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# Electric Vehicle Adoption in India: A Decade of Research Trends and Insights Through Bibliometric Analysis

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**Abstract**
The transition to electric vehicles (EVs) in India represents a pivotal shift in the nation's sustainable mobility agenda, yet their adoption remains constrained by multifaceted challenges. This study offers the first comprehensive bibliometric analysis of electric vehicle adoption (EVA) research in the Indian context, tracing its evolution over the period 2014–2024. Drawing from a curated dataset of 153 Scopus-indexed journal articles, the study employs performance analysis, co-word analysis, co-citation mapping, and bibliographic coupling using Biblioshiny and vosviewer tools. The findings reveal a sharp acceleration in research output post-2020, driven by policy momentum, technological advancements, and rising environmental concerns. Thematic evolution analysis uncovers a progressive shift from early concerns around infrastructure and policy gaps to more recent emphasis on integrated adoption strategies, battery technology, and sustainable urban mobility. High-impact studies predominantly focus on consumer behavior, total cost of ownership, and policy effectiveness, with limited but growing international collaboration. This review highlights key research clusters, knowledge gaps, and emerging themes, offering valuable insights for academics, policymakers, and industry stakeholders. It also presents the direction of future research with a focus on consumer-centric models, renewable integration, and data-based policy frameworks to help speed up EV adoption in India.

**Keywords:** EV adoption in India, Electric mobility ecosystem, Sustainable transportation, Co-citation and thematic evolution, Bibliometric analysis

## 1. Introduction

The shift to electric vehicles has emerged as one of the elements of sustainable mobility in India, particularly regarding the fight against climate change, environmental protection, and increased energy resilience in the country. The most significant of a limited number of targeted policy measures and financial incentives that the Indian government has introduced to accelerate this shift is the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) project. The program aims to provide the manufacturers and the end-users with economic incentives, thus contributing to the mass adoption of electric mobility (Digalwar and Rastogi, 2023; Manikandan and Gudipalli, 2022). The fact that these policies will be aligned with the overall environmental goals of India, in particular, its aims in the field of reducing carbon emissions and improving air quality in cities, is important, as India faces serious pollution problems (Bhosale and Mastud, 2023; Vidhi and Shrivastava, 2018).

The introduction of electric vehicles (EVs) in large quantities is associated with a large environmental impact. In comparison to conventional cars that generate and work with the assistance of internal combustion engines, EVs release much less greenhouse gas and air pollution and, thus, are a more acceptable and cleaner solution to use in future transportation (Bhosale and Mastud, 2023; Vidhi and Shrivastava, 2018). It is reported that the adoption of EVs can potentially lower the consumption of fossil fuels significantly, which is essential in enhancing the energy security of India (Aryan Gupta, 2024; Gopinathan and Shanmugam, 2022). Additionally, EVs will lead to a huge number of individuals having their jobs and the renewable energy business, which will stimulate economic growth and resolve the environmental problem (Manikandan & Gudipalli, 2022; TRANSITIONING TO ELECTRIC VEHICLES-AN EMPIRICAL STUDY, 2024).

However, despite the many economic and environmental benefits, the introduction of electric vehicles a large scale is still faced with many challenges in India. A lack of sufficient charging infrastructure is one of the most critical aspects since it will decrease consumer confidence and inhibit the potential of transition to being an electric mobility user. The insufficient number of charging stations instills fear in potential consumers of the lack of power resources, thus delaying the transition to

cleaner transportation (Dixit and Singh, 2022; Yadav et al., 2024). It has also been discovered that consumer perceptions and attitudes towards EVs are another vital aspect of the adoption rate, and financial incentives are a key influencing factor among the intentions of prospective buyers (Ali and Naushad, 2022b, 2022a). Moreover, though vehicles that operate using electricity have low operational costs compared to traditional vehicles, most consumers have been scared away by high initial costs. (Kumar & Chakrabarty, 2020; Liao et al., 2019). Research on EV adoption in India is growing, offering light on the several aspects that influence consumer choices. Socioeconomic conditions, as well as the impact of government policy, play a vital part in deciding how soon people are willing to adopt electric automobiles (Bhat, Seth, et al., 2024; "IIDENTIFYING AND EVALUATING THE FINANCIAL INCENTIVES AND SOCIO-ECONOMIC FACTORS AFFECTING THE ADOPTION OF ELECTRIC VEHICLES IN INDIA," 2023). Indicatively, machine learning has been used by multiple researchers to examine and forecast consumer behavior during the acquisition of electric vehicles. These results suggest that a person will be more willing to think of EV when he/she recognize visible environmental positives, and are motivated by desirable financial rewards. (Bhat et al., 2022; Dixit & Singh, 2022).

This study examines the progress of EV adoption research in India using a bibliometric review. It is trying to provide the answers to two basic scientific questions:

**RQ1.** What are the primary research trends in EV adoption studies in India?

**RQ2.** What are the gaps in current studies, and what are possible recommendations that could be proposed to conduct further research?

In order to answer these questions, the bibliometric analysis of research patterns and associations is performed within the research in the context of bibliometric tools like Biblioshiny and VOS Viewer. Using the performance analysis and science mapping techniques, it offers certain underlying tendencies, the most impactful researchers, co-citation networks, and broad themes that inform EV adoption research in India.

The paper shall be aimed at providing an elaborate overview of the work done on the adoption of electric cars in India. Section 2 includes the methodology, which entails the description of data collection and bibliometric tools. Section 3 contains the most important findings, which reveal the key research trends, the most significant ones, and intellectual connections in the field.

Sections 4 and 5 will provide the analysis of the findings of the study, limitations of it are identified, and recommendations are provided regarding future research. The study on the investigation of such features aims not only to learn more about the factors affecting the EV adoption in India but also to have valuable information that can inform the policy and industry's sustainable transportation policies based on data.

## 2. Methodology

The paper is dedicated to the development of the electric vehicle adoption (EVA) research in India, where it is possible to outline essential tendencies and aspects that impact the world. The performance measures, temporal pattern, and the science mapping methods will be combined in the analysis based on the bibliometric review. **Figure 1** illustrates the general research design and analysis plan in order to understand it better. The further findings and discussions are essential keys to state the developments that EVA research in India has undergone throughout the years.

### 2.1 Bibliographic Data Compilation and Source Criteria

The bibliographic data that have been utilized within the present study have been obtained on the Scopus database by using a systematically designed search query. The search string used was:

**TITLE-ABS-KEY ("Electric Vehicles" AND adoption AND India) AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")).**

In this research, bibliographic records of the Scopus database were searched based on the keywords "Electric vehicle", "India", and "Adoption", targeting literature published between 1971 and 2025. Following the relevance test, 210 articles were filtered out due to a lack of representation of the scope of the study. The remaining 158 records were further narrowed down based on pre-determined inclusion criteria that only included the journal articles that specifically addressed the electric vehicle adoption (EVA) in India. To guarantee that the information is not destroyed, the duplicate and unfinished entries were removed. Eventually, 153 articles that were eligible based on all quality and other criteria were to be analyzed. The selected data reflects a great and diversified overview of the dynamic world in EVA research in India.

### 2.2 Analytical Strategies

In the current study, a combination of data mining and analytic techniques was employed to come up with meaningful and robust findings, as Qin et al. (2022) propose. The ultimate objective was to perform a properly structured and repeatable literature review of the literature that existed in a bibliometric prism (Tranfield et al., 2003). To do so, the trends of publications and institutional distribution were plotted in Biblioshiny of R Studio, the methodological framework was founded on (Aria and Cuccurullo, 2017). Moreover, the co-occurrence analysis was conducted to uncover conceptual

relationships in the literature and predominant thematic clusters (Gurzki and Woisetschlager, 2017; Koseoglu, 2016). Co-authorship networks and correlation between keywords were also used during the analysis of the trends of academic collaboration and convergence in themes (Turatto et al., 2021). On the whole, these approaches allowed building a general understanding of the intellectual paradigm of EVA research in India.

The influential sources and foundational research, along with intellectual connections in the literature, were retrieved with the help of the citation-based mapping approaches, i.e., co-citation and bibliographic coupling (Kovács et al., 2015; Su and Lee, 2010). They were processed through vosviewer (van Eck & Waltman, 2010), and interconnections between documents, journals, and authors could be presented graphically.

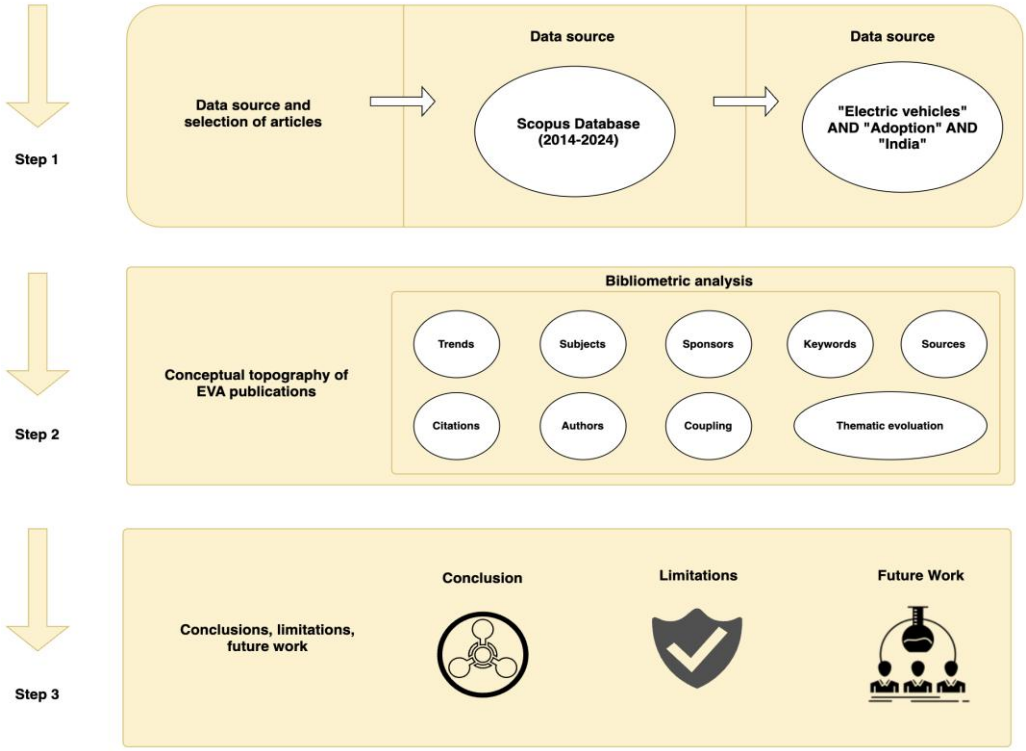



***Fig. 1.*** *The three-phase methodological framework used to conduct bibliometric analyses of electric vehicle adoption (EVA) studies in India.*

The purpose of the paper was to informally synthesize its findings by defining the limitations that have been established so far, outlining the significant perceptions, and suggesting the ways in which future research could be conducted. It was done through the assistance of thorough bibliometric research as well as an abductive examination of the material. Through this methodological approach, the research was attempting to provide a succinct overview of its limitations, provide the major research trends, and also present future prospective research areas. These were led by a rigorous methodology of analytical approach to increase the knowledge of the dynamic state of the electric vehicle adoption (EVA) study.

## 3. Findings

In this part, the conceptual landscape of EVA-related literature is examined, disaggregating the bibliometric information into nine thematic dimensions to understand it better. It offers detailed information on such key points as the trend of publication, annual production, institutional coverage, fund distribution, top authors, co-citation relationships, bibliographically coupled both at document and source levels, as well as the co-occurrence of keywords. By using visual mapping, the analysis is able to determine the themes existing in the existing research, the impact of scholar perspectives, and emerging trends in the EVA sphere. This research design will give a full picture of the current situation and the future of the study on the uptake of electric cars in India.

### 3.1 Evolution of EVA Research Output in India (2014–2024)

Table 1 shows the publication path of EVA-related research in India between the years 2014 and 2024. The analysis was done on articles that are indexed in Scopus and was accomplished via the Biblioshiny in R-Studio. In order to ensure methodological soundness, the peer-reviewed journal articles were the only articles to be considered, as they are academically sound and reliable in the capture of

validated research outputs and dynamic themes on the topic of electric mobility.

This study limits its research to completed publications, which is why it provides a sufficient ground to investigate the evolution of the EVA scholarship. The filtered list includes 153 research articles published in 94 academic journals, which means that the level of scholarly output has significantly increased, and the annual growth rate is 58%. The selected time period, 2014-2024, aligns with the global interest in electric mobility, which is especially strong in technologically developed countries, including Germany and China, where the studies of battery technology development and electric vehicle demonstrations have made a strong impact on the development of sustainable transport modes (Yang et al., 2020).

| MAIN INFORMATION ABOUT DATA | |
|---|---|
| Timespan | 2048:44:00 |
| Sources (Journals, Books, etc) | 94 |
| Documents | 153 |
| Annual Growth Rate % | 58 |
| Document Average Age | 2.48 |
| Average citations per doc | 20.14 |
| References | 9237.00 |
| DOCUMENT CONTENTS | |
| Keywords Plus (ID) | 870 |
| Author's Keywords (DE) | 521 |
| AUTHORS | |
| Authors | 376 |
| Authors of single-authored docs | 7 |
| AUTHORS COLLABORATION | |
| Single-authored docs | 8 |
| Co-Authors per Doc | 3 |
| International co-authorships % | 18.30 |
| DOCUMENT TYPES | |
| Article | 153 |

***Table 1:*** *Publications trends for EVA in India (Source: Scopus database, 2014–2024).*

Even though the search was restricted to a particular time, the number of studies that covered the research terms of interest was large. The mean age of the documents of the papers under investigation is 2.48 years, and each document has an average of 20.14 citations, which proves the increase in scholarly attention. The paper consists of 9,237 references and 870 keywords, which shows the scope and variety of research in this area.

Cooperation in research is now a key factor in developing the EVA knowledge base, and around 18.3% of co-authors collaborated in research internationally, reflecting the increasing interest in this area in the world. Additionally, every study is an academic article that has undergone a peer review and is thus of high quality in the field. Taken together, these results indicate a fast-changing and more interdisciplinary nature of a growing research field on EVA, with growing global involvement and thematic dispersion in EVA research.

| Paper | Total Citations | TC per Year | Normalized TC |
|---|---|---|---|
| TAREI PK, 2021, J CLEAN PROD | 212 | 42.4 | 3.16 |
| SHALENDER K, 2021, ENVIRON DEV SUSTAINABILITY | 201 | 40.2 | 3 |
| VIDHI R, 2018, ENERGIES | 136 | 17 | 3.28 |
| KHURANA A, 2020, VISION | 135 | 22.5 | 3.12 |
| JAISWAL D, 2021, TECHNOL FORECAST SOC CHANGE | 130 | 26 | 1.94 |
| JAIN NK, 2022, RES TRANSPORT BUS MANAGE | 119 | 29.75 | 4.85 |
| IRFAN M, 2021, TRANSP RES PART D TRANSP ENVIRON | 97 | 19.4 | 1.45 |
| SINGH PATYAL V, 2021, ENERGY | 88 | 17.6 | 1.31 |
| KRISHNAN VV, 2021, CASE STUDY TRANSP POLICY | 82 | 16.4 | 1.22 |
| GOEL P, 2021, SUSTAIN PROD CONSUM | 82 | 16.4 | 1.22 |

***Table 2:*** *Top 10 Most Cited Global Publications on Electric Vehicle Adoption (Source: Scopus Database, 2014–2024).*

**Table 2** brings into focus the top ten research papers on the topic of electric vehicle adoption (EVA) in the Indian scenario, both published between 2014 and 2024. These sources are ranked according to their overall number of citations and include other important bibliometric variables, including authorship, year of publication, journal, total citations (TC), average number of citations per year, and normalized TC, which is the annual impact of the article since its publication.

The study by Pradeep Kumar Tarei et al. (2021) takes first place in the list because it has a total of 212 citations and, on average, 42.4 citations per year. This is then succeeded by articles by Shalender et al. (2021) and Vidhi et al. (2018), with 201 and 136 citations, respectively. The standardized citation numbers are 1.22-4.85, which gives additional data regarding the continued applicability of these studies with the flow of time.

Overall, the most referred articles focus on the main themes relevant to the study of consumer perceptions and behavioral determinants of EV adoption, and the technological development of EVs, such as smart grid integration. Also, the variety of viewpoints, e.g., environmental science and economics, transportation policy, etc., proves the interdisciplinary type of EVA research. This demonstrates the various factors that promote or suppress the Indian environment's electric mobility (Singh et al., 2020).

### 3.2 Yearly Trends in EVA Research Output

| Sr. No. | Year | No. Of articles | Mean TC per article | Mean TC per year | Citable Years |
|---|---|---|---|---|---|
| 1 | 2015 | 1 | 7 | 0.64 | 11 |
| 2 | 2017 | 1 | 5 | 0.56 | 9 |
| 3 | 2018 | 4 | 41.5 | 5.19 | 8 |
| 4 | 2019 | 3 | 32.67 | 4.67 | 7 |
| 5 | 2020 | 7 | 43.29 | 7.22 | 6 |
| 6 | 2021 | 19 | 67 | 13.4 | 5 |
| 7 | 2022 | 31 | 24.55 | 6.14 | 4 |
| 8 | 2023 | 24 | 11.92 | 3.97 | 3 |
| 9 | 2024 | 63 | 2.9 | 1.45 | 2 |

***Table 3**: Year-wise Publications on Electric Vehicle Adoption in India (Source: Scopus Database, 2014–2024).*

**Table 3** presents an overview of the research trends in the electric vehicles adoption (EVA) in India from 2014 to 2024 and is based on the Scopus database. The volume of EVA-related publications has steadily risen over the years, and it rose drastically around 2020. This is in line with the growing attention to sustainable transportation policies and EV adoption programs, which underscores the growing scholarly and policy interest in the industry.

The number of articles published in 2015 and 2017 was only one article annually, but over the years, the research activity has slowly increased, to four articles in 2018 and seven in 2020. It is observable that there was a sharp rise in the research about EVA since 2021, which amounted to 19 articles, 31 articles, 24 articles, and 63 articles in 2021, 2022, 2023, and 2024, respectively. This rush indicates that there has been a rise in scholarly interest in EV adoption over the past few years. The maximum average total citations (TC) per article was in 2021, with a citation per article of 67, which indicates a good impact of research in that year. Nevertheless, since 2022, the average number of citations per individual article and the average rate of citation per year have shown a significant negative slope. This implies that the number of publications has grown, but the impact of the average publication per article has been dwindling.

Also, there are fewer citable years since the publication date of the new sources is recent, and therefore, the older research might be losing its relevance over time. This tendency is observed in accordance with the previous results of different areas of research because the influence of the previous studies is prone to decreasing as new research also appears.

The growth of the number of publications about the EVA and the change in the trends of the research impact are graphically demonstrated in **Figure 2**, which shows the rising popularity of the topic over the years. It is possible to observe in Figure 2 the column chart that the growth in EVA research was accelerated, especially after 2020, which is indicative of a growing research space on this topic.

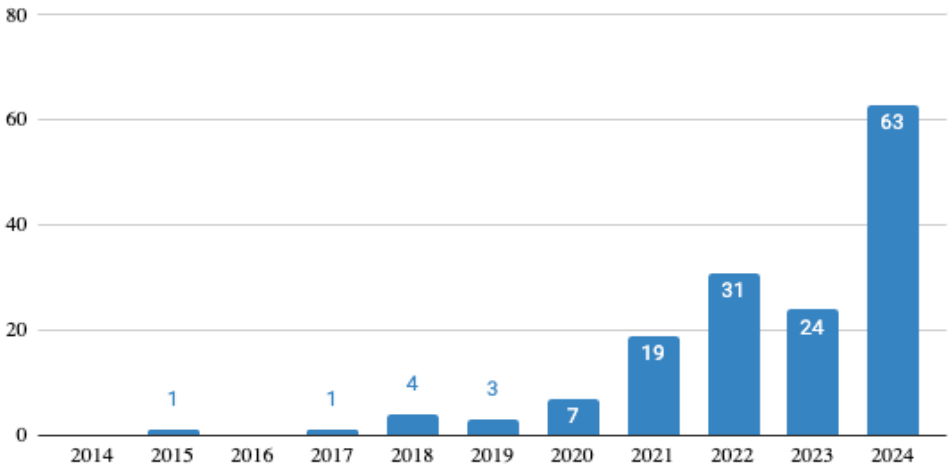



***Fig. 2**: Annual Trend of Publications on Electric Vehicle Adoption in India (Source: Scopus Database, 2014–2024).*

### 3.3 Disciplinary Distribution of EVA Research in India

The following figure (**Figure 3**) showcases how early publications on the topic of electric car/vehicle adoption (EVA) have been categorized by subject area between 2014 and 2024, based on information indexed by Scopus. The findings assist in highlighting the interdisciplinarity of EVA scholarly work, which is broad in aspects with numerous domains, such as technology, environmental science, social sciences, and economics. This cross-communication of perspective assists in achieving a big picture understanding of the problems of electric mobility as it relates to the Indian context.

Engineering has the highest-ranked articles in EVA research, and it focuses on key areas such as efficiency of vehicles, EV design, charging, and battery technologies. It provides valuable data on technological changes and the solution to significant issues when introducing EVs. The second one is Social Sciences (27 articles), meaning that EVA can also be described as change not only in technologies but in society, and incorporates such aspects as consumer behavior, policy framework, and whether people are ready to adopt EV. The role of EV acceptance in guaranteeing sustainability, emission reduction, and establishing the energy usage patterns is described in Environmental Science (18 articles) and Energy (17 articles). The fact mentioned above can be shown by the increased number of research on these fields as EVs become important in the green energy changes and in minimizing the effects of climate change. Business, Management, and Accounting (24 articles) discuss the financial and strategic considerations of EVA, such as market trends, business models, and economic feasibility. On the same note, Economics, Econometrics, and Finance (19 articles) also add information to the funding mechanisms, policy incentives, and cost-benefits that can be attributed to EV adoption. Computer Science (14 articles) is instrumental in the development of intelligent charging systems, integration of smart grids, and EV data analytics, which are vital in the optimization of EV technology and infrastructure.

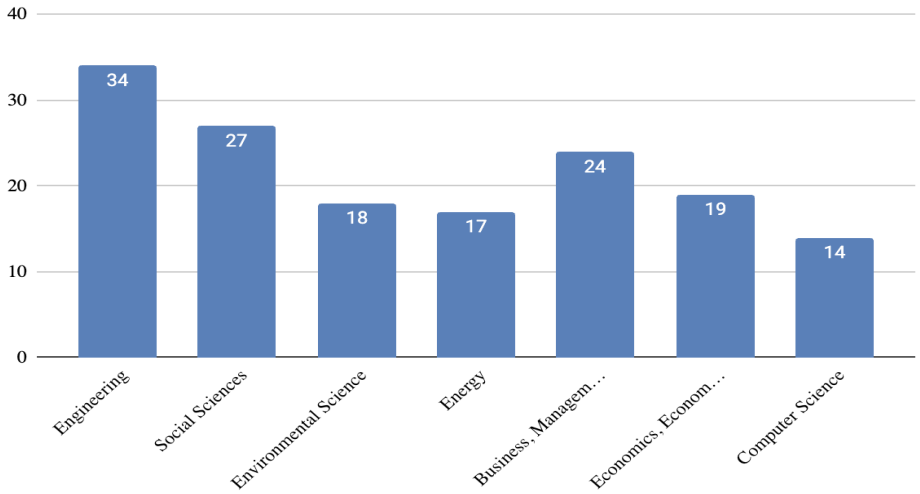



***Fig. 3**: Subject-Wise Distribution of EVA Research in India (Source: Scopus Database, 2014–2024).*

### 3.4 Institutional Contribution to EVA Research in India

**Figure 4** shows the distribution of the output of electric vehicle adoption (EVA) research in different academic affiliations in India between 2015 and 2024, through Scopus data. As the analysis reveals, the most active institutions that have a positive impact on the EVA research field are active, highlighting the increased academic interest in the problems of electric mobility.

The top two institutions in the number of research articles are Delhi Technological University and the NIT, and they added 10 each. In the second place comes the IIT Delhi with 9 publications. The Manipal Institute of Technology and the Rajiv Gandhi Institute of Petroleum Technology are next with 8 articles each, with a focus on the research on EV technologies, battery development, and charging infrastructure. A number of institutions contributed greatly to the study of EVA. Indian Institute of Science, the School of Mechanical Engineering, and the University of Lucknow have contributed 7 articles each with interests in the efficiency of EVs, sustainability, and adoption models. Otherwise, BITS and BITS Pilani have also had their own contribution with 6 articles each to the swelling body of EVA-related literature.

These have provided a valuable contribution to the research of EV adoption in the technology, policy, consumer behavior, and environmental impact that can prove useful to policymakers, industry, and academia. The interdisciplinary nature of the EVA research highlights the importance of the necessity of intersectoral cooperation in order to develop effective, sustainable mobility programs.

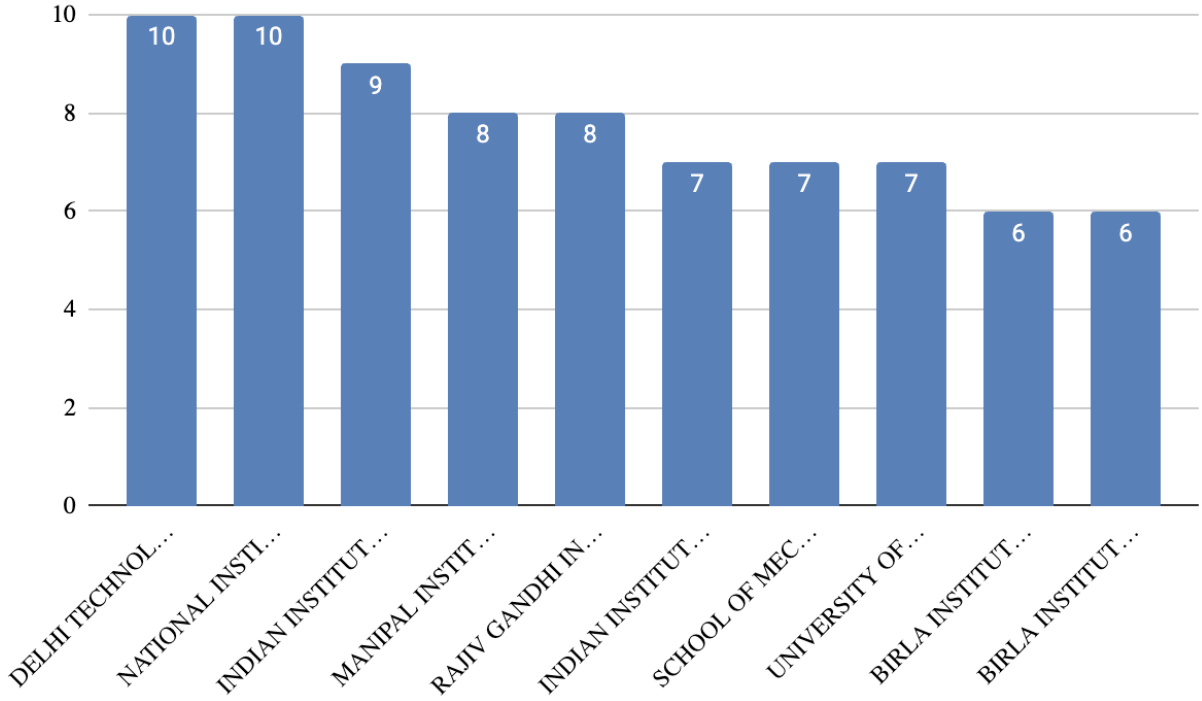



***Fig. 4.*** *Affiliation-Wise Distribution of EVA Research in India (Source: Scopus Database, 2014–2024).*

### 3.5 Analysis of Funding Support for EVA Publications

**Figure 5** illustrates the trend of distribution of funding agencies supporting electric vehicles adoption (EVA) research in India between 2015 and 2024 based on the Scopus database. The list is headed by the Ministry of Education, India, and UK Research and Innovation, which sponsor four publications each, then the Indian Institute of Technology Delhi, Istituto Italiano di Tecnologia, and Tata Motors as the sponsors of three publications each. The other prominent sponsors are the Indian Council of Social Science Research, International Institute of Applied Systems Analysis, and Royal Academy of Engineering, which have sponsored two publications each, and the Asian Development Bank and BITS Pilani have sponsored one publication.

The consolidation of EVA studies needs investment, and the presence of such sponsors is evidence of the increased attention to the creation the adoption of electric vehicles, their sustainability, and technology (Casella et al., 2022; Wang et al., 2019).

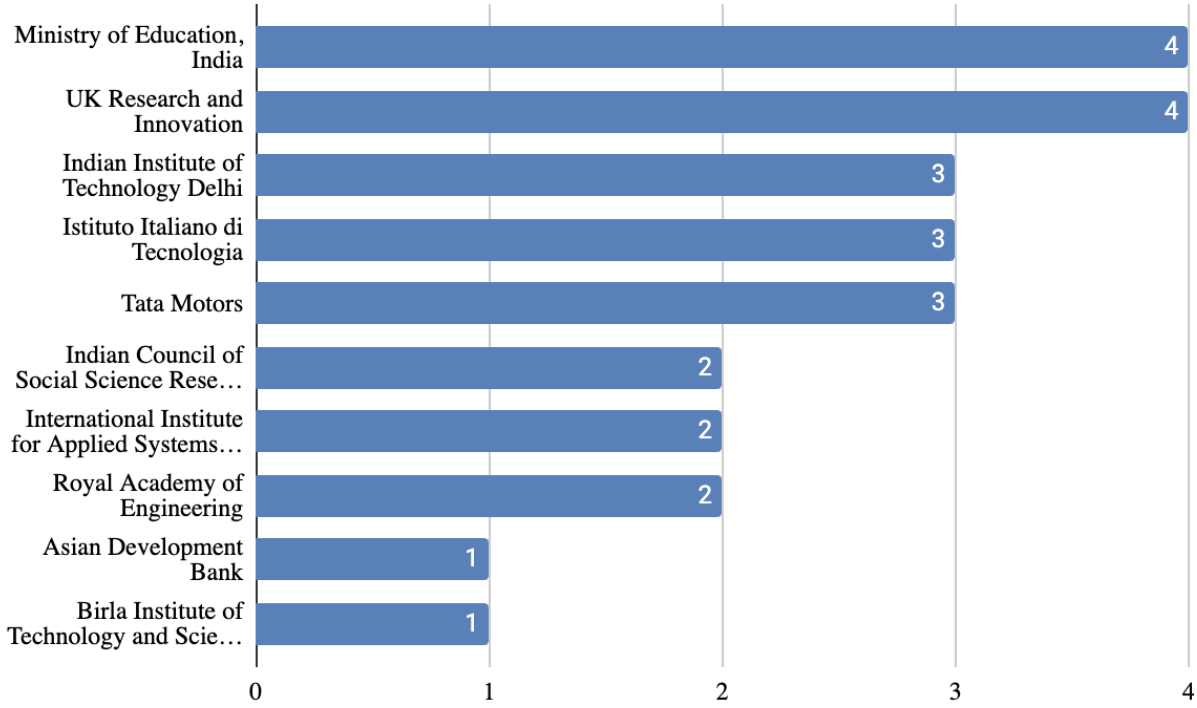



***Fig. 5**: Distribution of EVA Publications in India by Funding Sponsors (Source: Scopus Database, 2014–2024).*

### 3.6 Leading Contributors to EVA Research in India

In **Figure 6**, the top ten authors are presented who have made significant contributions to the study on electric vehicle adoption (EVA) based on Scopus-indexed publications. Marisamynthan S. leads with seven articles, and after that, Murugan M. with six articles. Bhat F.A. and Verma A. Five articles were given by each of them, with Kant R., Kumar A., and Kumar R. having four articles each. There is also Digalwar A.K., Dwivedi A., and Goswami R. All of them provided three articles in which they also made their contributions to the field of EVA. The illustration of the author-wise trend in publications in Figure 6 is a visual representation of the most prominent contributors in the study of EVA.

The integrated analytical parameters presented by Murugan and Marisamynathan give an in-depth analysis of the adoption of electric vehicles in India (Murugan & Marisamynathan, 2022). Their research on the possibility of battery swapping at refueling stations (Murugan & Marisamynathan, 2024) and the role of home-based charging with the help of solar rooftop facilities (Murugan & Marisamynathan, 2023) can be helpful in understanding what drives the adoption of electric mobility in India in particular.

Bhat and Verma have contributed to electric vehicle adoption (EVA) studies in India, especially in the study of the factors that affect the electric two-wheeler adoption. They examine how technological enthusiasm, social image, and environmental enthusiasm affect the adoption decisions of consumers (Bhat and Verma, 2023). The adoption of electric four-wheelers is another study they conducted that further explores how financial incentives, charging infrastructure, and social influence impact consumer preference (Bhat, Seth, et al., 2024). In addition, their analysis applies cluster analysis to categorize young Indian EV consumers into certain groups and identify them by various levels of social influence, perceived riskiness, and environmental awareness that have a significant effect on the adoption behavior of this group (Bhat, Verma, et al., 2024).

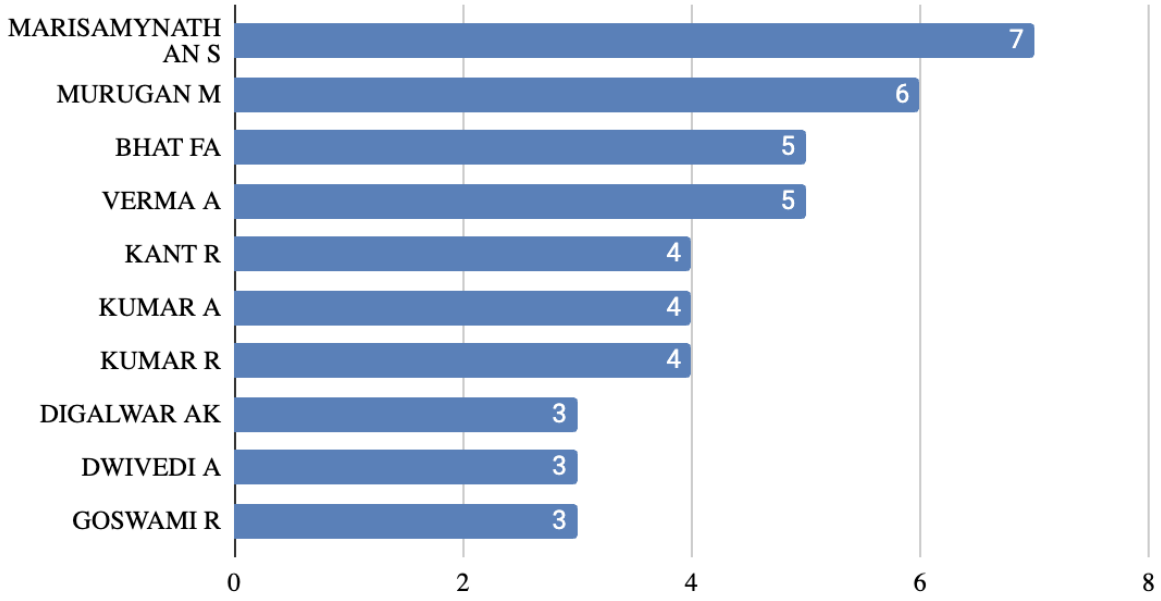



***Fig. 6**: Author-Wise Distribution of EVA Publications in India (Source: Scopus Database, 2014–2024).*

The rich diversity of the academic knowledge of those authors influences the EVA literature with nuanced data that can be informative to the process of decision-making among policy-maker formulators, automakers, and consumers involved in the process of EV adoption.

### 3.7 Co-Citation Patterns in Electric Vehicle Adoption Research

The co-citation analysis is also performed with the assistance of vosviewer and offers certain necessary information regarding the intellectual development of the electricity vehicle adoption (EVA) study (Kovács et al., 2015). A total of 9,074 authors were identified, and 79 authors who had at least 79 citations were clumped into four distinct clusters. The most frequently cited group is the biggest one, with 33 authors, which means that it is highly cited and has a significant role in the sphere. Green and blue teams of 21 and 15 authors, respectively, are an indicator of intensive cooperation and the thematic unity of subdomains. The yellow cluster, which has the fewest number of authors, is in comparison a more specific or narrower field of research in the EVA domain. The variation in the size and density of the clusters emphasizes the depth of scholarly involvement, and it can be seen that the discourse is multidimensional, with these knowledge communities playing a central role in it.

| Author | Documents | Citations V | Total link strength |
|---|---|---|---|
| Shalender, kumar | 2 | 229 | 57 |
| Chand, pushpendu | 1 | 212 | 0 |
| Gupta, himanshu | 1 | 212 | 0 |
| Tarei, pradeep kumar | 1 | 212 | 0 |
| Sharma, naman | 1 | 201 | 48 |
| Jaiswal, deepak | 3 | 172 | 24 |
| Kant, rishi | 3 | 172 | 24 |
| Shrivastava, prasanna | 1 | 136 | 0 |
| Vidhi, rachana | 1 | 136 | 0 |
| Khurana, anil | 1 | 135 | 83 |

***Table 4:** Leading Indian Scholars in EVA Research by Citation Impact (Source: Scopus Database, 2014–2024).*

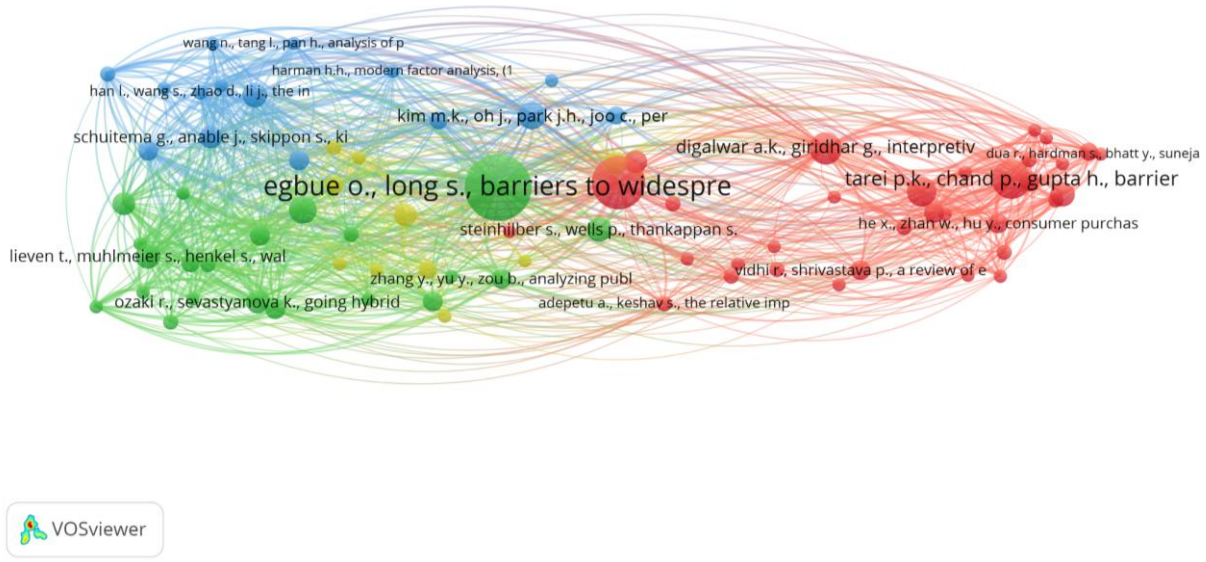



***Fig. 7.*** *Co-Citation Analysis of EVA Research Using vosviewer.*

**Table 4** presents ten figures that the authors consider to be the most-cited in the research field of EVA, yet they are also the most influential in the field's development. Their academic contributions discuss major obstacles to EV adoption and are often mentioned simultaneously, which supports the significance of their contributions to the discussion of the problem. The co-citation network in **Figure 7** depicts the inter-relationships between these authors, and some of these clusters of research define such thematic areas of the overall EVA literature. The size of nodes in the network reflects the more influential authors, and the clustering shapes of space give additional knowledge on the research fields and collaboration connections. This conceptual framework will add value to the intellectual landscape of EVA and offer substantive guidance to the academic community, policy-makers, and practitioners across the industry who wish to be involved in engaging with the new trends and significant contributions to the field.

### 3.8 Bibliographic Coupling in EVA Research

The bibliographic coupling is employed in this bibliometric study to identify the similarity of scientific articles based on the common references used in the articles (Chang et al., 2015). Basically, it measures the number of references between two articles that are shared- the more references shared, the closer the relationship. The method is significant in finding research trends and authors associations and among the keys of constructing co-citation networks (Fonteyn et al., 2020). In the next subsections, the bibliographic jointness of journals and individual publications in the area of EVA research are considered.

#### 3.8.1 Source-Level Bibliographic Coupling in EVA Research

The study has performed a bibliographic coupling analysis of 29 sources of publications, only choosing the ones that contained two or more articles to ensure the reliability of the analysis. The inter-source relationships were represented using vosviewer, and the total link strength was calculated relating each journal. As it would be anticipated, the stronger the similarity in references between two sources, the higher the coupling. There were four clusters identified in the analysis. Cluster 1 (Red) and Cluster 2 (Green), which had 10 sources each, represented considerable research networks. Cluster 3 (Blue), comprising 7 sources, was a fairly connected cluster. Lastly, Cluster 4 (Yellow) included just a single source, implying a narrow field of study. These clusters provide useful information on the relationships, influence, and thematic connections between the main sources that generated EVA research.

| Source | Documents | Citations | Total link strength | Average citations |
|---|---|---|---|---|
| Case studies on transport policy | 14 | 256 | 1518 | 18.3 |
| Environment, development and sustainability | 5 | 243 | 666 | 48.6 |
| Journal of cleaner production | 2 | 231 | 398 | 115.5 |
| Transportation research part d: transport and environment | 6 | 210 | 765 | 35 |
| Technological forecasting and social change | 3 | 195 | 552 | 65 |
| Energy policy | 6 | 160 | 689 | 26.7 |
| Energy | 2 | 91 | 375 | 45.5 |
| Cogent engineering | 2 | 85 | 464 | 42.5 |
| Management of environmental quality: an international journal | 2 | 84 | 170 | 42 |
| Transportation research part e: logistics and transportation review | 2 | 72 | 161 | 36 |

***Table 5:*** *Bibliographic Coupling Analysis of EVA-Related Sources in India (Source: Scopus Database, 2014–2024; Visualization by vosviewer)*

**Table 5** provides information about the best sources in EVA research, their volume of publication, and total and average citations. Although Case Studies on Transport Policy tops in terms of the number of publications (14) and total number of citations (256), its average of 18.3 citations per document makes it appear to have a moderate effect as compared to other sources.

On the other hand, "Journal of Cleaner Production," with only 2 documents published, has been cited 231 times, making it an average of 115.5 citations per document and thus the most influential source in terms of average citations. Equally, with 5 documents and 243 citations each, the average of "Environment, Development and Sustainability" is 48.6, but with 6 documents and 210 summative citations, the average of "Transportation Research Part D: Transport and Environment" is 35. This suggests that a smaller number of publications having higher citation averages might portray a greater impact of the research than sources that create more publications.

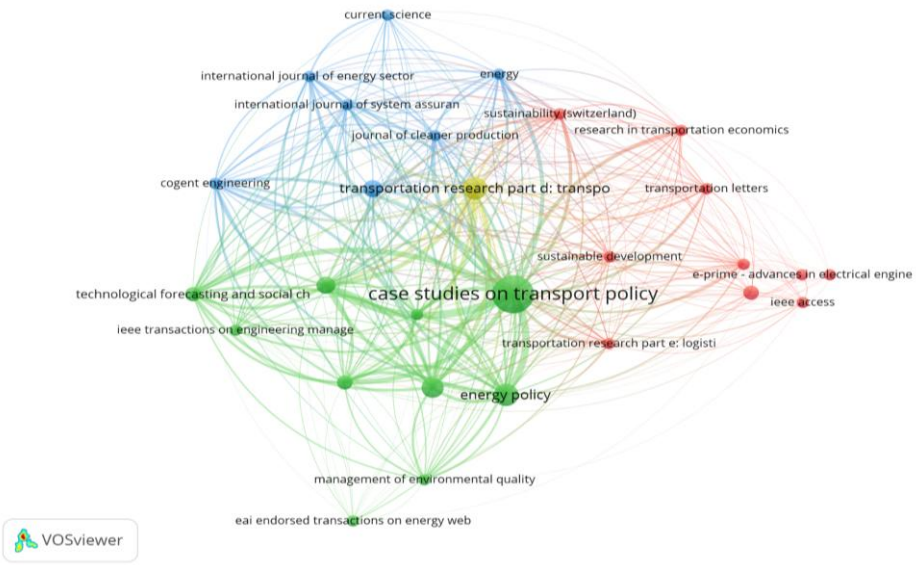



***Fig. 8****. Analysis of source relationships through bibliographic coupling*

**Figure 8** is the visual network of bibliographic coupling between sources, whereas **Figure 9** is the bar chart of the top ten most prolific sources by the number of publications. The given coupling analysis illuminates the relations between journals and defines the most influential and commonly contributing sources in the field of EVA scholarship. Using software like vosviewer, scholars can identify interesting citation relationships and determine the

strength of academic relationships among sources using clear criteria of analysis.

### 3.8.2 Document-Level Bibliographic Coupling in EVA Research

The top ten most influential papers on EVA-related papers based on citation count and total strength of the link in the dataset are shown in **Table 6.** (Goel et al., 2021; Irfan & Ahmad, 2021; Jain et al., 2022; Jaiswal et al., 2021; Khurana et al., 2020; Krishnan & Koshy, 2021; Shalender & Sharma, 2021; Singh Patyal et al., 2021; Tarei et al., 2021; Vidhi & Shrivastava, 2018). In order to narrow down to the most useful pieces of literature we ran vosviewer with a minimum of 5 citations, which reduced our analysis to 84 out of the 153 original documents. The 84 documents were then clustered into seven separate groups, as visually illustrated in **Figure 10**, in different colors.

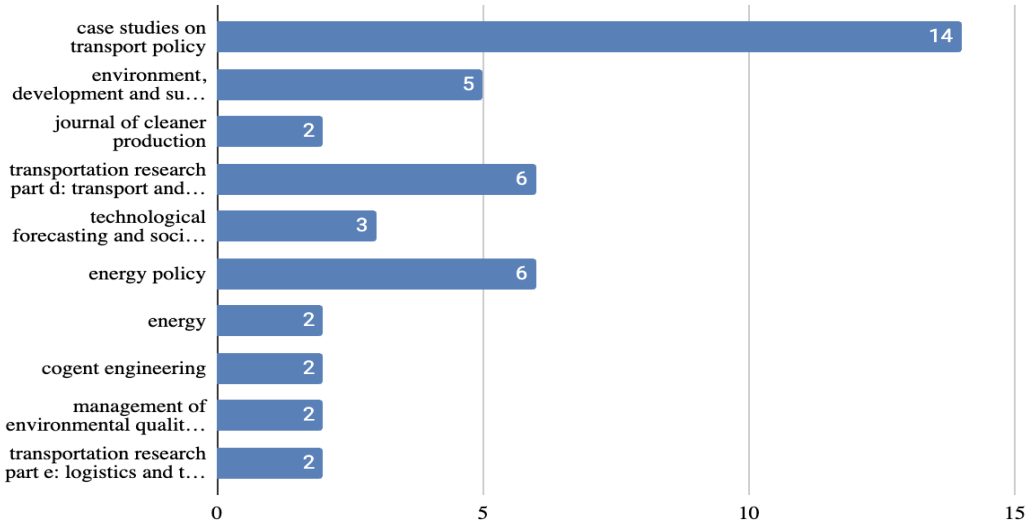



***Fig. 9.*** *Source-level publication analysis of EVA research in India (Source: Scopus Database, 2014–2024).*

| Author | Citations | Total link strength |
|---|---|---|
| Tarei (2021) | 212 | 173 |
| Shalender (2021) | 201 | 274 |
| Vidhi (2018) | 136 | 21 |
| Khurana (2020) | 135 | 143 |
| Jaiswal (2021) | 130 | 367 |
| Jain (2022) | 119 | 331 |
| Irfan (2021) | 97 | 137 |
| Singh patyal (2021) | 88 | 342 |
| Goel (2021) | 82 | 157 |
| Krishnan (2021) | 82 | 137 |

***Table 6:*** *Bibliographic coupling of documents related to EVA in India.*

The bibliographic coupling analysis revealed that there were seven different clusters of EVA-related publications, as seen in Figure 10. The largest cluster, the red cluster, included 25 documents, and the second-largest cluster, the green cluster, had 18 documents. There are other clusters, such as blue (12 documents), yellow (11), purple (9), cyan (7), and orange (2), all of which depict thematic connections in literature. The most frequently cited of these is the study by Tarei et al. (2016), which has 212 citations, and its total link strength is 173, which is why it has a considerable impact on scholarly work. Table 6 provides a summarized picture of the most influential publications in this field and is a primary source that should be used by scholars and practitioners who work in the entire field of EVA.

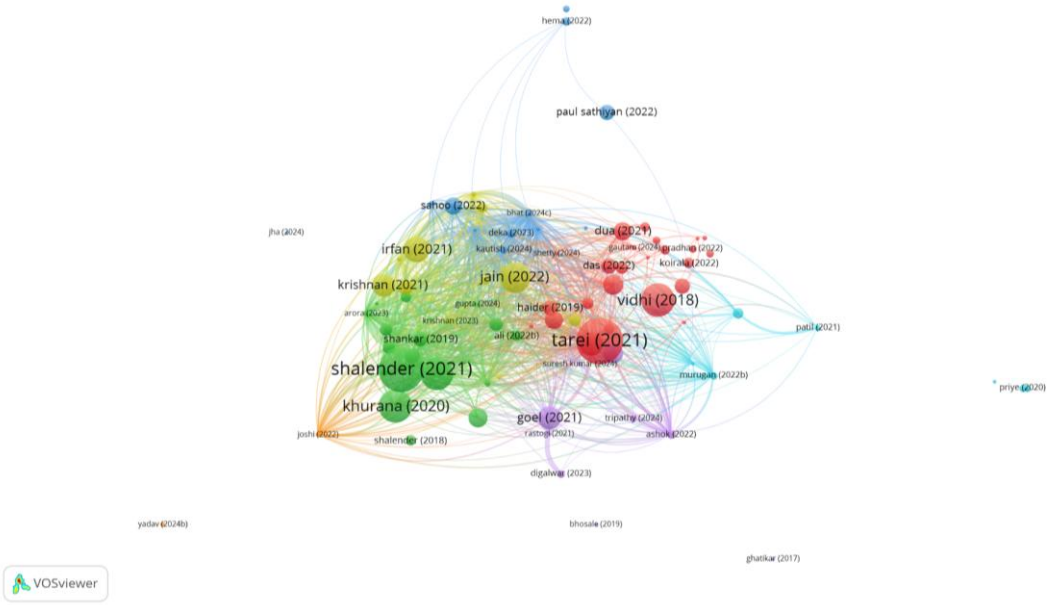
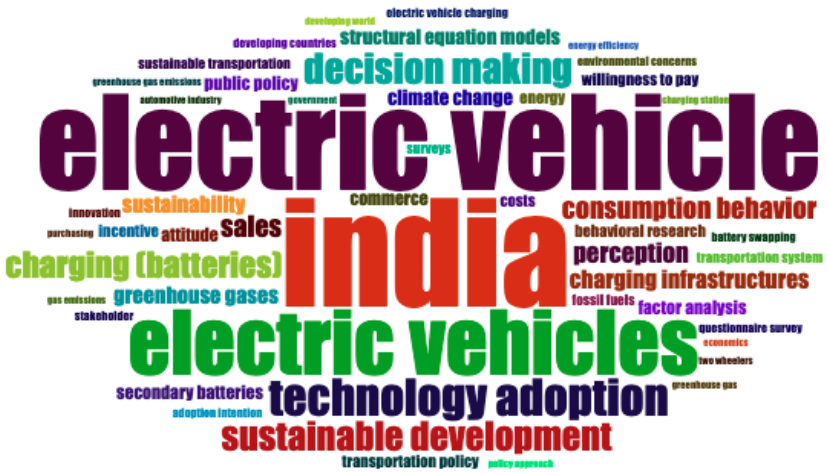



***Fig. 10.*** *Document-Level Bibliographic Coupling in EVA Research*

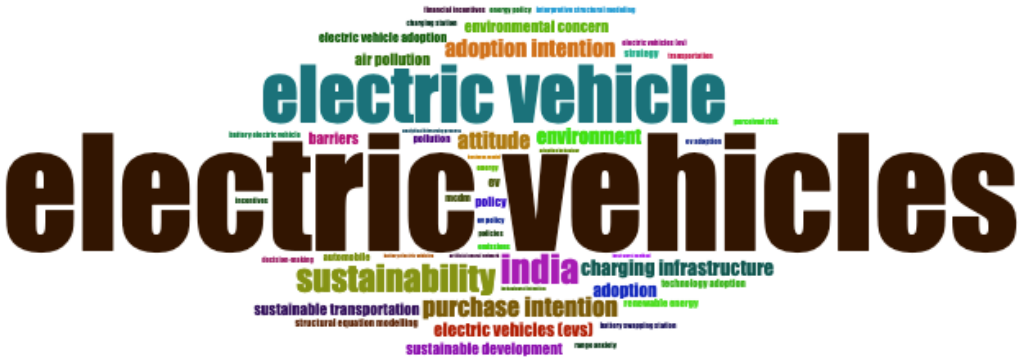
### 3.9 Keyword Co-Occurrence Analysis in EVA Literature

Author keywords and Keywords Plus play a significant role in unveiling the core issues and the key areas of concern in scientific works. Word clouds are some of the visual representations that are usually used to show the prominence and high frequency of these words. Both kinds of keywords are available through Scopus: Author keywords are those keywords chosen by authors explicitly, which are a clear indication of the subjects and the target thematic focus of the work (Goh and See, 2021; Uddin and Khan, 2016). On the other hand, Keywords Plus are automatically generated by Scopus by a computational analysis of titles, abstracts, and references of scholarly articles. Such keywords are usually broader in terms of thematic knowledge, which may include aspects that the authors may not directly name (Bhatnagar and Sharma, 2022; Uddin and Khan, 2016). In the past, it has been suggested that Keywords Plus may provide a better overall picture of the scientific contribution of an article (Bhatnagar and Sharma, 2022).

The 50 most commonly used words in the Author Keywords and the Keywords Plus are shown in **Figure 11**, where the relative size of each word shows the number of times it was used. In **Figure 11 (a)**, "India" appears as the most frequently used term (70 occurrences), followed by "electric vehicle" (62 occurrences) and "electric vehicles" (42 occurrences). Other frequently occurring Keywords Plus include "technology adoption" (24 occurrences), "decision making" (20 occurrences), "sustainable development" (19 occurrences), and "charging (batteries)" (17 occurrences). Additionally, keywords such as "greenhouse gases" (11 occurrences), "charging infrastructures" (12 occurrences), and "climate change" (10 occurrences) highlight the broader scope of research areas related to EVA.




***(a)*** *Keywords Plus*




***(b)*** *Authors Keywords*
***Fig. 11.*** *Word cloud of keywords.*

On the other hand, Figure 11 (b) shows that "electric vehicles" is the most frequently occurring Author Keyword (59 occurrences), then there is"electric vehicle" (29 occurrences), "India" (15 occurrences), and "sustainability" (14 occurrences). The consumer, policy, and environmental themes of EV adoption are reflected in other key terms like "purchase intention" (10 occurrences), "adoption intention" (9 occurrences), "charging infrastructure" (8 occurrences), and "environmental concern" (6 occurrences).

Importantly, "electric vehicles" and "technology adoption" are present in both Keyword Plus and Author Keywords, which means that the themes overlap. Nonetheless, Keywords Plus has more extensive coverage of topics, including "structural equation models," "costs," "public policy," and "government", reflecting broader research themes and methodologies. This observation highlights the benefit of Keywords Plus in bibliometric reviews since it gives a more detailed picture of the research trends in the use of green energy and the study of electric vehicles (Qin et al., 2022).

**Figure 12** shows the results of the co-occurrence network analysis based on 1,211 keywords obtained based on the title and abstract of the research publications analyzed. We were able to analyze the appearance of these keywords in combination using vosviewer. To narrow the search results, we have cut the list of keywords to 72 by setting the minimum frequency to five. These 72 keywords were, in turn, organized into five color-coded clusters.

he first group represents the red cluster, which consists of eighteen keywords, including "adoption behavior," "adoption intention," "behavioral research," "decision making," "developing countries," "economics," "electric vehicles," "environmental concern," "financial incentives," "incentive," "purchasing," "sales," "structural equation modeling," "technology adoption," "transportation policy," "two-wheelers," and "willingness to pay." This cluster mainly deals with consumer behavior, adoption trends, and financial variables that affect EVA. The second cluster (Green) consists of eight keywords, where the most significant ones are, with "air pollution," "automotive industry," "commerce," "costs," "energy policy," "environmental concern," "fossil fuels," "gas emissions," "greenhouse gas emissions," "greenhouse gases," "policy," "pollution," "surveys," "sustainable development," "sustainable transportation," "taxation," and "vehicle performance". The environmental impacts, sustainability and regulatory frameworks about EVA in India are emphasized in this cluster.

Seventeen keywords constitute the third cluster (Blue), such as, "attitude," "automobile," "barriers," "consumption behavior," "electric vehicle," "electric vehicle adoption," "environment," "government," "India," "innovation," "perception," "policy implications," "public policy," "purchase intention," "stakeholder," "strategy," and "sustainability." This category focuses on the contribution of policy, regulatory framework, and consumer behavior to the electric vehicles adoption. The fourth cluster, represented in yellow, includes fourteen keywords such as "battery swapping," "charging (batteries)," "charging infrastructure," "charging infrastructures," "charging station," "charging stations," "climate change," "electric vehicle charging," "energy," "EV infrastructure," "performance," "secondary batteries," and "transportation system." This cluster is concerned with the EV performance, energy storage, and charging infrastructure.

Lastly, the fifth cluster (Purple) is made up of four keywords, which are "adoption," "developing world," "policy approach," and "questionnaire survey." The cluster that is featured brings to the fore the use of policy frameworks and research methodologies in EVA. The co-occurrence network in Figure 12 provides valuable data about the thematic organization of the EVA literature, and it will allow scholars to follow the rise of new research directions, technological changes, policy interventions, and behavioral drivers related to the electric vehicles.

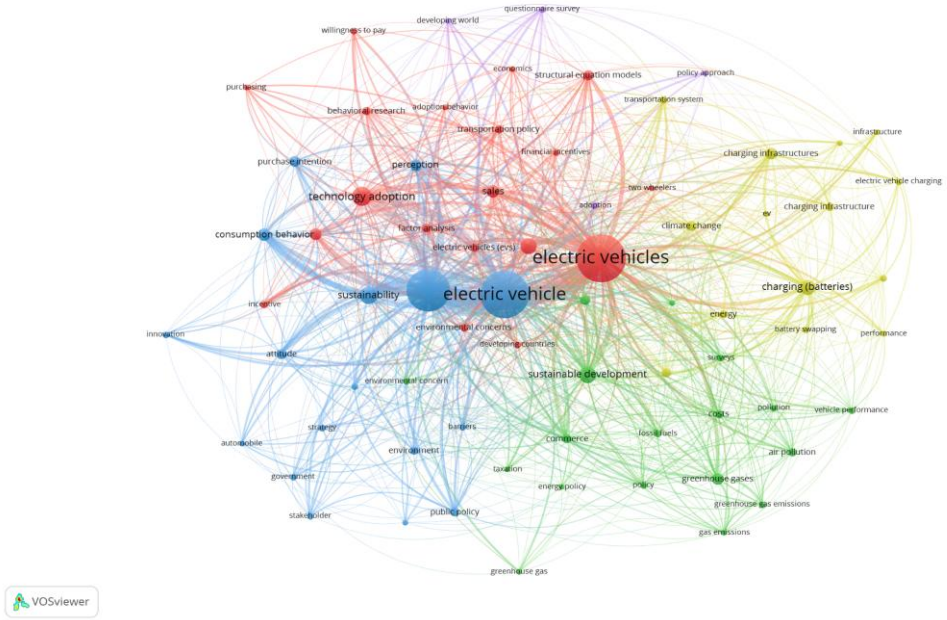



***Fig. 12.*** *Keyword Co-Occurrence Mapping in EVA Research (Source: Scopus database, 2014–2024 and authors' compilation with VOS Viewer).*

Thematic evolution analysis provides the full picture regarding the change in priorities of the research concerning the adoption of EV in India (EVA). This development can be pictorially shown using a Sankey diagram, as shown in **Figure 13** depicts the flow of major themes in various periods of time, in terms of the changing discourse in the field. The leading themes of 2015-2018 were the issues surrounding EVA, such as gaps in infrastructure, high investment costs, and uncertainties in policy. This is also when the research started focusing on India and electric vehicles as their interrelated issues, as the country started caring more about sustainable transportation solutions.

Between 2019 and 2022, the research topic became much more diversified. Although the challenges continued to feature, this was eventually combined with the concept of sustainability, suggesting that the issue was now focused on long-term environmental and policy responses. The electric vehicles turned into a key topic of study, and more and more conversations about green mobility, adoption, policy frameworks, and consumer behavior took place. Another indication of the need for a comprehensive strategy, which was to incorporate infrastructure development, monetary incentives, and consumer involvement, was the presentation of the approach as a thematic category later to be incorporated. The keywords used, such as charging infrastructure, barriers, and government policies, depicted an escalated rise in supportive policy frameworks to support adoption.

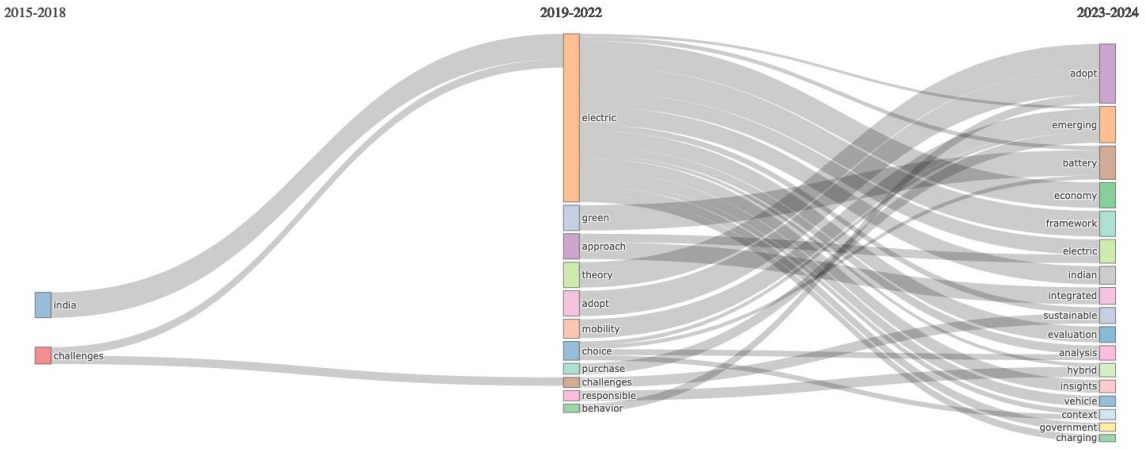



***Fig. 13.*** *Evolution of Research Themes in Electric Vehicle Adoption in India (2014–2024)*

The research tendencies of the last period, 2023-2024, were mostly concerned with the adoption, which presupposes its proven significance in the academic and policy domains. The problem of integrated systems has become an urgent one, and it is the manifestation of the increased awareness of the use of interdisciplinary solutions to enhance the penetration of EVs. Sustainable mobility is also another concept that has attracted much attention, and this bodes well with the general environmental endeavors of EVA in India. Moreover, the introduction of such themes as battery technology and economic analysis indicates the increased attention to such aspects as cost-efficiency, energy security, and the development of EV-related technologies.

There are various implications of the changing theme of research for policymakers and researchers. To start with, the long-standing relationship between difficulties and charging infrastructure indicates that the charging network in India should be extended to ensure mass adoption. Second, the shift of government policy towards economic influence highlights the necessity of highly designed financial incentives and subsidies to motivate consumer uptake. Third, the increased attention to battery efficiency and vehicle-to-grid (V2G) solutions demonstrates that the combination of renewable energy and EV technology should enhance sustainability. Finally, consumer adoption to sustainable transportation ecosystems indicates that earlier studies relied on barriers, but now studies are concerned with long-term behavioral transformation and market preparedness.

In general, this theme development brings into focus the course of EVA research in India, starting with the discovery of obstacles to the creation of integrated and sustainable solutions. The growing focus on economic sustainability, effectiveness of policies, as well as technological progress confirms the presence of a developed market where the actions of various spheres are to be harmonized to create a successful future of electric mobility.

## 4. Discussions and conclusions

This research is the first bibliometric evaluation that will focus on tracing the development of the electric vehicle (EV) adoption research in India in 2014-2024. It is based on the analysis conducted with the use of four methodological tools, namely: the temporal trend analysis, co-word analysis, citation analysis, and bibliographic coupling, which help to present the complete overview of the field development. During its early days, scholarly research on EV adoption in India was limited. Nevertheless, the past decade has also witnessed a tremendous increase in the academic output, which was largely predetermined by policy efforts like the FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles) scheme, increased environmental consciousness, and most importantly, fast technological development. The year 2017 was when the publication activity grew significantly, which was associated with implementing the national policies and developing the EV charging infrastructure.

As far as the structural development of EV adoption research is concerned, the temporal analysis allows us to point to the broadening of research topics as they nowadays extend beyond the simple policy discourse to such aspects as consumer behaviour, charging infrastructure, battery technologies, and market penetration strategies. This thematic diversification is the result of the changing challenges and opportunities in the EV ecosystem in India.

Concerning the theme of motor, basic, and emergent research, it is evident that in 2014 through 2017, the research themes were mainly government incentives and environmental benefits. In 2018-2020, the emphasis was made on the consumer acceptance, total cost of ownership, and technological advances in battery performance. In the last period, 2021-2024, such themes as charging infrastructure, supply chain localization, and renewable energy integration with EV have become major research topics. Remarkably, range anxiety and charging infrastructure development have always been a motor theme, and EV financing and second-life battery applications are newer areas that are likely to become hotspots in research in the future.

The thematic network visualization of the EV adoption study in India is a source of four main understandings. To begin with, the theoretical bases like the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) are commonly used to analyze consumer behaviour in the Indian electric vehicle market. Second, emerging evidence underlines the importance of building up the charging network and the development of domestic battery production as facilitators of faster uptake. Third, the methodological scene is dominated by empirical research, especially the ones based on quantitative methods (consumer surveys and cost-benefit analysis). Finally, the policy interventions and fiscal incentives are also present all the time as one of the leading themes, as these variables play a central role in affecting the dynamics of EV adoption in the Indian context.

In terms of the most frequently mentioned publications, the citation analysis has shown that the research that has been done on EV policy effectiveness, total cost of ownership comparisons, and consumer perception of EVs has had the most citations. Also, the citation analysis shows that the most prestigious Indian institutions, authors, sources, and nations have been the most prevalent contributors to the EV adoption research, including IITs and IIMs. The number of international

relationships is, however, minimal, and it can be viewed as a future source of knowledge exchange. With regards to the source of publication, journals on energy policy, sustainable transportation, and technological innovation have carried out the most influential articles in this field.

With respect to the predominant research areas, the bibliographic coupling analysis shows five distinct areas that have recently gained significant research attention:

1. EV Charging Infrastructure Development – Addressing range anxiety and grid integration challenges.
2. Consumer Adoption and Market Segmentation – Understanding demographic and psychographic factors influencing EV purchase decisions.
3. Battery Technology and Supply Chain Localization – Focusing on lithium-ion alternatives, battery recycling, and domestic manufacturing.
4. Policy Effectiveness and Government Incentives – Analyzing the impact of schemes like FAME-II and state-level subsidies.
5. Integration of Renewable Energy with EV Ecosystem – Studying the role of solar-powered charging stations and vehicle-to-grid (V2G) technology.

### 4.1 Theoretical Implications

The study makes an important contribution to the theoretical idea of EV adoption in India, particularly, the technology acceptance, policy influence, and consumer behavior. It is based on the already known models, such as the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DOI), which argue that the primary factors that precipitate the adoption are perceived ease of use, economic feasibility, and trust in the EV technology. In addition, the research is aligned with the theory of socio-technical transition, which is concerned with the engagement of technology, consumer behavior, and policy intercession, and the EV transition in India relies intensely on the consistency of policies, development of infrastructure, and technology.

Besides, the current piece of research work can contribute to the literature in behavioral economics and consumer psychology by demonstrating how the willingness of Indian consumers to adopt EVs can be predetermined by financial incentives, environmental awareness, and preparedness of the infrastructure. It also introduces the gap in research collaboration that reveals that the EV research in India is largely internal, and little effort has been put in the aspect of collaborating with other countries. The rise in the knowledge sharing of the world, especially the countries that have already managed to implement the strategies of EV adoption successfully, will be capable of assisting India in developing more specific approaches. The totality of these results can be entered into the current literature on the subject of sustainable transportation transitions and can be applied in the future as the basis of a study in this dynamic field.

### 4.2 Managerial Implications

The study will be of quality learning to the policymakers, car manufacturers and energy providers in the growing EVs in India. Among them is to enhance charging infrastructure by installing fast-charging stations, battery-swapping stations, and smart grid connectivity, which plays a key role in overcoming range anxiety and increasing the confidence of the consumer. Also, the consumer awareness campaigns are to be reinforced by the digital campaigns and dealership participation to ensure that the potential consumers know about EV benefits, incentives, and where to charge their cars nowadays.

There is also the need to have a particular approach to financial incentives wherein the various consumer groups, such as the price-sensitive customers, fleet operators, and Urban vs. Rural customers, require different drivers to embrace the product. It is recommended that the policymakers simplify the subsidy system, tax subsidies, and funds of financing to be able to serve these diverse populations. Simultaneously, one can produce and recycle more batteries locally to reduce Indian reliance on imports, lower the cost of EVs, and improve the resilience of the supply chain.

It will be significant to establish public-private partnerships to offer a strategic collaboration to develop technology in battery efficiency, infrastructure (smart charging), and vehicle-to-grid (V2G) integration. The electric vehicle charging systems should be integrated with renewable energy so that they can be more sustainable and their carbon footprint can be lower than that of EVs in India. This will entail the development of solar-powered charging points and smart grids. Such strategies in a holistic perspective will significantly support the EV industry in India and make it expand in the market in the long run.

## 5. Limitations and future research directions

Although this study makes a significant contribution to the current body of knowledge about EV adoption in India, there are some limitations of the study. It is based on a bibliometric (although the tool is effective in identifying the research trends) approach only, which does not presuppose a qualitative analysis of the results. In general, further studies can be based on systematic literature review, meta-analysis, or empirical research to form a more nuanced research on the topic of consumer behavior, the usefulness of policy, and technological innovations. The data derived using Scopus as an indexing tool can also be a weakness of this research. The publications of Web of Science and Google Scholar could be included in the analysis to provide a larger scope of research on

the topic at the global and regional levels. These are the avenues that could be pursued in future research.

### 5.1 Potential Research Areas

#### *5.1.1 EV Consumer Behavior and Purchase Intentions*

Although existing literature found out consumer acceptance of EVs, the perspectives of behavior that determine purchase decisions should be studied further, which involve risk perception, financial incentives, and environmental awareness. Recognition of the desires of Indian consumers to use EVs in urban and Rural contexts may also give tips on customized policy measures.

#### *5.1.2 Charging Infrastructure and Energy Grid Integration*

EV charging infrastructure has been a serious impediment to prevalence. The studies to be conducted in the future ought to examine how best the charging stations, the battery-swapping models, and the extension of the grid capacity can be deployed to meet the increased demand of EVs. Also, how smart charging solutions and vehicle-to-grid (V2G) technology can be used in the Indian energy ecosystem needs to be studied further.

#### *5.1.3 Battery Technology and Supply Chain Development*

The reliance of India on imported lithium-ion batteries poses some economic and environmental insecurity in the country. Future studies need to focus on alternative battery technologies (such as sodium-ion or solid-state battery), creating effective battery recycling initiatives, and creating domestic manufacturing policies to reduce costs and less sensitivity to foreign suppliers.

#### *5.1.4 Policy Effectiveness and Market Regulations*

The necessity to adopt EVs has recently been spurred by government policies such as the FAME-II and state-level EV subsidies, although their long-term effect has not been studied. Future studies are required to evaluate the effectiveness of policy implementation, the pattern of subsidy usage, and the efficacy of taxation policy in penetrating the EV market.

#### *5.1.5 Renewable Energy Integration in EV Infrastructure*

As India continues with the development of renewable energy sources, future research must determine how solar and wind energy can be incorporated into the EV charging networks. The studies concerning solar-powered charging stations and decentralized energy systems might facilitate the sustainable mobility objectives.

### *5.2 Potential Industry Applications*

#### *5.2.1 Public and Commercial Transport Electrification*

Emission reduction in the cities should focus on electrifying their transport, taxis, and delivery fleets. The next avenue of research should be the barriers to electrifying the fleets, the total cost of ownership, and the operational issues related to the deployment of EVs at large scales, both in the public and commercial sectors.

#### *5.2.2 Two-Wheeler and Three-Wheeler EV Market*

The market share of personal and commercial transport in India is the highest in the two-wheeler and the three-wheeler segments. Research ought to be conducted in the area of consumer preference, funding sources, and policy development to hasten the uptake of EVs in these groups.

#### *5.2.3 Second-Life Battery Applications*

Recycling of EV batteries as a source of energy is a new field of concern. Battery lifecycle management and second-life in renewable energy grids research might be useful in understanding sustainable EV implementation.

The discussion of the research gaps will allow future research to give a more comprehensive view of the EV transition in India, aid data-oriented policymaking, infrastructure development, and growth strategy in the market.

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