Three decades of consumers' environmentally friendly vehicles behavior: A comprehensive bibliometric network analysis and future research agenda

Ahmed M. Moustafa

University of Essex, 36 Queens Rd, Southend-on-Sea SS1 1BF, Essex, UK

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ABSTRACT

Environmentally friendly vehicles (EFVs) research has witnessed an exponential growth in recent years. In this article, we apply bibliometric network techniques to examine consumers' EFVs behavior research based on 662 Web of Science (WoS) and Scopus documents written by 1590 authors representing 61 countries and spanning three decades (1993–2023). Results show that the most impactful journals publishing consumers' EFVs behavior research are *Energy Policy, Transportation Research Part A: Policy and Practice, Journal of Cleaner Production, Transport Policy, Technological Forecasting and Social Change,* and *Energy Economics.* Furthermore, reference publication year spectroscopy (RPYS) was used to identify "citation classics" that lay the historical foundation for consumers' EFVs behavior research. The thematic evolution analysis reveals that emerging trends in this domain are related to environmental concerns, total cost of ownership, and adoption intention. This study provides valuable insights for future researchers by mapping the evolution of EFVs research over the past three decades, revealing connections among influential authors, key nations, and leading institutions, and uncovering current trends within the broader field of consumers' EFVs behavior.

Introduction

Environmentally Friendly Vehicles (EFVs) are defined as vehicles that reduce environmental impact by lowering emissions, enhancing fuel efficiency, and often using renewable or sustainable energy sources compared to traditional internal combustion engine vehicles (Ghorbani et al., 2020). Typically, these vehicles produce fewer greenhouse gases and pollutants, consume less energy, and may incorporate sustainable materials in their design and construction (Nealer & Hendrickson, 2015). The category of EFVs encompasses a range of vehicles, including battery electric vehicles (BEVs), hydrogen fuel cell vehicles (HFCVs), and hybrid vehicles. BEVs operate solely on electric power stored in batteries, producing zero tailpipe emissions and reducing air pollution (Balali & Stegen, 2021). Whereas hydrogen fuel cell vehicles, by contrast, generate electricity on-board through an electrochemical re-action, emitting only water vapor, which makes them suitable for longer ranges and heavier applications (Dash et al., 2022). Hybrid vehicles, which combine an internal combustion engine with an electric motor, offer improved fuel efficiency and reduced emissions compared to conventional vehicles (Sher et al., 2021). These vehicle types offer varied pathways to reducing fossil fuel dependency and pollution, each with unique benefits and challenges related to infrastructure, range, and energy sources (Yap et al., 2022; Secinaro et al., 2022).

As the EFVs industry is projected to reach a market value of USD 932 billion by 2031 (VMR, 2024), the development of adequate infrastructure becomes a critical challenge. The widespread adoption of EFVs hinges on accessible and extensive charging and refueling networks, which remain limited in many regions (Kchaou-Boujelben, 2021). Without sufficient infrastructure, the feasibility and consumer willingness to transit from conventional vehicles to EFVs may be significantly hindered, as potential adopters may be discouraged by the perceived inconvenience of limited charging options (İmre et al., 2024). Beyond the need for infrastructure, EFVs represent a promising solution for mitigating environmental impacts, urban congestion, and emissions in freight transportation (Rezvani et al., 2015). Their adoption fuels technological advancements across battery technology, charging infrastructure, and energy management, while also driving economic growth and job creation (Yong et al., 2018), enhancing both regional and national economic vitality (IEA, 2021). Furthermore, EFVs generally have lower operational costs compared to traditional vehicles, due to reduced fuel consumption and maintenance requirements (Wang et al., 2020), resulting in substantial long-term savings, particularly for businesses with large fleets and significant transportation needs.

A WoS and Scopus database search revealed 662 EFVs articles

published by 1590 authors representing 61 countries over the past three decades. Bibliometric analysis provides a quantitative approach to evaluating research output, impact, and productivity, which allows the researcher to measure and compare the performance of scholars, journals, and research topics using objective metrics (Paul and Cestero, 2021). Conducting bibliometric network analysis can also help in identifying emerging research trends, popular topics, and the evolution of scientific fields. Although bibliometric analysis has been applied to investigate fields as diverse as green energy adoption (Qin et al., 2022), consumer recycling behavior (Phulwani et al., 2020), consumer social responsibility behavior (Nova-Reyes et al., 2020), Islamic banking and finance (Hassanein & Mostafa, 2023), wireless sensor networks (Abdollahi et al., 2021), Wikipedia in scholarly publications (Mostafa, 2023), drones in agriculture (Rejeb et al., 2022), catastrophe theory research (Mostafa, 2022), artificial intelligence (AI) in healthcare (Guo et al., 2020), entrepreneurship (Xu et al., 2021), sustainable energy consumption (Tan et al., 2021), and corporate social responsibility (Ye et al., 2020), it appears that there is no bibliometric analysis conducted to examine consumers' EFVs behavior. A notable exception is the study by Secinaro et al. (2022), which focused solely on electric vehicles (EVs). Their research utilized a sample size of 254 documents from a single database, Scopus. In contrast, our paper encompasses a broader scope by focusing on EFVs and employs a larger sample of 662 documents from two databases, namely Web of Science (WoS) and Scopus. This approach not only enhances the comprehensiveness of our study but also mitigates potential selection bias. Therefore, we contend that by conducting this study, we make three notable contributions to the existing body of literature. First, we add to the extensive list of bibliometric studies examining other research domains (Ye et al., 2020; Xu et al., 2021; Tan et al., 2021; Rejeb et al., 2023). Second, by taking a network approach to examine consumers' EFVs behavior research, we make a significant contribution to the vast prior literature investigating information brokerage behavior (Mostafa, 2024; Wijewickrama et al., 2021; Kwon et al., 2020; Resch & Kock, 2021). Finally, by examining consumers' EFVs behavior, we contribute to the wider literature on sustainability and consumers' pro-environmental behavior (Afridi et al., 2021; McCarthy and Yang, 2010; Law et al., 1988; Li et al., 2020; Hwang and Lyu, 2020; and Keles et al., 2008). More specifically, we aim to find answers to the following research questions:

- RQ1: How has research on consumers' EFVs behavior evolved over time?
- RQ2: Which countries or regions are prominent in the geographical distribution of consumers' EFVs behavior research?
- RQ3: What collaborative networks can be identified among authors, institutions, and countries in the field of consumers' EFVs behavior research?
- RQ4: What are the main thematic trends in consumers' EFVs behavior research?

This study is structured as follows. The subsequent section outlines the research methodology employed to carry out the analysis. The third section deals with the findings of the study. The fourth section presents a comprehensive discussion and future research agenda, whereas the next section discusses the conclusions. The final section addresses the study's limitations and explores future research avenues.

Method

This study follows closely the methodological framework suggested by Mostafa (2022): (1) Selecting the database and defining search parameters; (2) Performing preliminary statistical analysis; (3) Carrying out bibliometric network analysis; (4) Developing conceptual structure, thematic, and historiographical maps; (5) Utilizing reference publication year spectroscopy (RPYS) to explore the "classical citations" forming of consumers' EFVs behavior. To conduct the analysis, we used the R

software version 4.3.1, with several libraries such as bibliometrix and biblioshiny. We also used the VOSviewer software version 1.6.19 for network visualization. Finally, the CRExplorer version 1.9 software was used to conduct the RPYS. A brief explanation of the steps mentioned above is presented in the following subsections.

Database, documents, and preliminary analysis

The consumers' EFVs behavior articles were collected from the WoS and Scopus databases. The two databases were selected because they provide extensive coverage of relevant academic literature, ensuring a more thorough and representative collection of documents for the study (Zhu & Liu, 2020). By utilizing both WoS and Scopus databases, the research benefits from a broader scope of high-quality sources, enhancing the reliability and validity of the findings (Pranckutė, 2021). After the retrieval process, these documents were converted to plain text to facilitate further sorting and examination. While some studies have focused solely on journal articles (Rejeb et al., 2022; Ye et al., 2020; Xu et al., 2021), others have incorporated both books and journal articles (Aryadoust & Ang, 2021). In this study, we followed Marx et al. (2017) in selecting only peer-reviewed articles and reviews. We opted for peer-reviewed articles because of their high quality and rigor.

In this study, we employed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach, a well-established guideline in the field of systematic reviews and meta-analyses. This framework offers a structured methodology for conducting bibliometric analyses (Moher et al., 2009), ensuring clarity, comprehensiveness, and standardization in reporting (García-Salirrosas & Rondon-Eusebio, 2022; Tranfield et al., 2003). Fig. 1 illustrates the steps followed to conduct this analysis. Following a thorough review of relevant literature (Hu et al., 2023; Irfan and Ahmad, 2021; Li et al., 2020; Rezvani et al., 2015; Salari, 2022; Secinaro et al., 2022), we determined the search keywords as follows:

"Consumer Behav*" OR "Customer Behav*" OR "Consumer Attitude*" OR "Customer attitude*" OR "Buyer*" OR "Purchas*" AND "Electric Vehicle*" OR "Electric Car*" OR "Hybrid Vehicle*" OR "Hybrid Car*" OR "Hydrogen Vehicle*" OR "Hydrogen Car*" OR "Alternative Fuel Vehicle*" OR "Alternative Fuel Car*" OR "Plug-In Hybrid Electric Vehicle*" OR "Plug-In Hybrid Electric Car*" OR "Plug-In Hybrid Electric Car*" OR "Extended-Range Battery Electric Vehicle*" OR "Extended-Range Battery Electric Car*" OR "Extended Range Battery Electric Vehicle*" OR "Extended Range Battery Electric Car*" OR "Battery-Electric Vehicle*" OR "Battery-Electric Car*" OR "Battery Electric Vehicle*" OR "Battery Electric Car*" OR "Hybrid-Electric Vehicle*" OR "Hybrid-Electric Car*" OR "Hybrid Electric Vehicle*" OR "Hybrid Electric Car*".

Table 1 presents the details of the data obtained. The data show that the 662 documents gathered from the WoS and Scopus databases were written by 1590 authors. Among these, 67 articles were written by single authors, while 595 articles were written by multiple authors. On average, each document is written by 2.4 authors, and the average citation per document was 49.3.

Bibliometric network analysis

A network can be defined as "a structure composed of a set of actors, some of whose members are connected by a set of one or more relationships" (Knoke & Yang, 2019, p.8). From a network perspective, social network analysis (SNA) is a valuable technique that can uncover hidden patterns, aiding in theory development and identifying potential areas for future research (Martino & Spoto, 2006). Previous studies have extensively employed network analysis in various domains, including the exploration of individual scientific collaboration networks (Hardman et al., 2018; Zou et al., 2018; Khan & Wood, 2016), collaboration among research institutions, and the analysis of keyword co-occurrence networks (Alnajem et al., 2021; Xu et al., 2021).
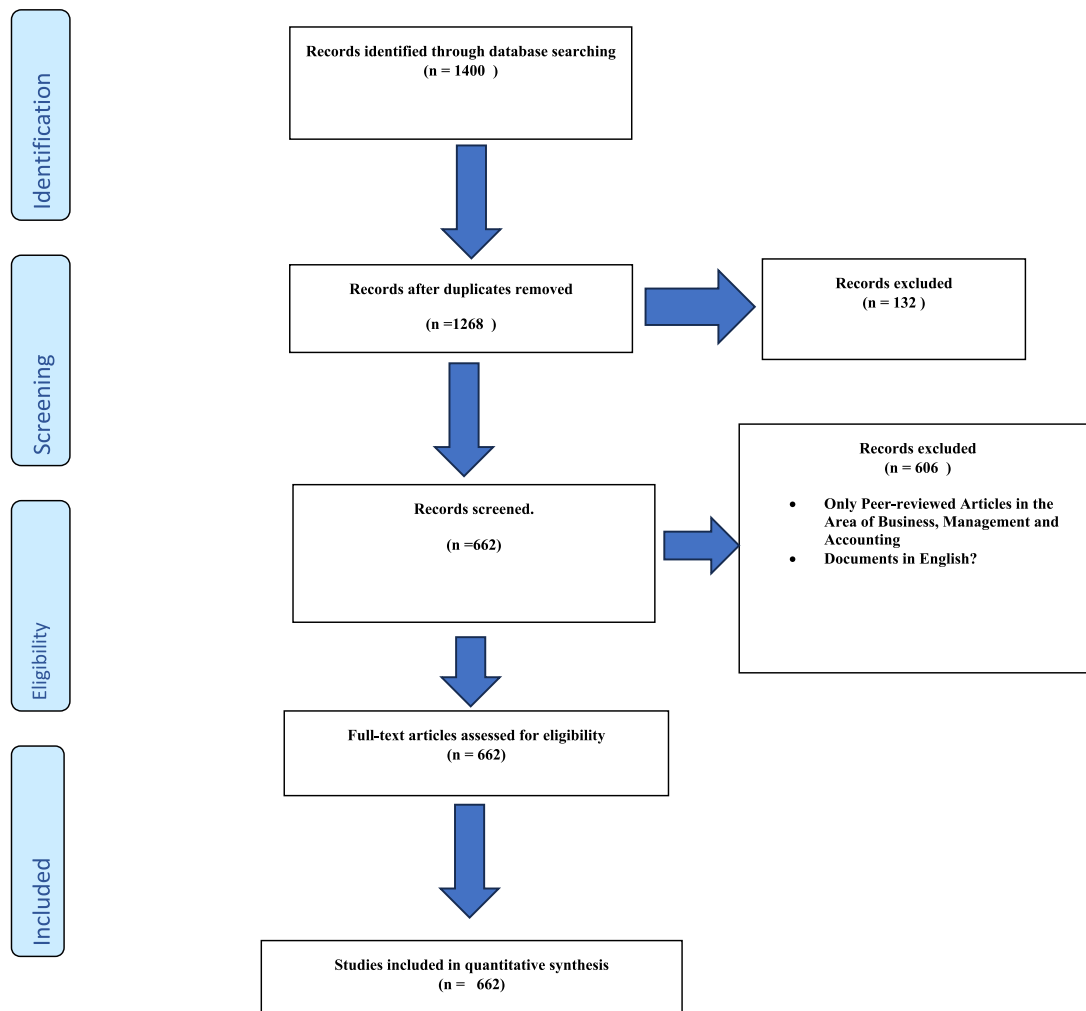
Fig. 1. PRISMA flowchart for selection of relevant consumers' EFVs behavior studies.

Table 1
Main information about consumers' EFVs behavior data.

Description	Results
Timespan	1993–2023
Documents	662
Average citations per document	49.3
Document Type	
Article	649
Review	13
Document contents	
Keywords Plus	1389
Authors Keywords	659
Authors	
Authors	1590
Authors of single-authored documents	67
Authors of multi-authored documents	595
Authors collaboration	
Documents per Author	0.416
Authors per Document	2.4
International co-authorships %	11.93

Thematic and conceptual structure maps

Thematic maps are utilized to uncover the evolving patterns within clusters by examining the occurrence of keywords or co-occurring words (Yang et al., 2022). Typically, density and centrality metrics are applied to create these visual diagrams (Mostafa, 2022). Additionally, these maps draw inspiration from financial portfolio analysis and concepts rooted in co-occurring word networks. Owing to their value, they have found widespread application in numerous research areas (Khasseh, et al., 2017; Law et al., 1988; Callon et al., 1991). Conceptual structure maps are characterized as visual instruments for arranging and portraying knowledge that consist of concepts, typically enclosed within circles or boxes, along with connections between these concepts (Novak & Cañas, 2008). The primary objective of such maps is to divide knowledge into discrete clusters. Conceptual structure maps assist in identifying research frontiers and gaps within a field by visualizing the connections between different research areas and the distribution of citations (Rejeb et al., 2023).

RPYS

RPYS is a bibliometric method that was introduced by Marx et al. (2017) to quantify the significance of historical publications and to reveal the historical roots of a given research field. Unlike traditional citation analysis, RPYS specifically targets references within a particular research field, offering a backward perspective on citation analysis.

RPYS involves three key steps: (Mostafa, 2022, p. 14): (1) The initial step involves selecting a set of publications that represent a specific research domain and extracting all the references cited within these publications; (2) Next, a frequency distribution is created for the cited sources, and the deviation of each reference from a 5-year median timeframe is calculated; (3) The concluding stage usually includes utilizing software such as CRExplorer for the analysis. RPYS has been found to be a valuable tool for identifying irregularities in the distribution of reference citations over time and assisting researchers in objectively identifying influential knowledge sources, which can include various forms such as books, book chapters, research articles, or reports (Wiarda et al., 2021).

Results

EFVs scientific production and impactful outlets

Fig. 2 shows the worldwide production of the consumers' EFVs behavior research. From the graph, we see that the most productive nations are the USA (316 articles), China (287 articles), India (103 articles), Germany (79 articles), the UK (77 articles) and Canada (67 articles). Moreover, Fig. 3 illustrates the growth of scientific production in this field, indicating a general exponential trend. Between 1993 and 2005, research publications related to consumers' EFVs behavior was rare. This could be due to the lack of technological advancements in the EFVs sector and the lack of consumer data available (Melander et al., 2022; Williamsson & Moen, 2022). Between 2006 and 2011, research published on consumers' EFVs behavior started to display a positive trend as research began to tackle the climate change crisis (Capstick et al., 2015). Finally, between 2013 and 2022, consumers' EFVs behavior research has substantially grown and reached a peak in 2022 with 103 articles. This could be attributed to the pressing environmental concerns and EFVs technological advancements (Liao et al., 2017).

Table 2 shows the major journals publishing research on consumers' EFVs behavior, including *Energy Policy* (99 articles), *Transportation Research Part A: Policy and Practice* (96 articles), *Journal of Cleaner Production* (71 articles), *Transport Policy* (32 articles), *Technological Forecasting and Social Change* (31 articles), and *Energy Economics* (26 articles). These journals commonly emphasize themes of sustainability, policy development, and technological innovation.

Table 3 illustrates the top institutions contributing to research on EFVs consumers' behavior. According to the graph the University of California, Davis leads with 31 publications, while Simon Fraser University follows with 18 articles. Other significant contributors are Cornell University (17 articles), the University of Trieste (15 articles), the University of Science and Technology of China (14 articles), and Tsinghua University (13 articles). The results highlight a global research effort in studying consumer EFVs behavior with leading contributions from institutions in the United States, Canada, Italy, and China.

Table 4 shows the most cited consumers' EFVs behavior articles. According to the table, the most cited paper is Egbue and Long (2012) with 997 citations. This article aimed to identify the main obstacles preventing the broader adoption of EVs. The study found that the primary concerns among consumers include limited battery range, high costs, and the uncertainty associated with EV technology. With 689 citations, the second most cited paper is Hidrue et al. (2011). This study estimated willingness to pay (WTP) for various EV attributes, such as driving range, charging time, fuel cost savings, pollution reduction, and performance. Findings indicate that consumers value driving range and fuel savings highly, with WTP decreasing incrementally with higher ranges. With 437 citations, the third most cited paper is Kumar and Alok (2020). In this research, the authors identified key factors influencing EV adoption, including economic, technological, social, and policy-related aspects. They showed that while technological advancements and supportive policies are crucial, consumer awareness and perception significantly impact adoption rates. With 383 citations, the fourth most cited paper is Jansson et al. (2010). This article explored the factors influencing green consumer behavior, focusing on the willingness to reduce car use and adopt eco-innovations such as EFVs. The study found
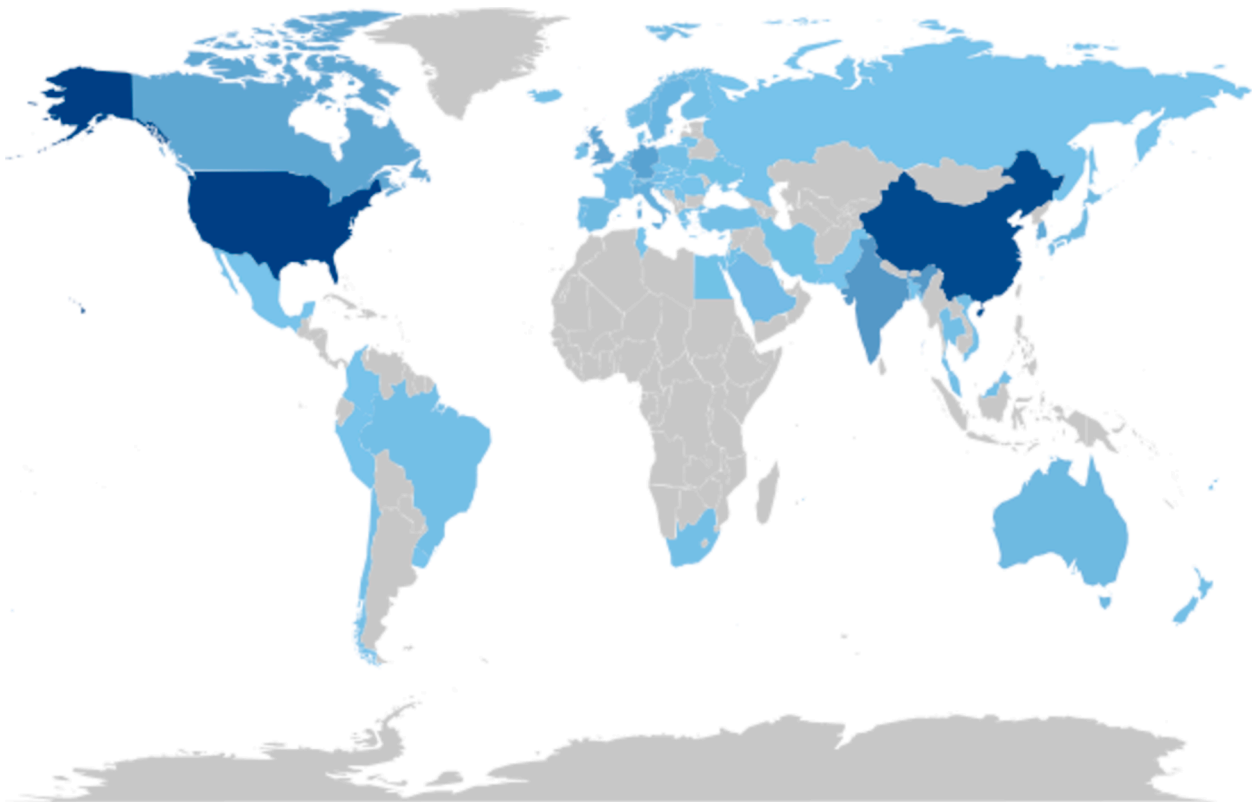

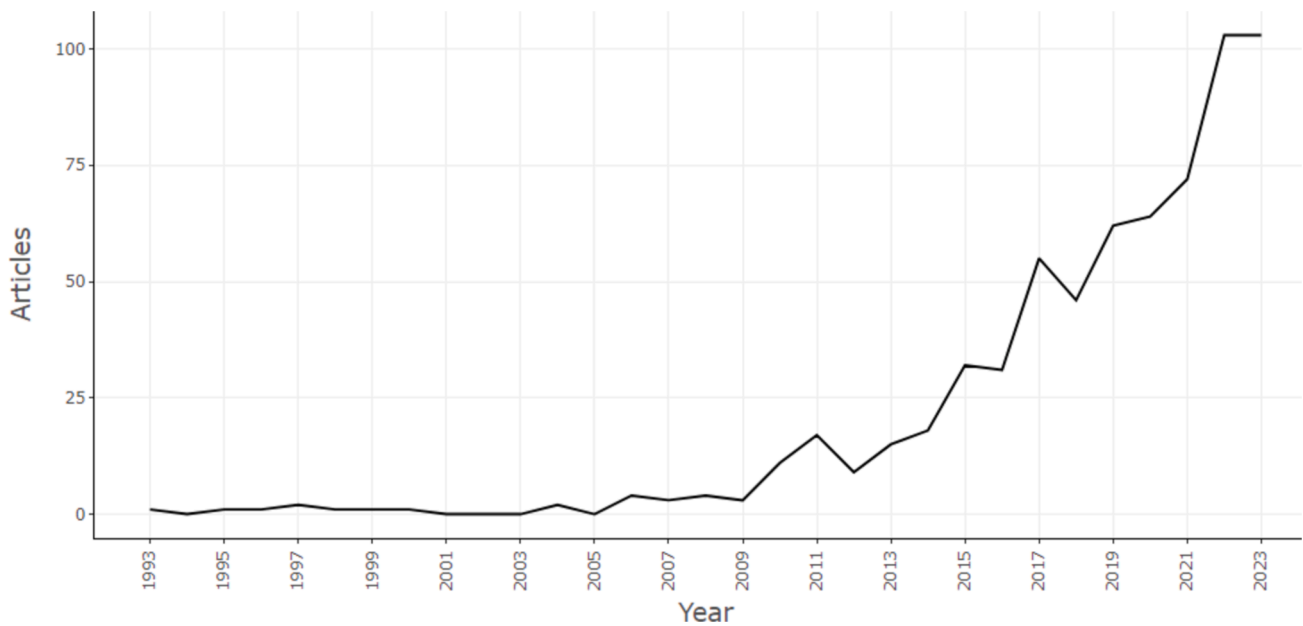**Fig. 2.** Consumers' EFVs behavior nations' scientific production.

Fig. 3. Consumers' EFVs behavior annual scientific production.

Table 2
Most relevant consumers' EFVs behavior sources.

Sources	Articles
Energy Policy	99
Transportation Research Part A: Policy and Practice	96
Journal of Cleaner Production	71
Transport Policy	32
Technological Forecasting and Social Change	31
Energy Economics	26
Research In Transportation Business and Management	21
Research In Transportation Economics	12
Ecological Economics	9
Journal of Transport Geography	7
Journal of Consumer Behaviour	6
Journal of Environmental Economics and Management	6
Transportation Research Part E: Logistics and Transportation Review	6
Business Strategy and The Environment	5

Table 3
Most relevant affiliations in consumers' EFVs behavior research.

Affiliation	Publications
University of California, Davis.	31
Simon Fraser University	18
Cornell University	17
University of Trieste	15
University of Science and Technology of China	14
Tsinghua University	13
Umeå Universitet	13
University of California	13
Xiamen University	13
Beijing Jiaotong University	10

Table 4
Most cited consumers' EFVs behavior articles.

Paper	Total Citations	TC per Year	Normalized TC
Egbue, O. (2012). Energy Policy	997	76.69	5.20
Hidrue, M. (2011). Resource and Energy Economics	689	49.21	5.07
Kumar, R. (2020). Journal of Cleaner Production	437	87.40	10.95
Jansson, J. (2010). Journal of Consumer Marketing	383	25.53	3.45
Plötz, P. (2014). Transportation Research Part A: Policy Practice	355	32.27	4.23
Ozaki, R. (2011). Energy Policy	314	22.43	2.31
Kahn, M. (2007). Journal of Environmental Economics and Management	306	17.00	2.33
Bunch, D. (1993). Transportation Research Part A: Policy Practice	278	8.69	1.0
Krupa, J. (2014). Transportation Research Part A: Policy Practice	269	24.45	3.20
Llopis-Albert, C. (2021). Technological Forecasting and Social Change	252	63.00	7.30
Eppstein, M. (2011). Energy Policy	251	17.93	1.85

that personal values, beliefs, norms, and habitual behaviors play significant roles in determining these behaviors.

The dominance factor is a bibliometric measure that is used to assess an author's prominence. It is computed by dividing multi-authored articles where the author is the first author by the total number of multi-authored articles (Gupta, 2021). Fig. 4 shows the consumers' EFVs behavior research dominating authors over time. From the graph, we see that Jonn Axsen dominated from 2009 to 2021. This author's research primarily focuses on understanding consumer preferences and behaviors

related to the adoption of EFVs sustainable transportation technologies. Johan Jansson is also a prominent author in research on EFVs, having dominated the field from 2009 to 2021. This author's research explores factors influencing consumers' behavior related to EFVs, including the impact of personal values, beliefs, norms, and habitual behaviors on the adoption of these sustainable transportation options. Yuyan Liu dominated from 2014 to 2023. This author's research investigates the technological aspects that influence consumers' adoption of EFVs. This includes examining advancements in technology, such as battery performance, charging infrastructure, and vehicle efficiency, on consumer purchasing intentions toward EFVs. Newcomers to the field of consumers' EFVs behavior research have also achieved some dominance. For example, Marco Giansoldati dominated from 2019 to 2021 and his work focused on understanding the role of digital technologies and data analytics in shaping consumer preferences and behaviors related to EFV, whereas Mariangela Scorrano dominated between 2019 and 2022 and her work focused on how emerging technologies, such as autonomous driving, connectivity, and smart energy management systems, influence
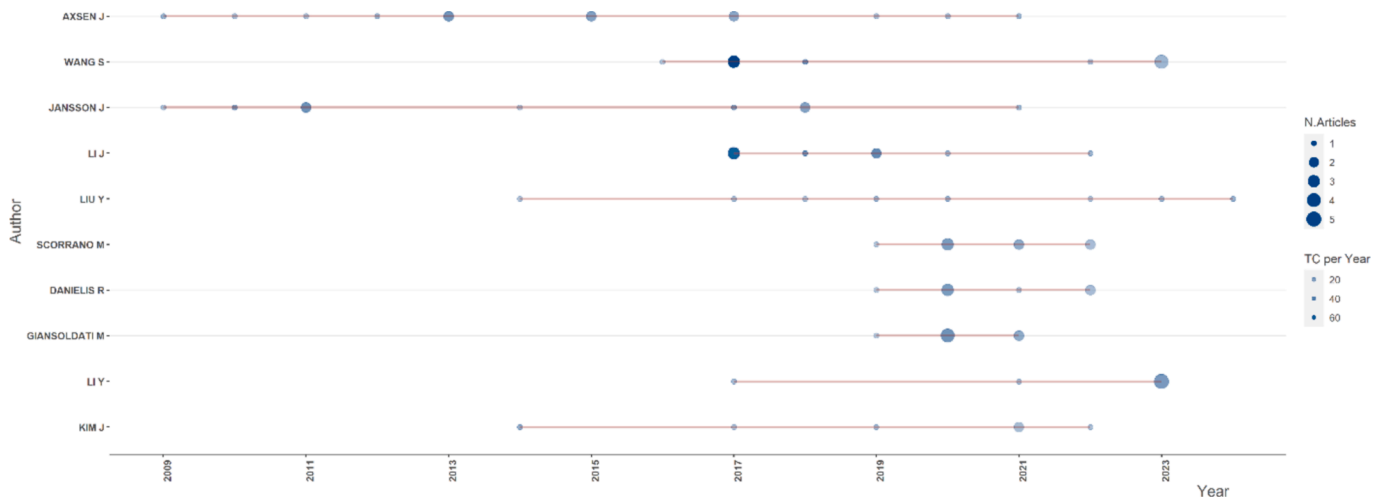
Fig. 4. Consumers' EFVs behavior authors' dominance over time.

consumers' acceptance and adoption of EFVs.

In bibliometric studies, Lotka's law suggests that the ratio between the number of authors who produce a certain number of articles and those who produce only one article is consistently fixed at 2 (Sahu & Jena, 2022). Fig. 5 shows Lotka's law in consumers' EFVs research. The graph suggests that Lotka's law appears to hold in consumers' EFVs behavior research (K—S two sample test p > 0.05).

Network analysis

Co-citation network analysis

A co-citation network is established when two authors are both referenced in a third source (Mostafa, 2022). Fig. 6 displays the consumers' EFVs behavior co-citation network. The graph appears sparse, indicating a diversity or dissimilarity among the referenced works, which suggests 'heterophily' or weak correlations between various co-citations (McPherson et al., 2001). This sparsity may result from shifts in consumers' EFVs behavior trends and methodologies over time. It could also reflect an evolving field, where consistent patterns or well-established clusters are yet to form (Zhao & Strotmann, 2015). This dynamic and fragmented network is likely shaped by various jurisdictional factors, including differences in infrastructure maturity,

regulatory environments, and technological capabilities across regions. These cross-border disparities contribute to weaker connections between clusters and highlight the need for region-specific research. Local policies and cultural factors play a crucial role in influencing the development and adoption of EFVs, underscoring the importance of tailoring research to distinct regional contexts.

Collaboration network analysis

Fig. 7 shows the authors' collaboration network in consumers' EFVs behavior. The graph reveals four main clusters: The first cluster (red colored) includes authors such as Mark Bradley, David Brownstone, David Bunch, and Gareth Occhiuzzo. This group of researchers focus on the analysis and modeling of consumer behavior towards EFVs, exploring factors such as preferences, perceptions, and decision-making processes. The second cluster (green colored) features authors like Jonn Axsen, Kenneth Kurani, Zoe Long, and Ekaterina Rhodes. This group appears to deal with the impact of various policy measures, incentives, and regulatory frameworks on the adoption of EFVs. They evaluate the effectiveness of governmental policies, incentive structures, and public engagement strategies in shaping consumer behavior and facilitating market growth for EFVs. The third cluster (blue colored) includes authors such as Joan Ogden, Kalai Ramea, and Christopher Yang, who
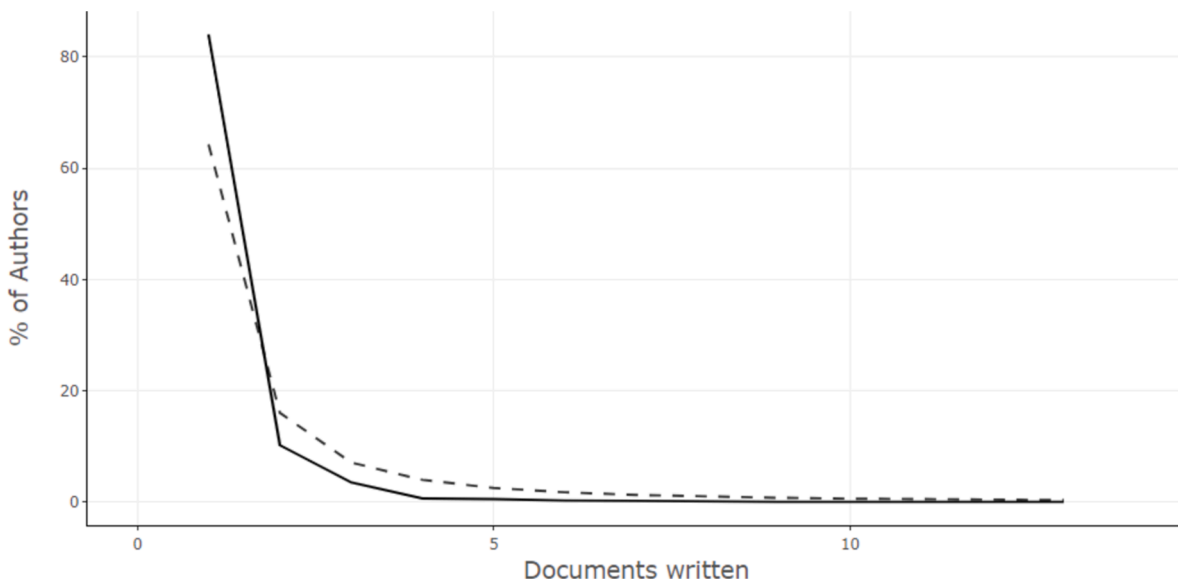

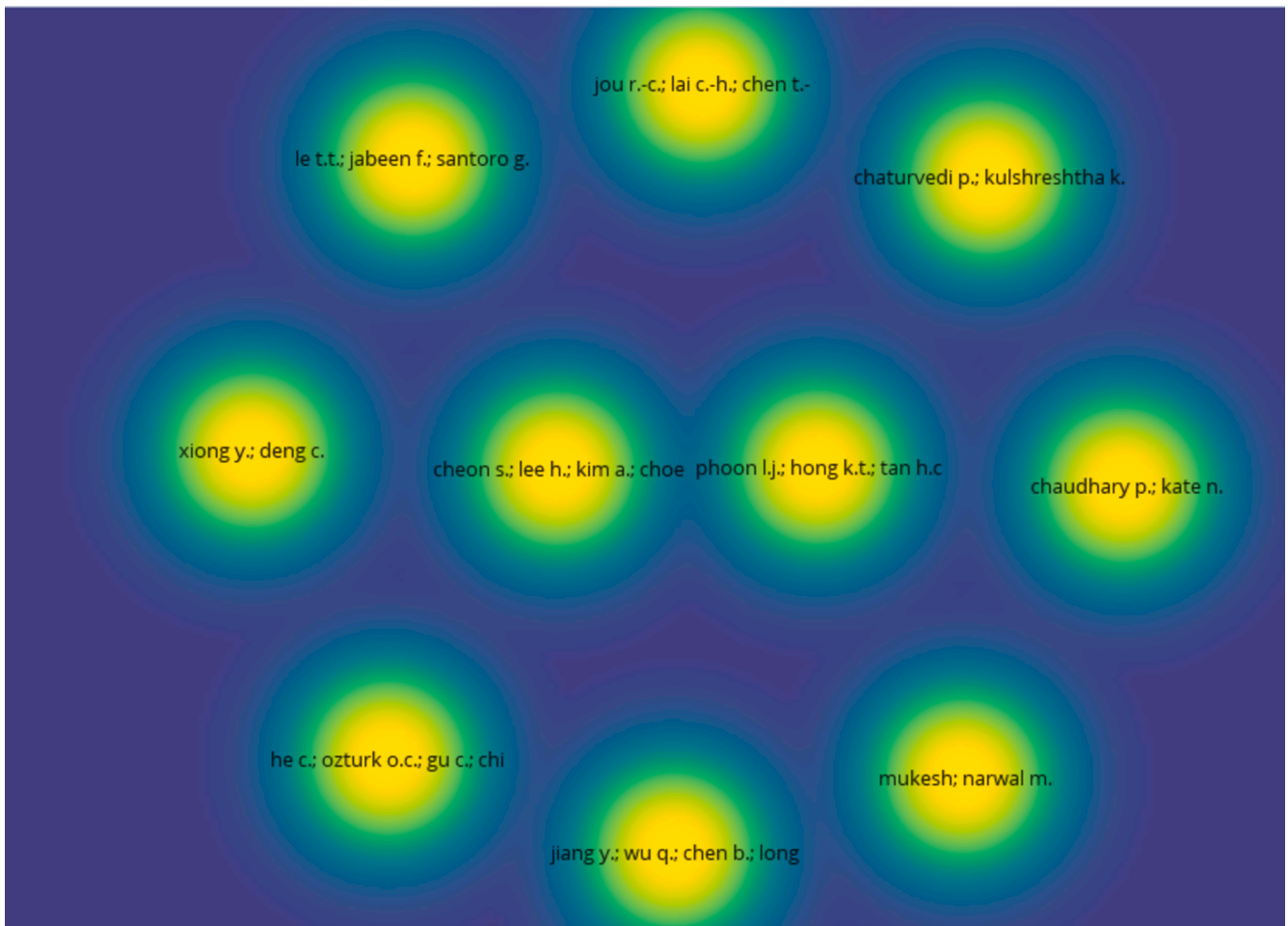**Fig. 5.** Consumers' EFVs behavior Lotka's law diagram.

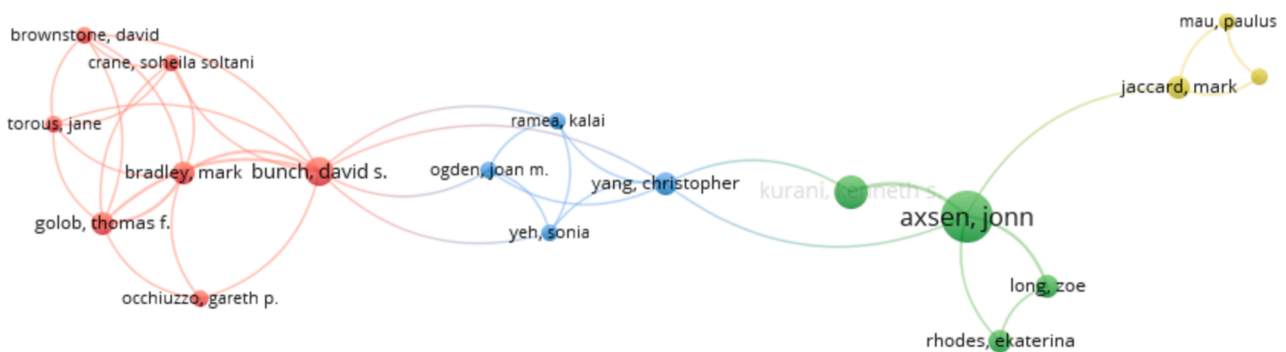**Fig. 6.** Consumers' EFVs behavior authors' co-citation network.

Fig. 7. Consumers' EFVs behavior authors' collaboration network.

focus on the technological and infrastructural aspects related to EFVs. This group investigates advancements in vehicle technology, infrastructure development (such as charging stations and refueling networks), and the integration of EFVs into existing transportation systems. The fourth cluster (yellow colored) features authors like Mark Jaccard, Paulus Mau, and Kenneth Tiedemann. Their focus is on economic and behavioral modeling related to EFV adoption, examining the economic implications, cost-benefit analyses, market dynamics, and consumer financial incentives to understand the factors driving or hindering the adoption of EFVs.

Fig. 8 shows consumers EFVs behavior collaboration network among institutions. According to the figure, there appear to be three main clusters. The first cluster (red colored) includes institutions such as "The Beijing Institute of Technology", "Tsinghua University", "The University of Science and Technology of China", and "Xiamen University". The second cluster (green colored) includes institutions such as "Cornell University", "The University of California, Davis", "The University of South Carolina", and "Seoul University". The third cluster includes institutions such as "Simon Fraser University", "The University of Texas at Austin", and "The University of Oxford". A closer look at the clusters formed reveals that most of the clusters point out to a north–south divide with virtually no cooperation between developed and developing nations.

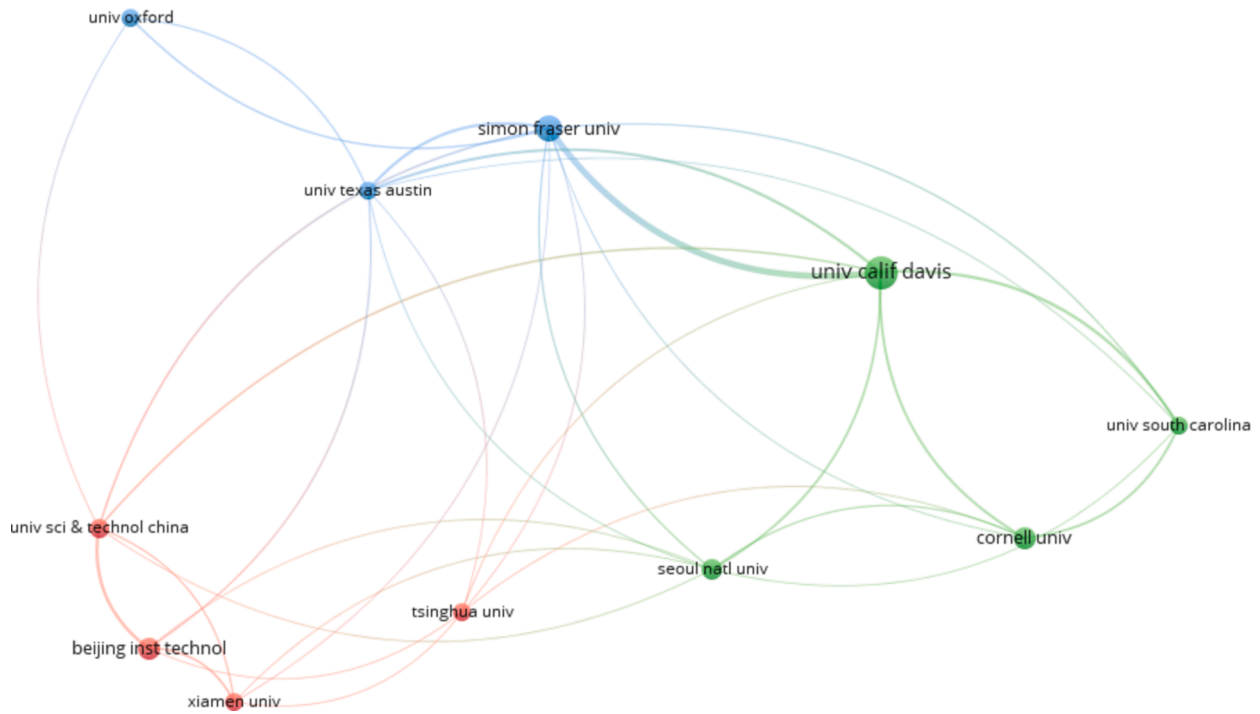This geographic divide underscores the importance of considering

Fig. 8. Consumers' EFVs behavior collaboration network among institutions.

regional and city-level factors when examining global collaboration patterns in EFVS research. Differences in infrastructure, local policies, and government support for EFVs can significantly shape research priorities and international partnerships. For example, institutions located in cities with advanced EFVs infrastructure such as Beijing (Beijing Institute of Technology, Tsinghua University), Los Angeles (University of California, Los Angeles), New York (New York University), San Francisco (University of California, Davis), Toronto (University of Toronto), Seoul (Seoul University), London (University College London), Berlin (Technical University of Berlin), and Vancouver (Simon Fraser University) tend to form concentrated research networks. City-specific factors like local policies, infrastructure readiness, and environmental initiatives in these locations drive collaboration within regions and often

set the research agenda (Axsen et al., 2011).

Fig. 9 shows the consumers' EFVs behavior collaboration network among countries. The results show three clusters. The first cluster (red colored) includes five countries, namely Australia, England, India, Netherlands, and Spain. The second cluster (Green colored) includes five countries: Italy, France, Sweden, Germany, and Switzerland. Whereas the third cluster (blue colored) includes three countries: the USA, South Korea, and China. A closer look at the clusters formed reveals that most of the clusters are formed based on linguistic similarity, geographical proximity, or cultural affinity (Accetturo et al., 2021; Jayasekara & Tan,2024; Serrano-Arcos et al., 2022).
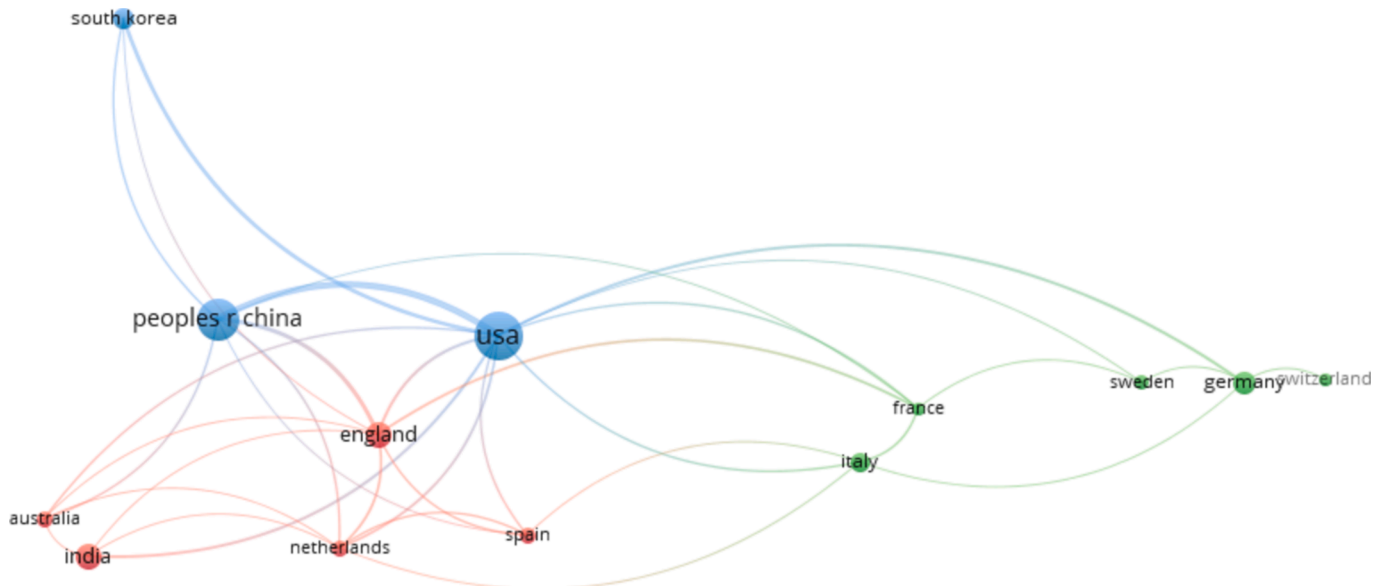

Fig. 9. Consumers' EFVs behavior nations' collaboration network.

Keywords and co-occurrence network analysis

Fig. 10 shows a wordcloud generated using authors' keywords. A wordcloud can be used to summarize textual information, where the importance of each word is determined by its size and proximity to the center of the cloud. From the graph, it appears that the most relevant keywords in consumers' EFVs behavior research used are "electric vehicles" (259 times), "purchase intention" (31 times), "consumer behavior" (29 times), "new energy vehicles" (19 times), "total cost of ownership" (19 times) and "sustainability" (16 times). These keywords reflect the primary themes and focal points in the literature, suggesting that studies often explore the intentions behind purchasing EFVs, overall consumer behavior, cost considerations, new energy, and sustainability aspects. The wordcloud provides a clear summary of the key topics driving research in EFVs consumer behavior.

We also utilized the keywords provided by the authors to create the consumers' EFVs behavior keyword co-occurrence network. Fig. 11 depicts the resulting network. From the figure, it appears that four clusters are formed. The first cluster (red colored) includes words such as "consumer behavior", "technology adoption", and "greenhouse gases". The common theme in this cluster is the adoption and environmental impact of alternative fuel vehicles, with a focus on understanding how consumers perceive and adopt alternative fuel vehicles, influenced by factors such as technology adoption and their potential to reduce greenhouse gases. The second cluster (green colored) includes terms such as "hybrid vehicles", "sustainable development", and "total cost of ownership". The common theme in this cluster is the economic and sustainability aspects of hybrid vehicles. It focuses on the role of hybrid vehicles in promoting sustainable development and considers the total cost of ownership, including long-term economic benefits and environmental impacts. The third cluster (blue colored) encompasses terms such as "electric vehicles", "new energy vehicles", "purchase intentions", and "sales". The common theme in this cluster is the market dynamics and consumer interest in EFVs, as the focus here is factors influencing purchase intentions and sales, highlighting how consumer demand and market trends drive the adoption of EFVs. The fourth cluster (yellow colored) includes terms such as "secondary batteries", "charging batteries", and "battery electric vehicles". The common theme in this cluster is the technological aspects and infrastructure of EFVs, as the focus here is on the development and optimization of secondary batteries and battery charging technologies.

Conceptual structure and thematic maps

Fig. 12 illustrates the thematic evolution timeline for consumers' EFVs behavior, depicting the changing focus of author keywords over time and providing insight into the shifting priorities and directions in the field. From 1993 to 2006, the focus on "electric vehicles" centers on advancements in battery technology, improvements in vehicle performance, market adoption challenges, the development of supporting infrastructure like charging stations, and the environmental benefits of EVs. This period highlights the foundational work necessary to establish electric vehicles as a viable alternative to conventional vehicles.

Moreover, the period from 2007 to 2015 includes terms such as "hybrid vehicles", "plug-in electric vehicles" and "consumer attitudes". This cluster reflects a shift towards exploring how consumer behaviors impact the adoption of EFVs. Between 2016 and 2020, the focus on "new energy vehicles", "charging infrastructure", "willingness to pay" and "adoption intention". It appears that the focus in this period has shifted toward evaluating the practical aspects of integrating advanced, sustainable transportation technologies into the market. This cluster emphasizes understanding consumer willingness to invest in new energy vehicles, the development and impact of charging infrastructure, and the factors influencing the intention to adopt these vehicles. The fourth period between 2021–2023 includes keywords such as "environmental concern", "electric vehicles", "hybrid vehicles" total cost of ownership" and "adoption intention". This cluster reflects a growing emphasis on understanding how environmental concern and the total cost of ownership influence consumer intentions to adopt EFVs. It highlights the importance of addressing both ecological impacts and financial considerations in promoting sustainable transportation options.

Fig. 13 depicts a thematic/strategic map where the average values for both axes are represented by a dashed line, dividing the map into four quadrants. Each quadrant signifies a unique theme, with the size of the bubbles indicating the frequency of keyword usage across documents. The Motor Themes quadrant (high density, high centrality) features themes with strong internal and external development (Shi et al., 2019). In the context of consumers' EFVs behavior research, keywords such as "consumer behavior", "vehicles", and "stated preference" are prominent, focusing on how consumers perceive, evaluate, and decide on purchasing EFVs, which is essential for understanding factors influencing EFVs adoption and developing strategies to promote sustainable transportation. The second quadrant is typically referred to as the "highly-developed-and-isolated themes" quadrant, focusing on niche themes (Maulidiya et al., 2024). It exhibits a high-density-low-centrality structure, indicating that while the themes within this quadrant are well-developed internally, they have limited external significance. Keywords like "climate change", "charging", "energy", and "mixed logit" are notable here, addressing the environmental impact of EFVs, charging infrastructure, energy efficiency, and advanced statistical modeling of consumer preferences. The third quadrant, characterized by low density and low centrality, is known as the "emerging-or-declining themes" quadrant (Sadatmoosavi et al., 2021). Such themes may indicate potential hotspots in consumers' EFVs behavior. Examples in this category include keywords such as "battery electric vehicle" and "innovation" which indicate ongoing or future developments in battery electric vehicle adoption and technological advancements within the EFVs sector. Finally, the "basic-and-transversal themes" quadrant, with low density but high centrality (Mostafa, 2022), includes themes that are less developed in terms of internal ties but have significant external connections. In the context of research on consumer behavior regarding EFVs, these themes encompass topics like "electric vehicle", "purchasing intention", "policy", and "total cost of ownership", serving as key foundations for understanding consumer behavior towards EFVs and emphasizing the importance of broad, interconnected topics within the research network.

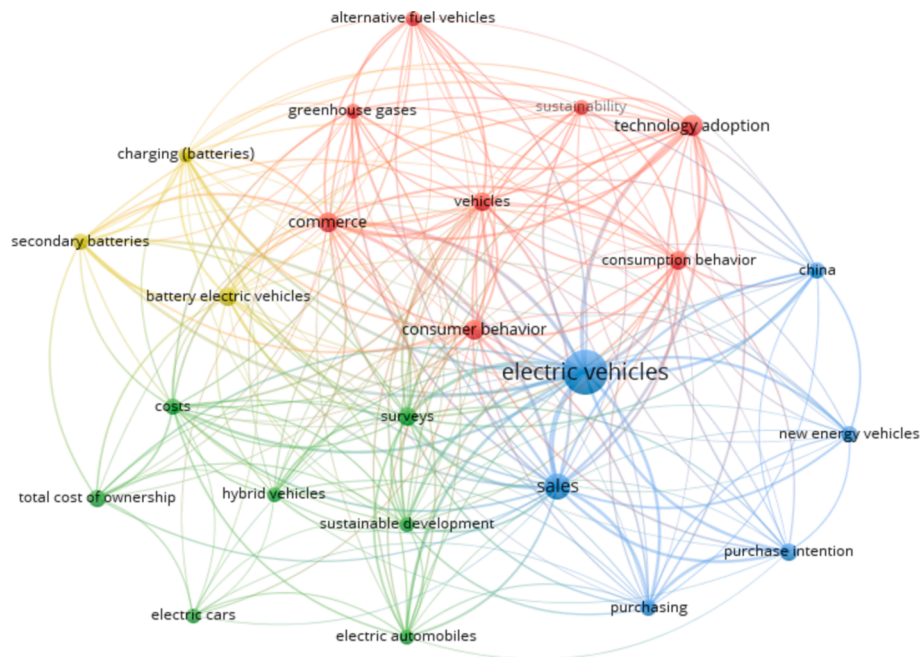**Fig. 10.** Consumers' EFVs behavior keyword-based wordcloud.

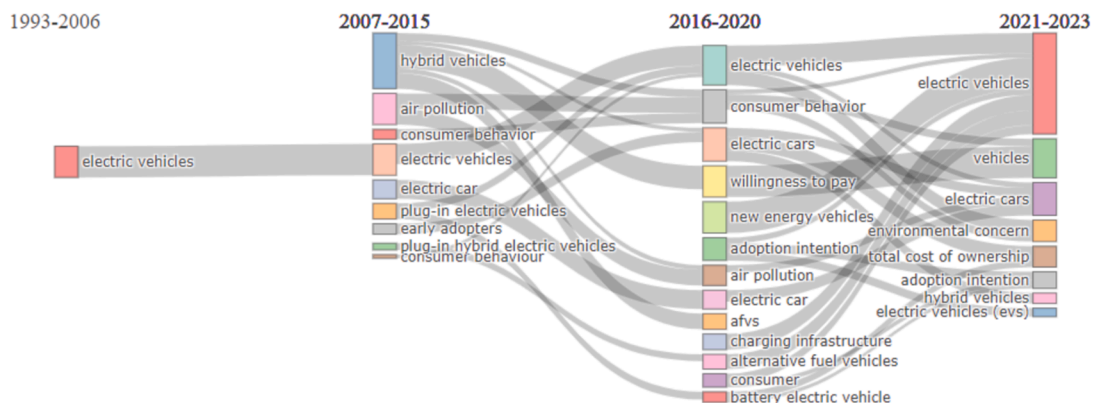**Fig. 11.** Consumers' EFVs behavior keywords co-occurrence network.

Fig. 12. Consumers' EFVs behavior thematic evolution map.

Reference publication year spectroscopy (RPYS)

The references cited in the 662 articles, totaling 13768, were imported into the CRExplorer software. The disambiguation feature of the software was utilized to refine and clean the cited references. Subsequently, the analysis was carried out on the cleaned set of cited references using R software. Fig. 14 illustrates the spectrogram of consumers' EFVs behavior research. The black line indicates the quantity of referenced citations, while the red line reflects the deviation from the 5-year median. The aim was to pinpoint the "citation classics" pivotal to the historical underpinnings of consumers' EFVs behavior. This was achieved by scrutinizing peaks in the red line, which typically denote significant milestones in the research domain.

Table 5 shows the major peaks associated with the consumers' EFVs research. From the table it is evident that the earliest citations date back to 1905, including significant historical works such as Max Lorenz's (Lorenz, 1905) "Methods of measuring the concentration of wealth" which introduced the Lorenz curve and the Lorenz ratio (or Gini coefficient), widely utilized in studying income and wealth distribution. The

first notable peak, with a positive deviation of at least 20, appeared around 1980, nearly eight decades after the earliest historical citation, coinciding with the publication of Kenneth Train's (1980) "The potential market for non-gasoline-powered automobiles". This article focused on developing consumer choice models for public transit using a market segmentation approach by focusing on the different factors that influence individuals' decisions to use public transportation. The second notable peak occurred in 1994 and is associated with the publication of Steven Berry's (Berry, 1994) "Estimating discrete choice models of product differentiation". This paper is considered to be very influential as it examines the challenge of conducting a supply and demand analysis across a range of oligopoly markets featuring products with distinct characteristics. The third notable peak occurred in 2009 and is associated with the publication of Jonn Axsen's (Axsen and Kurani, 2009) "Early US Market for plug-in hybrid electric vehicles: anticipating consumer recharge potential and design priorities". This paper scrutinizes the early stages of the U.S. market for plug-in hybrid electric vehicles and considerations related to consumer recharge potential and design priorities. The fourth notable peak occurred in 2011 and is associated
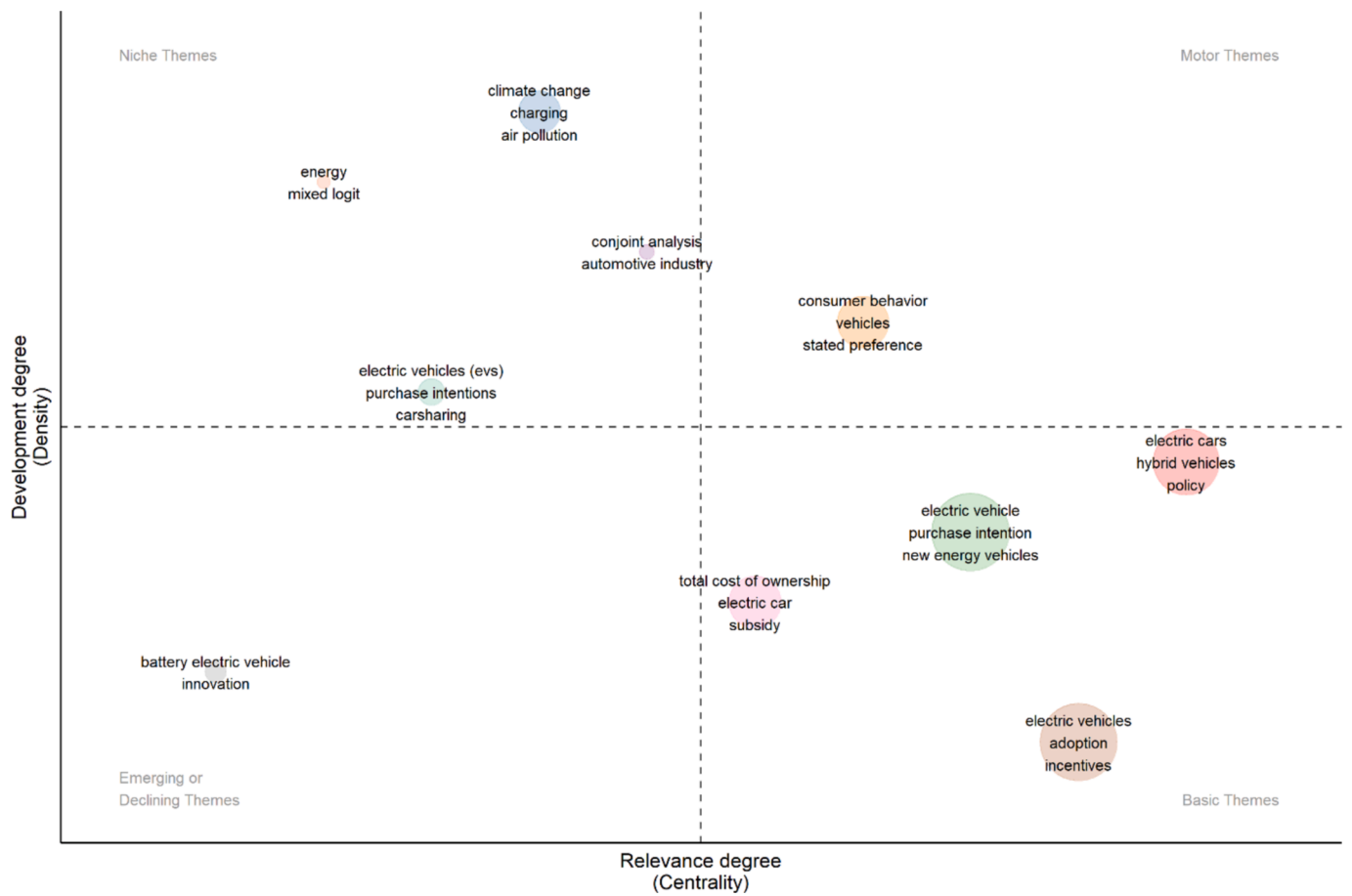
Fig. 13. Consumers' EFVs behavior thematic/strategic map.
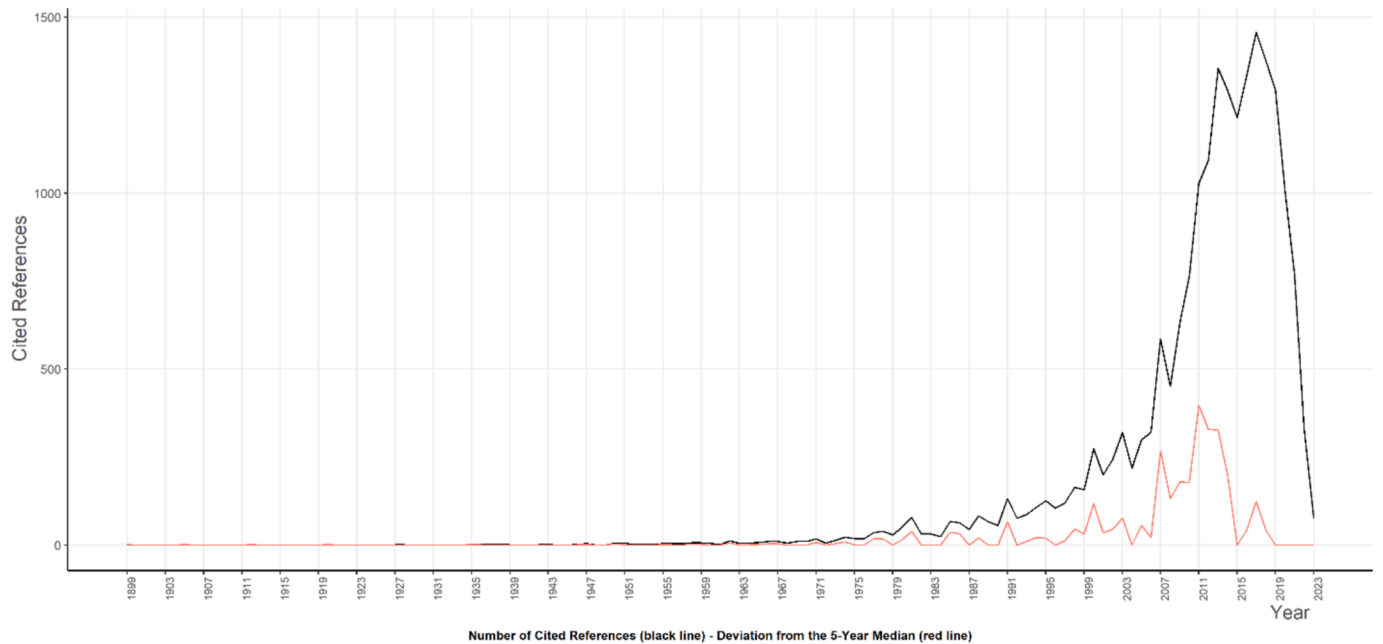
Fig. 14. Consumers' EFVs behavior spectrogram (1900–2023).

with the publication of Jonn Axsen's "Plug-in hybrid vehicle GHG impacts in California: integrating consumer-informed recharge profiles with an electricity-dispatch model energy policy". This paper is considered to be influential as it explored the greenhouse impacts of

plug-in hybrid vehicles in California. The fifth notable peak occurred in 2014 and is associated with the publication of Patrick Plötz's "Who will buy electric vehicles? identifying early adopters in Germany". This paper is very influential in EVs literature as it helps in identifying the

Table 5
RPYS peaks and associated documents.

Year	Citations	5-year median deviation	Document
1905	1	1	Lorenz.
1980	51	20	Train.
1994	73	21	Kurani et al.
2000	274	117	Brownstone et al.
2002	243	44	Ben-akiva et al.
2007	586	267	Chan.
2008	451	131	Bolduc et al.
2009	631	180	Axsen et al.
2010	764	178	Jansson et al.
2011	551	234	Axsen et al.
2014	1291	198	Plötz et al.
2017	1457	124	Andwari et al.

early adopters EVs in Germany. The sixth notable peak occurred in 2017 and is associated with the publication of Nadia Adnan's (Adnan et al., 2017) "Adoption of PHEV/EV in Malaysia: a critical review on predicting consumer behavior renewable and sustainable energy reviews". This paper is considered to be a seminal work in consumers' EFVs behavior research as it explores factors that influence consumers to purchase EFVs.

Discussion and future research agenda

In this research, we used bibliometric methods to analyze consumers' EFVs behavior research over three decades (1993–2023) based on 662 peer-reviewed articles written by 1590 authors from 61 nations. The exponential growth in the scientific production of consumers' EFVs behavior research, particularly from 2006 onwards, aligns with the global efforts to combat climate change. This implies a strong link between environmental concern and the increased focus on consumers' EFVs behavior research. We have conducted a comprehensive bibliometric assessment of all the WoS and Scopus indexed peer-reviewed articles related to consumers' EFVs behavior. This approach was taken to avoid any bias that can result from arbitrarily selecting evidence, potentially leading to a sample selection bias. Additionally, we used SNA to provide a holistic view of the field, uncovering intricate collaborative and interconnected networks within it. This interconnectedness proves valuable in gaining insights into the evolving themes and changing paradigms over time within this field.

Our analysis has revealed some major research trends in the field of consumers' EFVs behavior over three decades. For instance, we have identified a shift from early research on EVs to more recent studies on hybrid vehicles and self-driving cars. Understanding such trends can help researchers, policymakers, and marketers in their endeavor to formulate policies and strategies aiming at formulating marketing and advertising campaigns geared towards pro-environmental consumers. Our bibliometric network analysis has also highlighted influential authors and institutions that have made substantial contributions to the field. This information is valuable for recognizing major research hubs, which can be helpful for developing collaborative initiative and resource allocation.

Moreover, results show that the collaborative network between authors is sparse. This can be linked to the dynamic and evolving landscape of EFVs behavior research, characterized by changing trends, methodologies, and cultural influences over time. The sparse network possibly stems from geographical dispersion, disciplinary variations, or a lack of well-organized initiatives. The wordcloud and thematic evolution map indicated a pronounced emphasis on keywords like "electric vehicles", "hybrid vehicles", "new energy vehicles", "total cost of ownership" and "purchase intention". This trend may be reflective of a broader shift in the automotive industry towards sustainable transportation solutions. The prevalence of these keywords suggests that researchers are keen on understanding both the technological aspects of EFVs and the behavioral dynamics of consumers. Based on the study findings, we suggest the

following research agenda based the theory, methodology and context (Paul & Cestero, 2021):

Exploring the role of technological innovations in shaping consumers' attitudes toward EFVs

Our results indicate that there is a critical need to investigate the role of technological innovations in shaping consumers' perceptions toward EFVs. Despite a robust body of research on consumers' EFVs behavior (Axsen et al., 2009; Wang et al., 2019; Andwari et al., 2017), there remains a significant gap in understanding how advancements in EFVs technology, infrastructure, and automation influence consumer decision-making processes. For instance, our thematic analysis shows that consumer preferences and adoption factors related to EFVs have been extensively studied. The thematic and keyword co-occurrence analyses further emphasize key technological themes such as "new energy vehicles", "sustainability" and "technology adoption" indicating their relevance in the EFVs discourse but underscoring the need for more focused research on their integration into consumer decision-making frameworks. For instance, while the wordcloud analysis shows significant attention paid to "electric vehicles" and "consumer behavior", it also reveals limited exploration into how these technologies directly impact consumer perceptions and choices. Future research should focus on examining how technological innovations, such as advancements in energy storage, charging infrastructure, and automation, influence consumers' perceptions and decision-making processes regarding EFVs.

Policy development and equity implications

The results of this study highlight a significant gap in policy-oriented research regarding consumers' EFV behavior. Existing literature primarily focuses on understanding consumer preferences and adoption factors related to EFVs (Axsen et al., 2009; Tan et al., 2021; Zhang et al., 2019). While financial incentives such as subsidies, tax breaks, and rebates play a crucial role in encouraging consumers to adopt EFVs, equity considerations are vital in ensuring their effectiveness. Lower-income consumers may still face barriers, such as the high upfront cost of EFVs, despite the availability of incentives. This gap emphasizes the need for policies that ensure equitable access to sustainable transportation options across all socioeconomic groups. Moreover, there is a noticeable scarcity of studies that explore the impacts and implementation strategies of policies aimed at promoting EFVs adoption. Thematic analysis reveals key topics in the literature, including "electric vehicles", "consumer behavior", "total cost of ownership", and "purchasing". While these themes demonstrate the breadth of research on various aspects of EFVs, the co-occurrence network analysis indicates a significant gap in connecting these themes with policy outcomes. This underscores the need for research that bridges consumer behavior insights with effective policy frameworks to drive higher adoption rates of EFVs and promote sustainable transportation initiatives. Future research should focus on investigating the effects of various policy measures on the adoption and integration of EFVs. This includes examining how different policy frameworks influence consumer behavior, as well as evaluating the effectiveness of financial incentives, regulatory measures, and infrastructure investments in promoting EFVs. Studies should aim to bridge the gap between consumer behavior research and policy development, providing a comprehensive analysis of how policies can be designed and implemented to support sustainable transportation initiatives and enhance EFV adoption rates.

Addressing global diversity in consumers' EFVs behavior

This study detected a lack of cross-cultural research on consumers' EFVs behavior (Axsen et al., 2009; Tan et al., 2021; Zhang et al., 2019). The collaboration network analysis reveals limited engagement from other regions, including the Middle East and various parts of Asia,

suggesting a narrow geographical focus. This indicates a pressing need for more in-depth cross-cultural analysis of consumers' EFVs behavior across different countries. Exploring how cultural, economic, and policy variations impact the adoption and perception of EFVs could provide valuable insights. For instance, qualitative studies, surveys, or focus groups could identify cultural nuances influencing consumer decisions, such as differing attitudes toward sustainability and technology. This approach could lead to region-specific interventions to promote EFVs adoption, ensuring that policies and marketing strategies are tailored to the unique characteristics of each cultural context, thereby enhancing the global uptake of consumers' EFVs behavior knowledge. Future research should prioritize cross-cultural studies to examine how cultural, economic, and policy differences affect consumers' perceptions and adoption of EFVs. This includes conducting qualitative research, surveys, and focus groups across diverse regions to uncover cultural nuances and preferences. By identifying region-specific factors influencing consumer behavior, researchers can develop tailored policies and marketing strategies that address local needs and enhance EFVs adoption.

The dynamics of consumers' EFVs behavior research trends

This study found that most of the consumers' EFVs research published so far is cross-sectional (Funke et al., 2019; Peters and Dütschke, 2014; Plötz et al., 2014). The study findings highlight a need for more detailed temporal analysis of emerging trends in consumers' EFVs behavior. For instance, the growth of scientific production in this field shows an exponential trend, particularly between 2013 and reaching a peak in 2023. This suggests significant shifts in consumer preferences and research focus over time. However, the data also reveals that from 1983 to 2005, publications on consumers' EFVs behavior were rare, likely due to the lack of technological advancements and available consumer data. Key events such as the growing awareness of climate change between 2006 and 2011, and the pressing environmental concerns highlighted in 2013–2022, have influenced these shifts. Future research should focus on conducting longitudinal studies to analyze the evolution of consumer behavior toward EFVs over extended periods. This includes identifying and examining specific turning points, key events, and technological advancements that have influenced shifts in consumer preferences. By investigating the impact of historical events, policy changes, and technological innovations, researchers can gain a deeper understanding of the factors driving changes in EFVs adoption.

Conclusions

This study is innovative from several perspectives: (1) From a theoretical perspective, this study identified influential authors, dominant countries, and leading institutions revealing a global research effort. Key themes and seminal articles are highlighted, demonstrating the multifaceted nature of EFVs consumer behavior research, encompassing environmental, economic, social, and economic-related aspects. The study's network and keyword analyses elucidate the dynamic evolution of the field, offering a comprehensive understanding of the critical factors influencing consumers' EFVs adoption, such as driving range, cost, sustainability and technological advancements. By applying bibliometric measures through the SNA and PRISMA methodology such as the dominance factor and Lotka's law, it showcases the patterns of author prominence and productivity, and through co-citation and collaboration network analyses, it uncovers the diverse and interdisciplinary nature of the research. Additionally, thematic evolution further reveals the shifting focus and conceptual structure of the research, uncovering the diverse and interdisciplinary nature of the field.

(2) From a practical perspective, understanding consumers' EFVs preferences and the factors driving adoption, such as environmental awareness and charging infrastructure, can inform the development of more appealing and accessible EFVs, thereby enhancing market

strategies and product offerings. The geographical analysis of research output highlights regions with high EFVs research activity, guiding companies and governments on where to focus their efforts on market expansion and policy implementation. Additionally, the collaboration network analysis suggests potential partnerships and collaborative opportunities for academic and industry researchers, fostering innovation and technological advancements in the EFVs sector. The thematic and trend analyses provide a roadmap for future research, identifying emerging areas and gaps that require further exploration, thus ensuring continued progress in understanding and improving consumers' behavior toward EFVs.

Limitations and future research avenues

While this study has made valuable contributions, it is subject to certain limitations. First, the study's dataset was limited to English-language publications, potentially limiting its scope. Future research may explore incorporating other languages to enhance the breadth of coverage and assess the generalizability of findings. Our bibliometric network analysis is based on quantitative data, which may not capture the full complexity of research dynamics and interactions within the consumers' EFVs community. Qualitative methods, such as interviews or surveys, could provide richer insights into the motivations, perspectives, and challenges faced by researchers in this field. Future research could employ mixed methods approaches to integrate qualitative and quantitative data for a more nuanced understanding of consumers' EFVs research dynamics.

CRediT authorship contribution statement

Ahmed M. Moustafa: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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.

Data availability

Data will be made available on request.

References

Abdollahi, A., Rejeb, K., Rejeb, A., Mostafa, M.M., Zailani, S., 2021. Wireless sensor networks in agriculture: Insights from bibliometric analysis. Sustainability 13 (21), 12011.

Accetturo, A., Barboni, G., Cascarano, M., & Garcia-Appendini, E. (2021). Cultural proximity and the formation of lending relationships. Available at SSRN.

Adnan, N., Nordin, S.M., Rahman, I., 2017. Adoption of PHEV/EV in Malaysia: a critical review on predicting consumer behaviour. Renew. Sustain. Energy Rev. 72, 849–862.

Afridi, S.A., Khan, W., Haider, M., Shahjehan, A., Afsar, B., 2021. Generativity and green purchasing behavior: moderating role of man-nature orientation and perceived behavioral control. SAGE Open 11 (4), 21582440211054480.

Alnajem, M., Mostafa, M.M., ElMelegy, A.R., 2021. Mapping the first decade of circular economy research: a bibliometric network analysis. J. Ind. Prod. Eng. 38 (1), 29–50.

Andwari, A.M., Pesiridis, A., Rajoo, S., Martinez-Botas, R., Esfahanian, V., 2017. A review of Battery Electric Vehicle technology and readiness levels. Renew. Sustain. Energy Rev. 78, 414–430.

Aryadoust, V., Ang, B.H., 2021. Exploring the frontiers of eye tracking research in language studies: a novel co-citation scientometric review. Comput. Assist. Lang. Learn. 34 (7), 898–933.

Axsen, J., Kurani, K.S., 2009. Early US market for plug-in hybrid electric vehicles: anticipating consumer recharge potential and design priorities. Transportation Research Record 2139 (1), 64–72.

Axsen, J., Mountain, D.C., Jaccard, M., 2009. Combining stated and revealed choice research to simulate the neighbor effect: The case of hybrid-electric vehicles. Resour. Energy Econ. 31 (3), 221–238.

Axsen, J., Kurani, K.S., McCarthy, R., Yang, C., 2011. Plug-in hybrid vehicle GHG impacts in California: Integrating consumer-informed recharge profiles with an electricity-dispatch model. Energy Policy 39 (3), 1617–1629.

Balali, Y., Stegen, S., 2021. Review of energy storage systems for vehicles based on technology, environmental impacts, and costs. Renew. Sustain. Energy Rev. 135, 110185.

Ben-Akiva, M., McFadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., Munizaga, M. A., 2002. Hybrid choice models: Progress and challenges. Mark. Lett. 13, 163–175.

Berry, S.T., 1994. Estimating discrete-choice models of product differentiation. Rand J. Econ. 242–262.

Bolduc, D., Boucher, N., Alvarez-Daziano, R., 2008. Hybrid choice modeling of new technologies for car choice in Canada. Transp. Res. Rec. 63–71.

Brownstone, D., Bunch, D.S., Train, K., 2000. Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles. Transp. Res. B Methodol. 34 (5), 315–338.

Bunch, D.S., Bradley, M., Golob, T.F., Kitamura, R., Occhiuzzo, G.P., 1993. Demand for clean-fuel vehicles in California: a discrete-choice stated preference pilot project. Transp. Res. A Policy Pract. 27 (3), 237–253.

Callon, M., Courtial, J.P., Laville, F., 1991. Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemistry. Scientometrics 22, 155–205.

Capstick, S., Whitmarsh, L., Poortinga, W., Pidgeon, N., Upham, P., 2015. International trends in public perceptions of climate change over the past quarter century. Clim. Change 6 (1), 35–61.

Chan, C.C., 2007. The state of the art of electric, hybrid, and fuel cell vehicles. Proc. IEEE 95 (4), 704–718.

Dash, S.K., Chakraborty, S., Roccotelli, M., Sahu, U.K., 2022. Hydrogen fuel for future mobility: Challenges and future aspects. Sustainability 14 (14), 8285.

Egbue, O., Long, S., 2012. Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy Policy 48, 717–729.

Eppstein, M.J., Grover, D.K., Marshall, J.S., Rizzo, D.M., 2011. An agent-based model to study market penetration of plug-in hybrid electric vehicles. Energy Policy 39 (6), 3789–3802.

Funke, S.Á., Sprei, F., Gnann, T., Plötz, P., 2019. How much charging infrastructure do electric vehicles need? A review of the evidence and international comparison. Transp. Res. Part D: Transp. Environ. 77, 224–242.

García-Salirrosas, E.E., Rondon-Eusebio, R.F., 2022. Green marketing practices related to key variables of consumer purchasing behavior. Sustainability 14 (14), 8499.

Ghorbani, E., Alinaghian, M., Gharehpetian, G.B., Mohammadi, S., Perboli, G., 2020. A survey on environmentally friendly vehicle routing problem and a proposal of its classification. Sustainability 12 (21), 9079.

Guo, Y., Hao, Z., Zhao, S., Gong, J., Yang, F., 2020. Artificial intelligence in health care: bibliometric analysis. Journal of Medical Internet Research 22 (7), e18228.

Gupta, S. (2021). A Categorical Review paper on Bibliometric and Citation Studies.

Hardman, S., Jenn, A., Tal, G., Axsen, J., Beard, G., Daina, N., Witkamp, B., 2018. A review of consumer preferences of and interactions with electric vehicle charging infrastructure. Transp. Res. Part D: Transp. Environ. 62, 508–523.

Hassanein, A., Mostafa, M.M., 2023. Bibliometric network analysis of thirty years of islamic banking and finance scholarly research. Qual. Quant. 57 (3), 1961–1989.

Hidrue, M.K., Parsons, G.R., Kempton, W., Gardner, M.P., 2011. Willingness to pay for electric vehicles and their attributes. Resour. Energy Econ. 33 (3), 686–705.

Hu, X., Zhou, R., Wang, S., Gao, L., Zhu, Z., 2023. Consumers' value perception and intention to purchase electric vehicles: A benefit-risk analysis. Res. Transp. Bus. Manag. 49, 101004.

Hwang, J., Lyu, S.O., 2020. Relationships among green image, consumer attitudes, desire, and consumer citizenship behavior in the airline industry. Int. J. Sustain. Transp. 14 (6), 437–447.

İmre, Ş., Çelebi, D., Asan, U., 2024. Estimating potential adoption rate of electric vehicles in urban logistics. Transp. Plan. Technol. 47 (3), 370–399.

International Energy Agency. (2021). Global EV Outlook 2021.

Irfan, M., Ahmad, M., 2021. Relating consumers' information and willingness to buy electric vehicles: Does personality matter? Transp. Res. Part D: Transp. Environ. 100, 103049.

Jansson, J., Marell, A., Nordlund, A., 2010. Green consumer behavior: determinants of curtailment and eco-innovation adoption. J. Consum. Mark. 27 (4), 358–370.

Jayasekara, D.N., Tan, J.H., 2024. How do intercultural proximity and social fragmentation promote international patent cooperation? Small Bus. Econ. 63 (1), 421–445.

Kahn, M.E., 2007. Do greens drive Hummers or hybrids? Environmental ideology as a determinant of consumer choice. J. Environ. Econ. Manag. 54 (2), 129–145.

Kchaou-Boujelben, M., 2021. Charging station location problem: A comprehensive review on models and solution approaches. Transp. Res. Part C Emerging Technol. 132, 103376.

Keles, D., Wietschel, M., Möst, D., Rentz, O., 2008. Market penetration of fuel cell vehicles–Analysis based on agent behaviour. Int. J. Hydrogen Energy 33 (16), 4444–4455.

Khan, G.F., Wood, J., 2016. Knowledge networks of the information technology management domain: A social network analysis approach. Commun. Assoc. Inf. Syst. 39 (1), 18.

Khasseh, A.A., Soheili, F., Moghaddam, H.S., Chelak, A.M., 2017. Intellectual structure of knowledge in iMetrics: A co-word analysis. Inf. Process. Manag. 53 (3), 705–720.

Knoke, D., Yang, S., 2019. Social network analysis. SAGE publications.

Krupa, J.S., Rizzo, D.M., Eppstein, M.J., Lanute, D.B., Gaalema, D.E., Lakkaraju, K., Warrender, C.E., 2014. Analysis of a consumer survey on plug-in hybrid electric vehicles. Transp. Res. A Policy Pract. 64, 14–31.

Kumar, R.R., Alok, K., 2020. Adoption of electric vehicle: A literature review and prospects for sustainability. J. Clean. Prod. 253, 119911.

Kumar, A., Paul, J., Unnithan, A.B., 2020. 'Masstige'marketing: A review, synthesis and research agenda. J. Bus. Res. 113, 384–398.

Kurani, K.S., Turrentine, T., Sperling, D., 1994. Demand for electric vehicles in hybrid households: an exploratory analysis. Transp. Policy 1 (4), 244–256.

Kwon, S.W., Rondi, E., Levin, D.Z., De Massis, A., Brass, D.J., 2020. Network brokerage: An integrative review and future research agenda. J. Manag. 46 (6), 1092–1120.

Law, J., Bauin, S., Courtial, J., Whittaker, J., 1988. Policy and the mapping of scientific change: A co-word analysis of research into environmental acidification. Scientometrics 14 (3–4), 251–264.

Liao, F., Molin, E., van Wee, B., 2017. Consumer preferences for electric vehicles: a literature review. Transp. Rev. 37 (3), 252–275.

Li, L., Wang, Z., Chen, L., Wang, Z., 2020. Consumer preferences for battery electric vehicles: A choice experimental survey in China. Transp. Res. Part D: Transp. Environ. 78, 102185.

Llopis-Albert, C., Rubio, F., Valero, F., 2021. Impact of digital transformation on the automotive industry. Technol. Forecast. Soc. Chang. 162, 120343.

Lorenz, M.O., 1905. Methods of measuring the concentration of wealth. J. Am. Stat. Assoc. 9 (70), 209–219.

Martino, F., Spoto, A., 2006. Social Network Analysis: A brief theoretical review and further perspectives in the study of Information Technology. PsychNology J. 4 (1), 53–86.

Marx, W., Haunschild, R., Thor, A., Bornmann, L., 2017. Which early works are cited most frequently in climate change research literature? A bibliometric approach based on reference publication year spectroscopy. Scientometrics 110, 335–353.

Maulidiya, D., Nugroho, B., Santoso, H.B., Hasibuan, Z.A., 2024. Thematic evolution of smart learning environments, insights and directions from a 20-year research milestones: A bibliometric analysis. Heliyon.

McCarthy, R., Yang, C., 2010. Determining marginal electricity for near-term plug-in and fuel cell vehicle demands in California: Impacts on vehicle greenhouse gas emissions. J. Power Sources 195 (7), 2099–2109.

McPherson, M., Smith-Lovin, L., Cook, J.M., 2001. Birds of a feather: Homophily in social networks. Annu. Rev. Sociol. 27 (1), 415–444.

Melander, L., Nyquist-Magnusson, C., Wallström, H., 2022. Drivers for and barriers to electric freight vehicle adoption in Stockholm. Transp. Res. Part D: Transp. Environ. 108, 103317.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group, T, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann. Intern. Med. 151 (4), 264–269.

Mostafa, M.M., 2022. Five decades of catastrophe theory research: Geographical atlas, knowledge structure and historical roots. Chaos Solitons Fractals 159, 112078.

Mostafa, M.M., 2023. Twenty years of Wikipedia in scholarly publications: a bibliometric network analysis of the thematic and citation landscape. Qual. Quant. 1–31.

Mostafa, M.M., 2024. A Social Network Analysis of The Citation Diffusion of Academic Articles. Int. J. Inf. Technol.

Nealer, R., Hendrickson, T.P., 2015. Review of recent lifecycle assessments of energy and greenhouse gas emissions for electric vehicles. Current Sustainable/Renewable Energy Reports 2, 66–73.

Novak, J. D., & Cañas, A. J. (2008). The theory underlying concept maps and how to construct and use them.

Nova-Reyes, A., Muñoz-Leiva, F., Luque-Martínez, T., 2020. The tipping point in the status of socially responsible consumer behavior research? A Bibliometric Analysis. Sustainability 12 (8), 3141.

Ozaki, R., Sevastyanova, K., 2011. Going hybrid: An analysis of consumer purchase motivations. Energy Policy 39 (5), 2217–2227.

Paul, J., Feliciano-Cestero, M.M., 2021. Five decades of research on foreign direct investment by MNEs: An overview and research agenda. J. Bus. Res. 124, 800–812.

Peters, A., Dütschke, E., 2014. How do consumers perceive electric vehicles? A comparison of German consumer groups. J. Environ. Plann. Policy Manage. 16 (3), 359–377.

Phulwani, P.R., Kumar, D., Goyal, P., 2020. A systematic literature review and bibliometric analysis of recycling behavior. J. Glob. Mark. 33 (5), 354–376.

Plötz, P., Schneider, U., Globisch, J., Dütschke, E., 2014. Who will buy electric vehicles? Identifying early adopters in Germany. Transp. Res. A Policy Pract. 67, 96–109.

Pranckutè, R., 2021. Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. Publications 9 (1), 12.

Qin, Y., Xu, Z., Wang, X., Škare, M., 2022. Green energy adoption and its determinants: A bibliometric analysis. Renew. Sustain. Energy Rev. 153, 111780.

Rejeb, A., Abdollahi, A., Rejeb, K., Treiblmaier, H., 2022. Drones in agriculture: A review and bibliometric analysis. Comput. Electron. Agric. 198, 107017.

Rejeb, A., Rejeb, K., Treiblmaier, H., 2023. Mapping metaverse research: identifying future research areas based on bibliometric and topic modeling techniques. Information 14 (7), 356.

Resch, C., Kock, A., 2021. The influence of information depth and information breadth on brokers' idea newness in online maker communities. Res. Policy 50 (8), 104142.

Rezvani, Z., Jansson, J., Bodin, J., 2015. Advances in consumer electric vehicle adoption research: A review and research agenda. Transp. Res. Part D: Transp. Environ. 34, 122–136.

Sadatmoosavi, A., Tajedini, O., Esmaeili, O., Abolhasani Zadeh, F., Khazaneha, M., 2021. Emerging trends and thematic evolution of breast cancer: Knowledge mapping and co-word analysis. JMIR cancer 7 (4), e26691.

Sahu, A., Jena, P., 2022. Lotka's law and author productivity pattern of research in law discipline. Collection and Curation 41 (2), 62–73.

Salari, N., 2022. Electric vehicles adoption behaviour: Synthesising the technology readiness index with environmentalism values and instrumental attributes. Transp. Res. A Policy Pract. 164, 60–81.

Secinaro, S., Calandra, D., Lanzalonga, F., Ferraris, A., 2022. Electric vehicles' consumer behaviours: Mapping the field and providing a research agenda. J. Bus. Res. 150, 399–416.

Serrano-Arcos, M.M., Sánchez-Fernández, R., Pérez-Mesa, J.C., Riefler, P., 2022. A review of consumer affinity research: recent advances and future directions. Int. Mark. Rev. 39 (5), 1252–1282.

Sher, F., Chen, S., Raza, A., Rasheed, T., Razmkhah, O., Rashid, T., Erten, B., 2021. Novel strategies to reduce engine emissions and improve energy efficiency in hybrid vehicles. Cleaner Engineering and Technology 2, 100074.

Shi, B., Wei, W., Qin, X., Zhao, F., Duan, Y., Sun, W., Cao, Y., 2019. Mapping theme trends and knowledge structure on adipose-derived stem cells: a bibliometric analysis from 2003 to 2017. Regenerative medicine 14 (1), 33–48.

Tan, H., Li, J., He, M., Li, J., Zhi, D., Qin, F., Zhang, C., 2021. Global evolution of research on green energy and environmental technologies: A bibliometric study. J. Environ. Manage. 297, 113382.

Train, K., 1980. The potential market for non-gasoline-powered automobiles. Transportation Research Part a: General 14 (5–6), 405–414.

Tranfield, D., Denyer, D., Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. Br. J. Manag. 14 (3), 207–222.

Verified Market Research, 2024. (n.d.). Green vehicles market size and forecast. Retrieved from https://www.verifiedmarketresearch.com/product/green-vehicles-market/#:~:text=Green%20Vehicles%20Market%20size%20was,to%20boost%20the%20market%20growth.

Wang, J., Luo, T., Fu, T., 2019. Crash prediction based on traffic platoon characteristics using floating car trajectory data and the machine learning approach. Accident Analysis & Prevention 133, 105320.

Wang, Y., Hao, C., Ge, Y., Hao, L., Tan, J., Wang, X., Li, J., 2020. Fuel consumption and emission performance from light-duty conventional/hybrid-electric vehicles over different cycles and real driving tests. Fuel 278, 118340.

Wiarda, M., van de Kaa, G., Yaghmaei, E., Doorn, N., 2021. A comprehensive appraisal of responsible research and innovation: From roots to leaves. Technol. Forecast. Soc. Chang. 172, 121053.

Wijewickrama, M.K.C.S., Rameezdeen, R., Chileshe, N., 2021. Information brokerage for circular economy in the construction industry: A systematic literature review. J. Clean. Prod. 313, 127938.

Williamsson, J., Moen, O., 2022. Barriers to business model innovation in the Swedish urban freight transport sector. Res. Transp. Bus. Manag. 45, 100799.

Xu, Z., Wang, X., Wang, X., Skare, M., 2021. A comprehensive bibliometric analysis of entrepreneurship and crisis literature published from 1984 to 2020. J. Bus. Res. 135, 304–318.

Yang, K., Wang, L., Yang, G., Jiang, X., 2022. Research hotspots and trends in nursing education from 2014 to 2020: A co-word analysis based on keywords. J. Adv. Nurs. 78 (3), 787–798.

Yap, K.Y., Chin, H.H., Klemeš, J.J., 2022. Solar Energy-Powered Battery Electric Vehicle charging stations: Current development and future prospect review. Renew. Sustain. Energy Rev. 169, 112862.

Ye, N., Kueh, T.B., Hou, L., Liu, Y., Yu, H., 2020. A bibliometric analysis of corporate social responsibility in sustainable development. J. Clean. Prod. 272, 122679.

Yong, Y., Polak, J., Tretvik, T. K., Roche-Cerasi, I., Quak, H., Nesterova, N., & van Rooijen, T. (2018). Electric freight vehicles for urban logistics–technical performance, economics feasibility and environmental impacts. Proceedings of 7th Transport Research Arena TRA 2018, April 16-19, 2018, Vienna, Austria.

Zhang, S., Wang, H., Zhang, Y.F., Li, Y.Z., 2019. A novel two-stage location model of charging station considering dynamic distribution of electric taxis. Sustainable Cities and Society 51, 101752.

Zhao, D., Strotmann, A., 2015. Analysis and visualization of citation networks. Morgan & Claypool Publishers.

Zhu, J., Liu, W., 2020. A tale of two databases: the use of Web of Science and Scopus in academic papers. Scientometrics 123 (1), 321–335.

Zou, X., Yue, W.L., Le, Vu., H., 2018. Visualization and analysis of mapping knowledge domain of road safety studies. Accid. Anal. Prev. 118, 131–145.