 and 2020 articles, it is shown that crucial ideas centred on vehicle safety technologies, allocated resources, and improvement of the current road safety intervention.

However, most researchers propose improving road safety interventions for more reliable results to resolve the most critical road safety issues. These recommendations include developing a road safety campaign and compliance (Heydari et al., 2020), enhancing targeted action for the Sustainable Development Goals (Dandona et al., 2020), establishing a coherent structure for road safety (McIlroy et al., 2019), and examining personal characteristics such as gender and cultural context (Lucidi et al., 2019).

3.8. Thematic Evolution of Road Safety Intervention Research

The thematic evolution of road safety intervention research is examined using the SciMAT software tool. The evolution map shows that; how thematic field evolution is accompanying the study period. The nodes’ size is reflected in the number of documents within a given theme, and links between nodes are proportional to the similarity in a topic. It will be at least one out of all the theme keywords that the theme will contain.

The overlapping map allows the researcher to determine how stable the first and second period’s data was. The horizontal line is the number of words that are shared. The forward-directed arrow shows how many keywords would be missing during the first period. The inward arrow indicates the number of new keywords, on the other hand. Key outputs of the SciMAT are graphical depictions of the thematic structure across the researcher’s selected periods. A strategic diagram has grouped themes into four groups, as discussed in Table 1. The strategic maps in this review are presented in Figure 8 and Figure 9. In these diagrams, the nodes’ size is relative to the number of articles allied with each theme.

The first period (2001 – 2010), as shown in Figure 8, has been inadequate, and only a few major themes have emerged. The topics are “attitude” in the motor themes, “bus operator” in-between motor themes and highly developed, while “traffic-accident” was in between motor themes and basic and transversal themes. In this study, “young driver” was the emerging and declining themes, and “accident-risk” was in highly developed and isolated themes.

Throughout this period, attention was focused on the “attitude”. The reason is between 2001 and 2010, road safety intervention research has emerged and was compellingly necessary for road safety performance and change implementation to overcome road accidents. According to Şimşekoğlu et al. (2012), traffic risk perception was associated with attitudes and behaviours toward road safety, regardless of differences in traffic safety, traffic culture, or development level. It is indicated that a study on attitude toward road safety is deemed necessary from 2001 to 2010.



Figure 8: Strategic diagram for the first period (2005 - 2012)

The keyword “accidents” was identified in the motor themes during the second analysis period (2011 - 2020), as shown in Figure 9. “pedestrian”, “aged”, and “traffic-accident” were found to be in highly and isolated themes. The topic of “cross-sectional-studies” is one of the basic and transversal themes which is related to performance measures. This is because assessing road user behaviour, according to Bärghman (2016), is conceptualised differently.

Thus, cross-sectional studies are considered an essential research tool for determining the driver’s behaviour. The cross-sectional studies used the questionnaire to obtain the related data and analyse critical factors related to risk prevention and road safety behaviour. This is because the human mind influences behaviour through psychology, and the most unsafe behaviour is performed without proper thinking, making it vulnerable to accidents (Ma et al., 2021). Therefore, a questionnaire set through a quantitative study is needed to examine these factors and the relationship with road user behaviour.

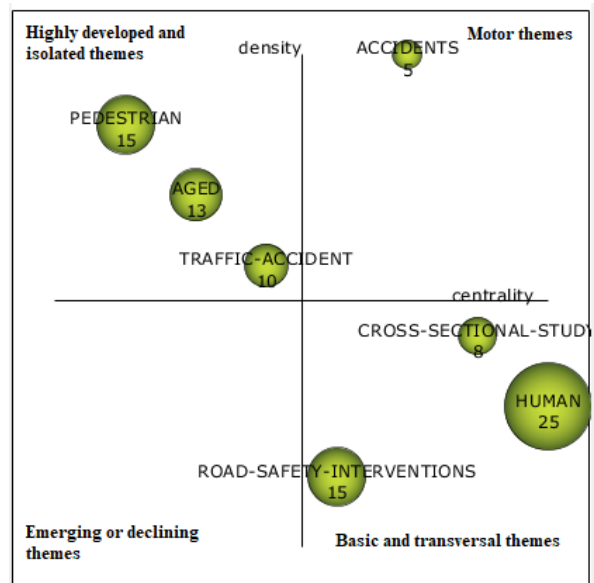


Figure 9: Strategic diagram for the second period (2011 - 2020)

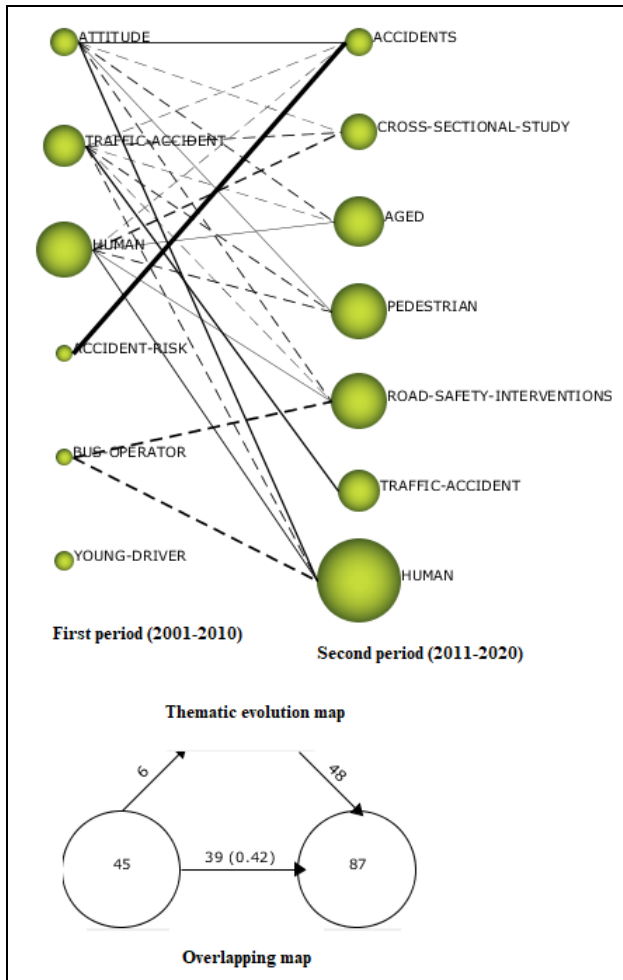


Figure 10: The map of thematic evolution and overlapping (stability between periods)

Information in Figure 10 indicated the vital fact as follow: The first-period evolution map (2001 - 2010) for road safety intervention research was based on “attitude”, “traffic-accident”, “human”, “accident risk”, “bus-operator”, and “young-driver”. These five themes underpin the argument that these issues have received relatively more attention in the literature. In the second period (2011-2020), the themes of “accidents” are closely related to “attitude”, “accident risk”, “traffic accident”, and “human” in the first period. The keywords such as “cross-sectional study”, “aged”, and “pedestrian” were nexus to “attitude”, “traffic accident”, and “human”. Where the keyword of “road safety interventions” is linked with “attitude”, “traffic accident”, “human”, and “bus-operator”. In this analysis, “young-driver” was declining themes since there is no connection to the second period. The stability between the two periods (overlapping map) also showed that the number of keywords has increased over time (see Figure 10). This represents a continuation of the emphasis on expanding road safety intervention research. The number of

emerging road safety intervention research themes is high, suggesting that this research is continually developing and growing due to the study’s complexity, dynamic and uncertain nature.

4. Conclusion

This study could infer that road safety intervention is an increasingly important topic, with an exponential increase in publications over 26 years. It represents a significant step forward in the resolution of road safety concerns.

By comparing the most influential countries, it has been seen that the United Kingdom, Australia and the United States are notable, as they have invested more budget on increasing road safety intervention to resolve road safety issues. The most renowned authors are Hyder from the Johns Hopkins Bloomberg School of Public Health in the United States of America, which has published seven articles on road safety intervention. The most cited source was Accident Analysis and Prevention, with 31 publications on road safety interventions published over 26 years.

“Medicine” has been most researched with 79 publications. It is indicated that road safety and medical concerns create an increase in public health issues. Human factors were the most exciting research subject among researchers in 2019 and 2020. In the search results, the keywords “young drivers”, “risk driving”, “speeding”, and “injury prevention” were also found to be heavily connected. This information would help future researchers to understand human factors associated with road safety better. Future research proposed in 2019 and 2020 articles showed that vehicle safety technologies, allocated resources, and improved road safety intervention would be critical.

SciMAT research tools provided relevant information on themes or keywords that split based on two periods. The first period (2001 – 2010) depicted that the themes have been inadequate, and only a few major themes have emerged. The themes are “attitude” in the motor themes, and the theme “bus operator” in-between motor themes and highly developed, while “traffic-accident” was in between motor themes and basic and transversal themes. Also, this study generated one motor themes in the second analysis period (2011 - 2020), namely “accidents”. In this analysis, “road safety interventions” was found nexus to “attitude”, “traffic accident”, “human” and “bus-operator”. It is indicated that road safety intervention research was diversified and highly vital at successive periods.

This article’s limitation is the inability to determine the most widely used keywords, as the database data was insufficient, resulting in marginal tests. Besides, the essence of bibliometric analysis per se is minimal. As stated in the methodology section (“road safety intervention”), only articles that meet the search parameters and refinement requirements were included.

Further studies should be conducted to determine road safety intervention in particular countries to recognise credible strategies for excellent outcomes and identify the relationship between road safety interventions and road safety performance. Other search engines such as Google Scholar and Microsoft Academic can also uncover current trends and future research directions. Based on this study’s findings, future researchers would be able to make more effective use of critical concepts related to road safety intervention.

Table 4: Overview of 2019 and 2020 articles to determine future research directions

Author	Year	Title	Type of Study	Intervention	Future Research Direction	The Main Idea for Future Research Direction
Bhalla & Gleason	2020	Effects of vehicle safety design on road traffic deaths, injuries, and public health burden in the Latin American region: a modelling study	Counterfactual Analysis	Vehicle Factors	Regulating and encouraging proven vehicle safety technologies would be a good idea.	Vehicle safety technologies

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Table 4 – Continued from previous page.

Author	Year	Title	Type of Study	Intervention	Future Research Direction	The Main Idea for Future Research Direction
Mohan et al.	2020	PROTOCOL: Effectiveness of road safety interventions: An evidence and gap map	Review	Human Factors, Vehicle factors, Protective devices, Road design, Infrastructure and traffic control, Post-crash pre-hospital care and legal and Institutional framework	Use resources to promote interventions that have proven effectiveness in road safety.	Allocate resources
Dandona et al.	2020	Mortality due to road injuries in the states of India: The Global Burden of Disease Study 1990–2017	Review	Human factors	Plan to improve targeted interventions to achieve the Sustainable Development Goals (SDG) target by 2030.	Improve current road safety interventions
Heydari et al.	2020	Is speeding more likely during weekend night hours? Evidence from sensor-collected data in Montréal	Observation	Human Factors	Road safety interventions, such as publicity campaigns and police enforcement, aim to reduce speeding.	Improve current road safety interventions
Salmon et al.	2019	Using the abstraction hierarchy to identify how the purpose and structure of road transport systems contributes to road trauma	Design and Development Research	Institutional Framework	Further validation with a larger set of subject matter experts with abstraction hierarchy.	Improve current road safety interventions
Baru et al.	2019	Injury severity levels and associated factors among road traffic collision victims referred to emergency departments of selected public hospitals in Addis Ababa, Ethiopia: The study based on the Haddon matrix	Cross-sectional Study	Human Factors	The need to target basic identified host-agent and environment and time sequence of collisions is urgent (pre-crash, crash and post-crash events).	Improve current road safety interventions
McIlroy et al.	2019	Who is responsible for global road safety? A cross-cultural comparison of Actor Maps	Review	Institutional Framework	The Actor Map is a starting point and is consistent across countries and offers a supporting tool that aids the development of Accimap analysed.	Improve current road safety interventions
Salmon et al.	2019	Bad behaviour or societal failure? Perceptions of the factors contributing to drivers' engagement in the fatal five driving behaviours	Cross-sectional Study	Human Factors	Study age, gender, and driving experience factors to help develop road safety strategies, policies and interventions.	Improve current road safety interventions
Lucidi et al.	2019	Personality traits and attitudes toward traffic safety predict risky behavior across young, adult, and older drivers	Cross-sectional Study	Human Factors	Investigate the differences in the relationship between groups of drivers for other personal characteristics, such as gender or cultural background.	Improve current road safety interventions

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