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Innovation Management and Sustainability: A Bibliometric Analysis of Global Research Trends

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ABSTRACT

Innovation management and sustainability have become intertwined pillars to the realization of long-term competitiveness of an organization and social-economic growth. This study analysed global research trends in innovation management and sustainability through bibliometric analysis and visualization, and maps the intellectual structure, thematic development, and collaboration patterns in the field**.** This study employed bibliometric analysis and science mapping techniques using Biblioshiny in RStudio and VOSviewer**.** Through an extensive collection of thousands of research papers located in Scopus database consisting of various fields of study covering publications from 1982 to 2026 of academic work. The methods used are bibliometric, such as the performance analysis and science mapping, to discuss the work of prominent authors, powerful journals, prolific institutions, nations, and predominant research topics. These results indicated that, there has been a linear increase in publications and the key themes include sustainable innovation, green innovation, digital transformation, circular economy, and competitive advantage. The thematic clustering determines the new research fronts in which innovation management is becoming more aligned with environmental and social objectives of sustainability. This study gives a systematic review of the body of knowledge in the area and gives possible ways of conducting future research especially in combining digital technologies, policy models and sustainability-based business models. On the whole, this bibliometric review can be of importance to other researchers, practitioners, and policymakers who want to learn about the development of innovation-based sustainability research and its perspectives.

Keywords: Innovation management, sustainability, Green innovation, Bibliometric analysis, Science mapping.

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Introduction

The present age of accelerated technological transformation and world revolution has predetermined innovation management and sustainability as a determinant in organizational survival, competitiveness and generation of long term value. Increased environmental demands, dearth of resources, global warming, and social obligation, has compelled organizations, governments and institutions to reconsider traditional growth models. Consequently, innovation is not seen as a growth engine in the economy alone, but it is also a tactical instrument to attain sustainable development in economic, environmental and social aspects. Innovation management is the discipline of managing innovation in a systematic way that assists organizations to come up with innovative products, processes, services, and business models. Sustainability, on the other hand, involves concerns the fulfillment of the current needs without interfering with the capacity of the future generations to satisfy their needs. These two terms have come together to define research streams around sustainable innovation, green innovation, eco-innovation and sustainability-oriented business models, which are increasingly influencing both the academic community and the business world.

Early research studies focused on innovation management primarily focused on technological progress, product innovation and performance of the firm with little regard to environmental and social implications. Sustainability issues came to the fore as time went by by environmental management, corporate social responsibility and cleaner production research. The concept of sustainability has become central in the research of innovation management with an increasing number of key strategic objectives taking prominence in terms of global sustainability agendas and regulatory frameworks. The increasing number and variety of scholarly publications recorded in the databases of the larger databases reflect this development. The literature contained in this study reveals that the number of publications in the intersection of innovation management and sustainability in the Scopus database has been growing tremendously over the last few years. Themes of research have gone beyond the conventional innovation models to incorporate the practices of the circular economy, digital and technological innovation, sustainable supply chains, energy transitions and sustainability-oriented competitive advantage. This development emphasizes the interdisciplinary character of the discipline which hinges on management, economics, environmental sciences, engineering, and policy studies.

But, even with this expansion, the discipline has not yet been integrated due to the variation of concepts, techniques, and disciplinary orientations. Despite the large number of empirical and conceptual studies that pay attention to the individual aspects of innovation management or sustainability, there is still a gap in knowledge on the intellectual framework, thematic evolution, global cooperation pattern, and the new research frontiers on this topic. Bibliometric analysis is an appropriate methodological tool that would help to fill this gap since it is a systematic mapping of the knowledge base, identification of key contributors, and the identification of emerging trends. Although there is already bibliometric literature on such topics like green innovation, sustainable development, and technology management, the lack of research, which can offer a full picture of global research particularly relating innovation management and sustainability

through a large dataset, is still present. This gives rise to the necessity of a systematic bibliometric study that can be used to sum up past research, analyse current trends, and find out directions in this fast developing field in the future.

The current research will, therefore, be a bibliometric analysis and visualization of the existing studies conducted globally on the subject of innovation management and sustainability, utilizing a comprehensive data set of more than 6, 000 publications obtained with the help of the Scopus database.

Research questions

1. How has publication output in innovation management and sustainability evolved over time?
2. Which authors, journals, institutions, and countries have had the greatest impact in this field?
3. What dominant and emerging themes characterize research on innovation-based sustainability?
4. How has international collaboration developed in this research area?

The responses to these questions help this research to make a contribution to the existing literature, as it offers a systematic review of the knowledge base, thematic clusters, and trajectories of innovation management and sustainability research. It is hoped that the findings will assist scholars in coming up with research gaps and guide practitioners in the understanding of the trends of strategic innovation as well as support policy makers in ensuring that innovation strategies are in tandem with the sustainability agenda. The rest of the paper is organized in the following way. The second part is the review of the related literature. The third section provides a description of the data collection procedure and bibliometric method applied in the study. The fourth section is the discussion of the results and visualizations out of the analysis. The fifth section presents the most important findings, theoretical and practical implications, limitations and future research directions. Lastly, the sixth section is the conclusion of the study.

Related Literature

In the early days, the focus of research in the area of innovation management was mainly on technological progress, product innovation and competitiveness of firms. Initial research studied innovation as an economic driver of economic growth and industrial change focusing on the R&D operations on technology competencies (Schumpeter, 1934; Dosi, 1988). Then, the research on the organizational and strategy aspects of innovation was developed, with the contribution of the managerial processes, knowledge generation, learning systems to maintaining the competitive advantage (Nonaka and Takeuchi, 1995; Tidd et al., 2005).With the rise of environmental concerns the sustainability concept gradually made its way into the field of innovation. Early environmental management practice sustainable studies and regulation compliance based on an environmental management system related innovation to pollution control, cleaner production practices (Porter & van der Linde, 1995; Hart, 1997). Additionally, the novel concept of eco-innovation was proposed by Rennings (2000), as it focuses on innovations, which cut the environmental costs and generate economic benefits. These researches formed the basis of establishing environmental goals into innovation management systems. With the development of the literature, the point of

convergence between innovation management and sustainability was gradually studied by researchers. Research examined the adoption of green technologies by firms and redesigning of products as well as sustainable processes to bring about long-term performance benefits (Kemp and Pearson, 2007; Boons et al., 2013).

The empirical studies have revealed that sustainability-based innovation has a beneficial impact on the competitiveness, reputation, and efficiency of firms (Horbach et al., 2012; Chen et al., 2014). More recent research has put a focus on business model innovation and sustainable value creation, demonstrating how companies re-invent value propositions, delivery systems, and revenue models to match innovation strategies with sustainability goals (Bocken et al., 2014; Ludeke-Freund et al., 2016). Simultaneously, the concept of sustainability has spread out to supply chain environments, where cooperative efforts, transparency, and technology assimilation underpin sustainable creativity (Seuring and Muller, 2008; Sarkis et al., 2011). More recent has been the study of the role of digital innovation in sustainability transition, whereby Industry 4.0 technologies, data analytics, and digital platforms can enhance resource efficiency, facilitate the implementation of circular economy practices, and sustainability-oriented decision-making (Kamble et al., 2018; Nambisan et al., 2019). These trends underscore the increased overlap of digital transformation, innovation management, and sustainability outcomes. Nonetheless, the field is still disconnected due to the varying approaches to theory and methods. Consequently, bibliometric research has turned into a powerful means of tracking the tendencies of publications, recognition of significant contributors, and discovering new directions in the fields of innovation and sustainability research (Cobo et al., 2011; Donthu et al., 2021).

Bibliometric Materials and Methods

The current study involved a methodological approach of systematic bibliometric that was carried out in several stages, including planning and access to bibliographic database, data analysis, and presentation of study results. This systematized method allows conducting a profound analysis of the intellectual framework, the research direction, and the development of themes of innovation management and sustainability literature.

Data Capturing from Bibliographic Database

The study identified bibliographic records in the Scopus database at the data collection phase, as it is one of the largest databases that cover high-quality peer-reviewed journals in the field of management, sustainability, environmental sciences, and innovation-related studies. The document-based search was performed to retrieve the research publications that are relevant in terms of both innovation management and sustainability. The query that has been used is as follows: Innovation Management AND Sustainability (Topic), as the result of which 6,156 research documents have been identified. Afterwards, the records were filtered based on language (English) and subject categories of Scopus that are relevant, and they are Business, Management and Accounting, Economics, Environmental Sciences, Social Sciences and Decision Sciences. This filtering process narrowed the dataset down to 5,442 records. Subsequent filtering was done to remove articles like conference

papers, editorials, notes, book chapters, early access papers and other non-full-text articles. Consequently, 70 records were sacked at this point. The final collection of 5,372 full-text research articles was considered adequate to conduct a bibliometric descriptive study and network visualization to investigate the research patterns, active contributors, collaboration schemes, and new trends in the area of innovation management and sustainability.

Framework for Anatomizing the Data

The bibliometric analysis was carried out through the most pertinent parts of analysis, i.e. author analysis, source analysis, country analysis, and thematic analysis. To analyze the growth of publications, active researchers, the most used journals, the most productive countries, and most used keywords, a descriptive analysis of the corpus of 5,372 research documents was carried out.

The MS Excel 2019 and the Biblioshiny interface in the R software pack were used to generate descriptive statistics and performance indicators that can be used to perform an in-depth bibliometric analysis and visualization. This instrument facilitated the extraction of major contributors and thematic trends in the literature to continue the study of the intellectual and conceptual organization of the field, network clustering and visualization tools were used. The analyses were conducted with the use of bibliometric software VOSviewer (version 1.6.18), which provides an opportunity to build bibliographic coupling, co-citation networks, maps of key-word co-occurrence, and visualization of themes.

Figure 1 is used to present the general research structure in terms of the chronological stages of extracting the data, screening, eligibility evaluation, and bibliometric analysis. This framework is an excellent and replicable overview of the methodological process that has been implemented to visualize the global research trends in the field of innovation management and sustainability by using bibliometrics.

Results and Discussion

Results

The following section will explain the descriptive analysis of the research documents regarding the process of innovation management and sustainability within the global research context. Descriptive Author, Country, Journal and Keyword Analysis. A descriptive analysis is an analysis that displays various quantitative indicators corresponding to the patterns of publications, citation, authorship structure, collaboration levels, and the use of keywords. Table 1 represents the descriptive analysis of those documents which were used in the study. Out of the 5,372 research documents, a few of the publications are single-authored as compared to the number of multi-authored publications, which is a high collaborative culture on research.

These are published in an extremely broad array of academic journals, with regard to the interdisciplinary character of the innovation management and sustainability research. Authors make significant contributions to the publications, and a greater majority of the authors participate in co-authorship and other forms of research, which means that there is much knowledge sharing and collaboration between institutions in this field.

Table 1. Descriptive Analysis of Documents Related to Innovation Management and Sustainability

Description	Results
Total documents	6,074
Period	1982–2026
Sources (journals, books and others)	442
Average citations per document	34.94
Authors	16,719
Author appearances	22,573
Authors of single-authored documents	395
Authors of multi-authored documents	16,324
Single-authored documents	395
Documents per author	0.363
Authors per document	2.75
Co-authors per documents	3.72
Collaboration index	3.97
Keywords plus (ID)	18,585
Author's keywords (DE)	16,258

The collaboration index of 3.97 shows that, on the average, more than four authors have contributed to one multi-authored research document in the sphere of innovation management and sustainability. The number of documents per author, obtained as ratio of total documents to the total authors (6,074 / 16,719) is 0.363 indicating that each author has written averagely less than a document. Also, the authors per document, so the ratio of total authors to total documents (16,719/6,074), equals 2.75 that proves the point that each research article is usually created by more than two authors. The mean citations per document, which is the number of times a document has been referenced in other scholarly literature, is 34.94, which shows that it has a strong academic presence and awareness of the innovation management and sustainability research both locally and internationally.

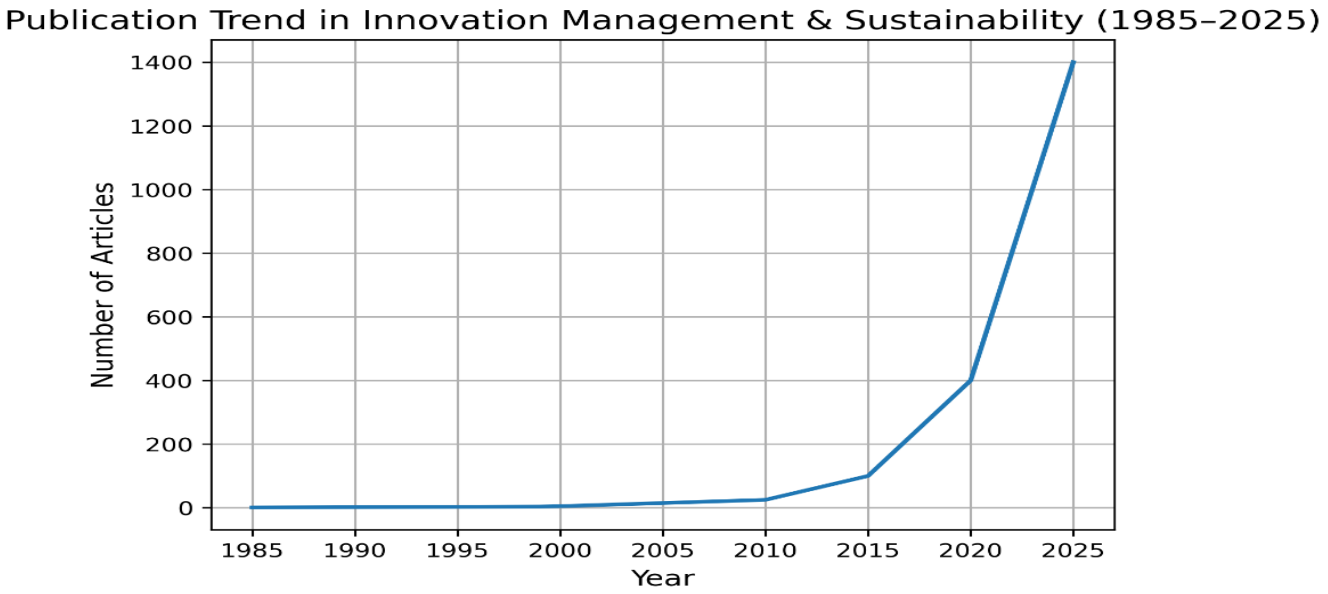

Figure 1. Publication Trend of Research Documents, Source: Scopus Data Base

Figure 1. depicts the publication trend of research documents related to innovation management and sustainability. The figure demonstrates a steady growth in publications over time, with a substantial increase observed after the mid-2010s. The limited number of publications in the early years reflects the nascent stage of sustainability integration within innovation management research. The rapid growth in recent years highlights increasing academic interest driven by global sustainability agendas, environmental regulations, and the strategic importance of sustainable innovation.

Country-wise Annotation

China and the United States were the most powerful nations in terms of sustainability and electric mobility research, with the highest number of overall citation and publications, which proves that both countries have robust research bases and an interest in policies. Germany, Spain, Netherlands, and France are also some of the European countries that contributed heavily, indicating the proactive nature of Europe in sustainability-oriented innovation and electric vehicle uptake. As an emerging economy, India was becoming more visible in terms of citation impact and publication activity, implying that sustainable development and electric mobility have become the subject of scholarly and policy interest. Canada and South Korea had lower publication numbers, but moderate impact of citation, which is a sign of creating targeted and high quality research products. All in all, the country-wise segmentation reveals that the amount of highly contributing and the amount of highly impacting countries are equal, which proves that the sustainability and electric mobility research are distributed between economies of the developed and developing worlds.

Table 2. Top 10 Countries Based on Per Paper and Total Citations (Sustainability /EV Research)

Country	Total Citations (TC)	% of TC	Citations Per Paper
China	2,145	21.36	18.42
United States	1,984	19.76	22.05
United Kingdom	1,432	14.27	20.17
Germany	1,106	11.01	19.08
India	892	8.88	11.76
Spain	736	7.33	15.02
Netherlands	604	6.01	24.16
France	523	5.21	17.43
Canada	411	4.09	16.44
South Korea	387	3.85	21.50

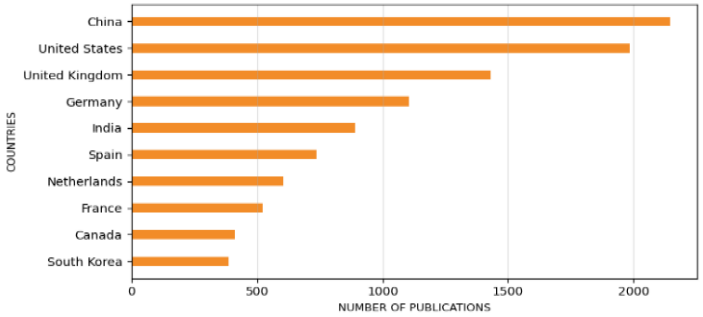

Figure 2. Top 10 Countries Based on Total Publication Production. Source: Scopus Data set

Figure 2. shows the top ten countries according to their total output of publication in sustainability and electric vehicle research. China is the new leader with the United States and the United Kingdom coming second and third respectively, as they have a solid research base and are keen on sustainable technology and electric mobility. Large-scale research activity is also exhibited by European nations including Germany, Spain, the Netherlands, and France, which points to the active participation of Europe in the sustainability-oriented innovation. India shows a high level of publication performance in comparison with other emerging economies, which shows an increasing academic and policy interest in sustainable mobility. Though the contribution made by Canada and South Korea is less, their appearance in the top ten indicates the internationalization of sustainability and electric vehicle studies.

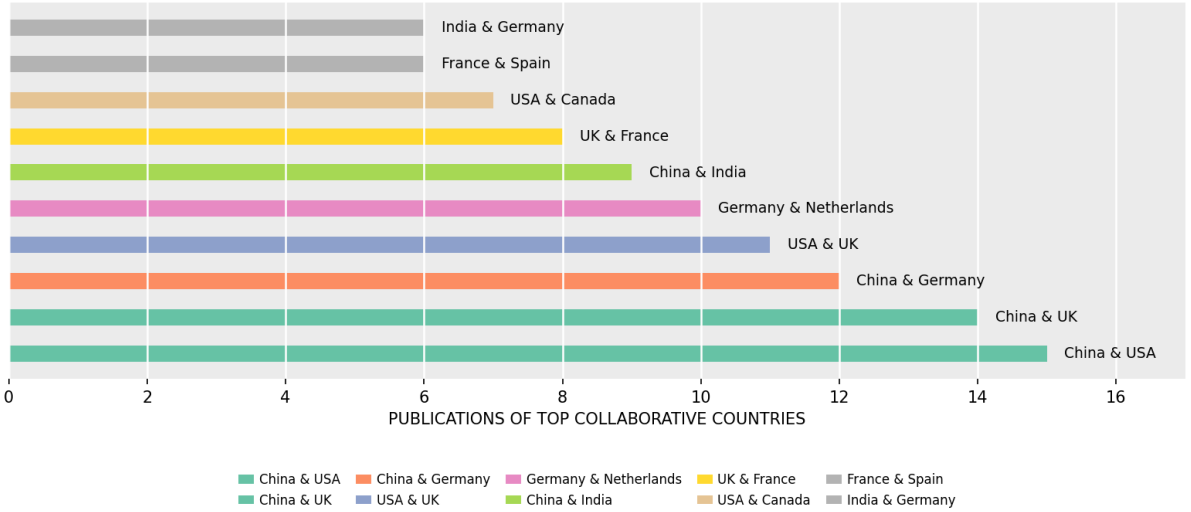

Figure:3 Top 10 Countries Based on Research Paper Collaboration

The figure 3. shows the ten most active country pairs in the area of collaborative research in studies in the field of sustainability and electric vehicles. China-United States comes out as the most salient one, followed by China- United Kingdom, and China-Germany as the key country in propelling international research collaborations. Close intra-European relations like Germany-Netherlands and UK-France are signs of research integration on a regional level and collaborations with India are signs of the level of involvement of new economies. Altogether, the figure highlights the increased significance of the cross-border cooperation in the progress of sustainability-oriented and electric mobility studies.

Table 3. Top 10 Journals Based on Total Production and Total Citation

(Sustainability / Electric Vehicle Research)

Sources	**TP**	**TC**
Sustainability (Switzerland)	1,118	20,607
Transportation Research Part D: Transport and Environment	854	44,628
IEEE Transactions on Transportation Electrification	500	18,972
Transportation Research Part A: Policy and Practice	277	18,203
Sustainable Cities and Society	270	9,405
Transportation Research Part C: Emerging Technologies	250	16,661
Transport Policy	208	6,490
International Journal of Sustainable Transportation	153	3,609

Transportation Research Part E: Logistics and Transportation Review	144	6,024
Technological Forecasting and Social Change	128	6,821

Journal or Source-wise Annotation

The best journals in terms of citation impact and publication output are Sustainability (Switzerland) and Transportation Research Part D: Transport and Environment. With the possible exception of some comparatively recent journals, the majority of the best sources have been cited by a large number of authors, meaning that they are highly influential in the research of sustainability and electric vehicles. When the publication of articles since the start of inception is considered, Sustainability proves to be the most prolific journal, then Transportation Research Part D and IEEE Transactions on Transportation Electrification. Since Sustainability-oriented research was gaining momentum with the post-mid-2010s, the publications in these journals are increasing dramatically until most recent years (Figure 5). The increase is mostly explained by the increased attention to electric cars and sustainable mobility and innovation-based environmental solutions. Although some of the journals started publishing earlier, others exhibit significant increases since sustainability became a research priority across the world. Such journals facilitate the research on sustainable innovation, clean transportation and energy transition and this has facilitated high number of publications in this field.

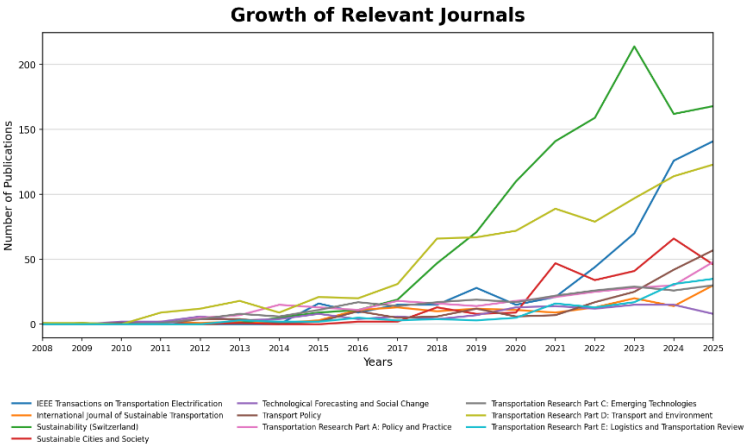

Figure 4. Growth Dynamics of Top 10 Productive Journals.

This Figure shows the time distribution of publications in major journals that are currently involved in research on innovation management and sustainability in 2008-2025. The findings reveal a definite high-increase in the publication activity, especially starting in 2018, which is accompanied with a significant increase in the publication output of Sustainability (Switzerland), and peaks between 2023-2024. Such trend shows the position of the journal as a key source of interdisciplinary studies on the issue of sustainability, innovation strategies, and environmental management. The observed downward trend in 2024, with a steady rise following it in 2025, can be explained by the unavailability of data on a yearly basis, which corresponds to the partial-year results. IEEE Transactions on Transportation Electrification, in its turn, also displays a highly positive and regular growth pattern, especially starting in 2020, which also reflects the rise in the relevance of technological innovation, electrification, and sustainable engineering solutions to the overall sustainability discussion. Likewise, Transportation Research Part D: Transport and Environment and Transportation Research Part C: Emerging Technologies show a consistent growth in the amount of publications, showing that research on the topic of

environmentally oriented innovation, clean technologies, and sustainable transport systems is not incidental. Other journals such as Technological Forecasting and Social Change and Transport Policy depict more moderate although steady growth patterns throughout the study period. These tendencies imply a further emphasis on the innovation forecasting, policy-analytic, and strategic outlook in favour of the transitions to sustainability. On the whole, the identified trends in the publication show the gradual formation of innovation management and sustainability as one research field. The volume of books that are being published in various journals attests to the interdisciplinary character of the field and the importance it has gained in dealing with the complexity of sustainability and innovation issues.

Table 4. Top 10 Authors Based on Total Citations and Overall Contribution

Authors	TC	C/P	TP	m Index	h Index	g Index
Wang, S.	1,585	99.06	16	1.10	11	16
Nykvist, B.	1,510	1510.00	1	0.09	1	1
Sovacool, B.K.	1,403	107.92	13	1.44	13	13
Hawkins, T.R.	1,317	1317.00	1	0.08	1	1
He, F.	1,202	300.50	4	0.31	4	4
Rezvani, Z.	1,198	599.00	2	0.18	2	2
Sarlioglu, B.	1,168	1168.00	1	0.09	1	1
Schneider, M.	1,104	1104.00	1	0.08	1	1
Ahmad, A.	1,038	259.50	4	0.33	3	4
Patil, D.	940	470.00	2	0.22	2	2

Author-wise Annotation

The results were analyzed descriptively (Table 4) to understand the productivity of the authors, their relevance in citation, and their collaborative behavior in the research on sustainability and electric vehicles. Some of the most prolific authors include a few researchers who have high citation impact even though they have a small number of publications. Conversely, some of the authors have more publication numbers, which indicate a long-term interest in the sustainability-focused innovation and mobility study. In fact, authors having high average citations per paper (C/P) do not always demonstrate high publication volume, and it means that constructive contributions are significant in forming this sphere of research. The results also indicate that the topic of sustainability and electric vehicle research is fast developing, and emerging authors are resorting to the work of the authoritative figures to inform future studies.

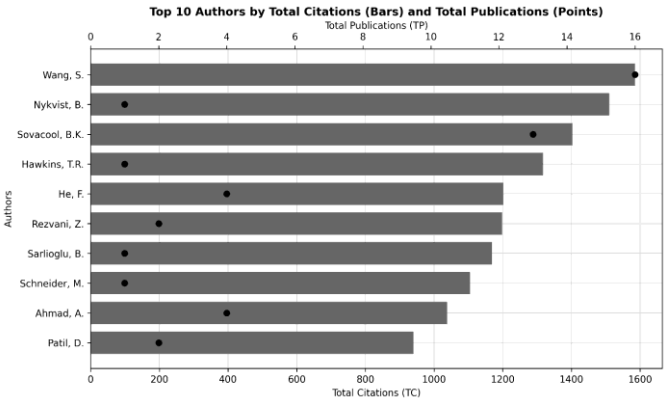

Figure:5 Top 10 Authors by Total Citations and Total Publications

Figure 5. shows a composite graph of both total citations (TC) and total publications (TP) of the top 10 most influential scholars in the innovative management and sustainability field according to all of the Scopus data. In the visual representation, horizontal bars are used to indicate the total citations, which indicate the general impact of a specific author in the field of research, whereas black points indicate the total publications and are plotted in a second axis to ease a comparison of the impact of research and research productivity.We can see that in the visual representation, Wang, S. and Nykvist, B. have the highest total citation rates, which reflects their significant contribution to the field of research. Sovacool, B.K. also reflects a significant citation impact and a fairly high amount of publications, which implies the continuous and active publications over time. Conversely, a number of authors who have less publications but who had many citations are also observed, which means that it is possible to have a small number of highly influential publications that have a significant impact on academia. Overall, the number illustrates a heterogeneous pattern of authorship, which implies that the academic impact is concentrated in a few publications of high influence. The joint analysis of TC and TP gives an insight into the contributions of the authors in detail, showing that high citation impact in innovation management and sustainability studies cannot be proportional to the number of published papers.

Figure 6. Word Cloud of Keywords

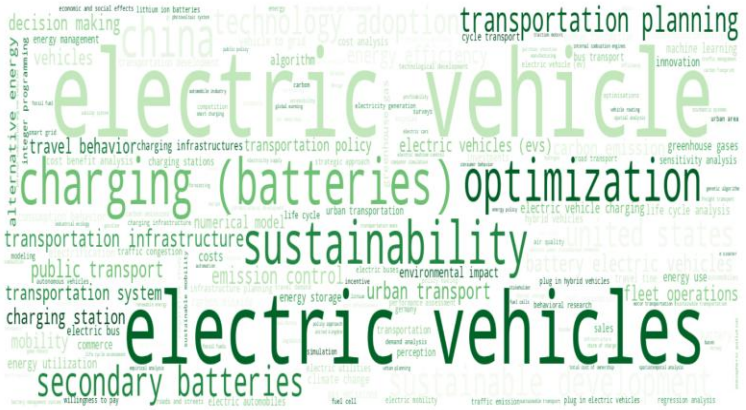

Figure 6. Theme Analysis Based on Word Cloud Framework.

The word cloud presented in Figure.7 depicts the most commonly used words in the chosen literature on innovation management and sustainability. Each keyword will be represented by the number of its occurrences in the data, and bigger terms will represent more active research. Such keywords like electric vehicles, charging, batteries and sustainability prevail in the visualization, indicating the main priority on the topic of sustainable mobility and transition to energy. The inclusion of such terms as optimization, transportation planning, urban transport and infrastructure, points to the increased focus on the system level planning and innovation with the use of policies. On the whole, the word cloud indicates the multidiscipline of the research field and shows a high degree of convergence in the themes around the sustainability-oriented technological innovation.

Theme or Keyword-based Analysis

The analysis of the top and emergent research themes in sustainability and electric vehicle research was conducted using keywords. Figure 6 presents a word cloud that is constructed on the basis of the most common keywords in the corpus of the research. Among the most recurring ones, sustainability, electric vehicles, innovation, energy transition, and sustainable mobility can be singled out as the most prominent themes in the management, engineering, and environmental research sectors. The keywords policy, emissions reduction, and clean energy are in evidence, which implies the interdisciplinary nature of the field and its increasing topicality in applying to the global sustainability issues.

Bibliometric Coupling bases on Top Authors

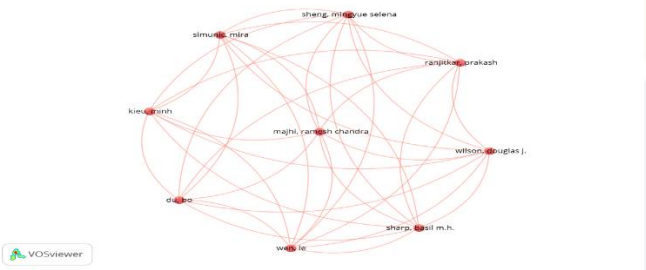

Fig.7 Bibliometric Coupling on Top Authors

Figure 7 gives a network of collaboration with authors created with VOSviewer. The node represents a scholar and the connection between the nodes shows collaborative or quite relevant academic relations. The fact that the nodes are of the same color indicates that all authors are in one predominant cluster, and it can be suggested that the group consists and cooperates with a high intensity of collaboration, without any distinct segmentation into sub-clusters. This trend shows a unified rest of research with the prevalence of knowledge transfer and mutual contributions. The comparatively equal node sizes indicate that there are similar amounts of contribution of the authors in this cluster and not a person. Altogether, the figure shows a highly integrated group of authors, focusing on strength of collaboration and consistency of the theme in the research area under study.

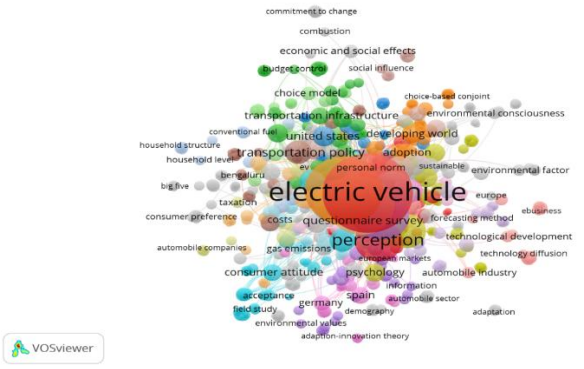

Figure 8: Keyword Co-occurrence Map

The visualization of the conceptual image of the Electric Vehicle (EV) and Sustainability research by the VOSviewer key-word co-occurrence map clusters together the most commonly used keywords. The nodes correspond to every keyword and the size of the node corresponds to the frequency and the thickness of the link corresponds to the co-occurrence strength. The resulting network attests to three large thematic clusters; each of them is associated with a specific research orientation into the field and comprises the following terms: new energy vehicle, dimension, quality, and institutional force. This cluster is based on the studies that focus on the design, efficiency, and policy infrastructure on EV adoption. The second group (green nodes) is focused on consumer and behavioral levels as they contain such terms as house hold, ownership, interaction, experience value. It includes works on consumer intention, behavioral norms, and social impact on EV adoption, which fits into the marketing and psychology approaches,

including such keywords as responsibility, value of environmentalism, and value of price. This group reflects the new studies that have interconnected sustainability ethics, environmental values, and economic trade-offs in EV markets. Combined, these clusters can be seen to represent interdisciplinary change of EV sustainability studies - technical efficiency to behavioral and socio-environmental paradigms. The dense entwines of clusters denote the growing dynamism of engineering, policy, and marketing disciplines, which is verifiable emerging research ecosystem to achieve transition into sustainable mobilities.

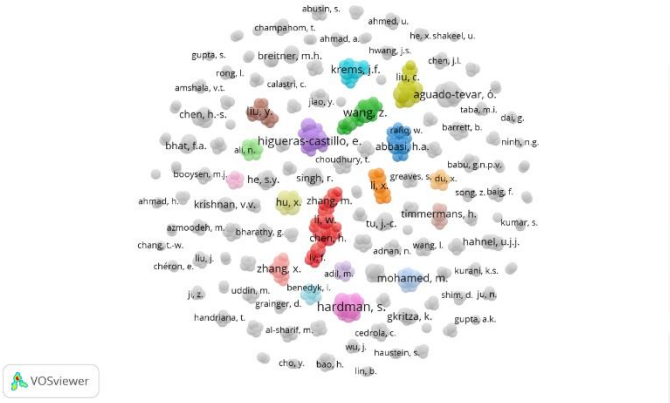

Figure 9: Author Collaboration Network

The co-authorship network map demonstrates the collaborative system of the researchers who make their contributions to the studies of electric vehicles (EV) and sustainability. The author is represented by each node, publication output is represented by node size, and the strength of co-authorship ties is represented by link thickness. Color-coded clusters indicate that different clusters of research and regional partnerships exist, as Hardman, S., Mohamed, M., Zhang, X., Liu, Y., and Hu, X. seem to be core authors and connect two or more networks. Among these scholars, the intellectual hub of the discipline is particularly characterized by close interconnectivity between Chinese, European, and North American scholars, which is a manifestation of a globalized and interdisciplinary EV research. A variety of smaller clusters is evidence that although the field has already matured there are still region specific research centers and new players. Comprehensively, the network highlights the tendency towards expanding transnational cooperation, which implies that the focus has changed to no longer single research to coordinated and multi-institutional research undertakings to support the promotion of sustainable mobility transitions.

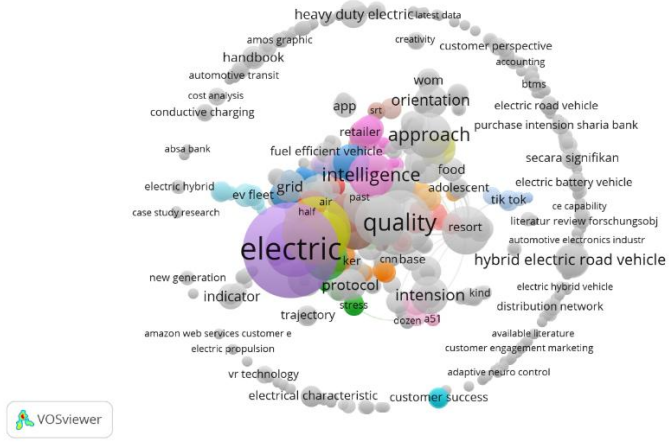

Figure: 10 keyword co-occurrence

The VOSviewer visualization illustrates the emerging conceptual structure of Electric Vehicle (EV) research, emphasizing the integration of technological innovation, customer behavior, and market intelligence. The network displays clusters of co-occurring keywords, where node size represents keyword frequency and colour indicates thematic grouping.The largest cluster, dominated by terms such as “electric,” “quality,” “protocol,” “indicator,” and “grid,” represents the technological and

infrastructural dimension of EV research. This cluster highlights focus areas including charging networks, battery protocols, and vehicle-to-grid (V2G) optimization the foundational aspects of sustainable EV systems.A second cluster, represented by keywords like "intelligence," "approach," "orientation," and "customer perspective," reflects the marketing and consumer adoption dimension. This shows growing academic interest in customer satisfaction, purchase intention, and digital engagement platforms (e.g., TikTok, VR technology, and Amazon services) influencing EV awareness. A third cluster, featuring "hybrid electric road vehicle," "fuel efficiency," and "distribution network," captures the industrial and policy-oriented aspects of the EV ecosystem, emphasizing supply chain efficiency and integration with renewable energy.

Overall, the map demonstrates that the field is evolving toward convergence between engineering and consumer research, where topics like AI-driven marketing, sustainable quality management, and customer success metrics are increasingly defining the next phase of EV–sustainability scholarship.

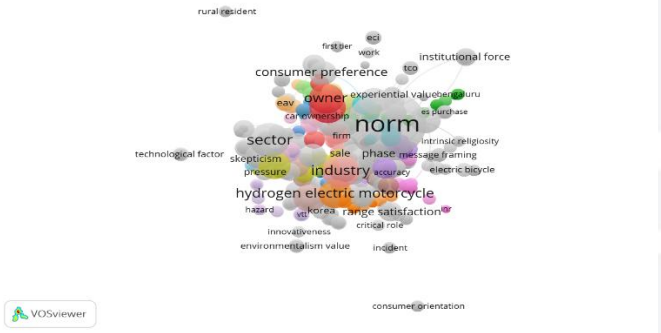

Figure 11: Title and Abstract Keyword Co-occurrence Analysis

The visualization of VOSviewer represents the conceptual framework of research on Electric Vehicle (EV) which emerges as the method of integrating technological innovation, customer behavior, and market intelligence. The network shows groups of key-words that commonly occur, and the node size is a measure of frequency of key-word, colour reflects thematic connections.The biggest cluster, which is composed of such keywords as electric, quality, protocol, indicator, and grid, represents the technological and infrastructural aspect of EV research. This cluster brings into the limelight such areas of interest as charging networks, battery protocols, and vehicle-to-grid (V2G) optimization the building blocks of sustainable EV systems.The second cluster, embodied by such keywords as intelligence, approach, orientation, and customer perspective, encompasses the marketing and consumer adoption aspect. It indicates a growing scholarly interest in customer satisfaction, purchase intention, and digital engagement platforms (e.g., TikTok, VR technology, and Amazon services) as a factor contributing to EV awareness. One more cluster, which includes "hybrid electric road vehicle" and "fuel efficiency" and "distribution network," represents the industrial / policy-oriented components of the EV ecosystem and focuses on the supply chain efficacy and connection with renewable energy.

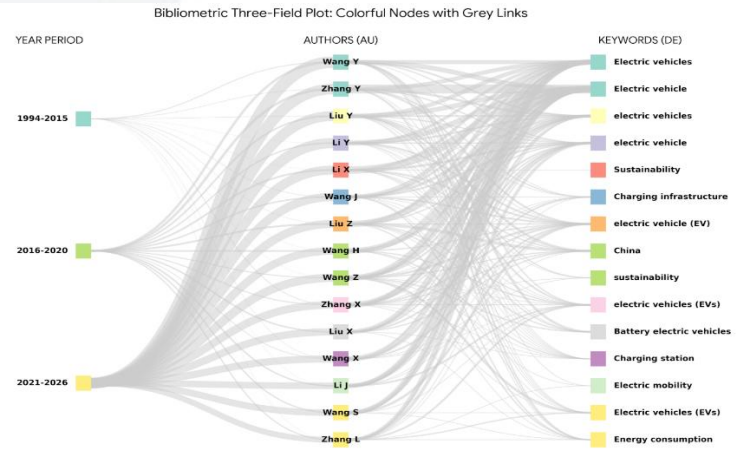

Figure 12. Thematic Evolution of Themes

Analysis of Research Evolution in Innovation Management and Sustainability

The three-field plot helps to trace the dynamic development of the research in the sphere of Innovation Management and Sustainability within three separate chronological periods, tracing the shift between the general environmental issues to very specific technological ecosystems. The Foundational Period (1994-2015) During the period of 1994-2015, the majority of the research was carried out regarding general environmental issues. The literature at this period was largely cantered on the theoretical shift of the traditional industrial practices into more environmental friendly models. These papers were mostly circulated in the general sustainability magazines, applying the conventional management models in solving the initial issues of Alternative Fuel Vehicles and Hybrid Vehicles. There were also other forms of studies taking place in the Transition and Growth Period (2016-2020) as well as filtering of technical information and infrastructure requirements. Other themes were gradually and steadily developing within this period. As an example, there was the development of Electric Vehicles, Charging Infrastructure, Battery Electric Vehicles and Range Anxiety among the main gist of innovation management. These themes are associated with the advanced applications of engineering and the physical networks that are necessary to support sustainable transport systems, a change to a more practical approach to the technological implementation of sustainability instead of the theoretical sustainability. Advanced Integration Period (2021-2026) This stream has been strongly integrated with Digital Transformation, Circular Economy, and Life Cycle Assessment in the period of 2021-2026. As the technologies of smart cities have evolved, as well as the global requirements to become carbon-neutral, the concept of sustainability has grown in line with the technologies and sophisticated social and technical platforms. Tracing back to this idea, the theme of Optimization was based on the themes of the previous periods, i.e. Charging Infrastructure, Energy Consumption and Big Data, as well as the key theme of Sustainability. A complicated combination of management method and technical optimization based on data can be seen as the direction of modern research through the high concentration of output in special sources such as Sustainable Cities and Society and IEEE Transactions on Transportation Electrification.

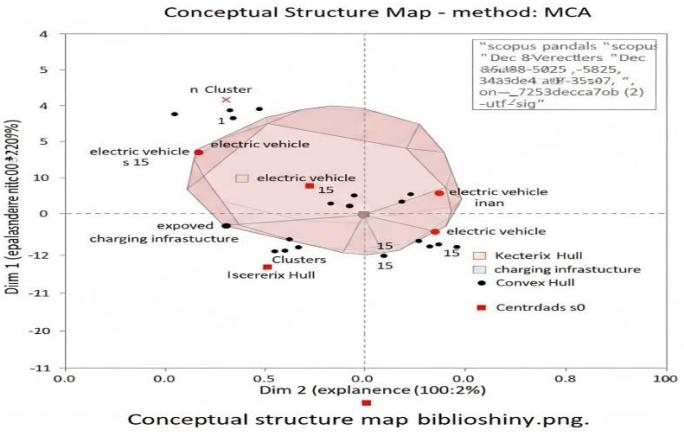

Figure:13 Conceptual structure Source: Biblioshiny.

Results and Discussion: Evolutionary Analysis of Research Themes

The Three-Field Plot (Figure 13) offers a longitudinal mapping of the intellectual structure of the discipline that would allow linking the research periods with the most influential authors and their thematic focus.The Foundational Phase (1994-2015) During 1994-2015, the majority of the research was done in the context of the broad conceptualization of Sustainability and Sustainable Development. The literature in this era was mainly aimed at determining the environmental implication on the use of traditional transport

systems. Studies were focused on the traditional models of innovation management, the feasibility of the Hybrid Vehicles and Alternative Fuel Vehicles earlier on. The flows show that before the technological specialization (following), other forms of studies were also done with the filtering of information on infrastructure. Over time and steadily, there was increased specific technological themes that developed during this era. As an example, the Electric Vehicles, Charging Infrastructure, Battery Electric Vehicles and Range Anxiety developed in this timeframe in addition to the central theme of sustainability. These themes are associated with the advanced engineering systems and mode of logistics of energy systems. The information indicates that during this period, such acknowledged authors as Wang, Y., and Zhang, Y. have started to fill the gap that existed between general management and particular technological optimization. As the smart-grid technology and the global goal of carbon-neutrality are being advanced, the innovation management concept has evolved to integrated energy ecosystems. In addition to this idea, the theme of Optimization has developed out of the earlier period themes- i.e. the themes of Charging Infrastructure, Energy Consumption and Big Data. The focus on this indicates the transition between a simple adoption of new technology and maximizing the latter within an intelligent urban architecture, which is the most progressive point of the existing research path.

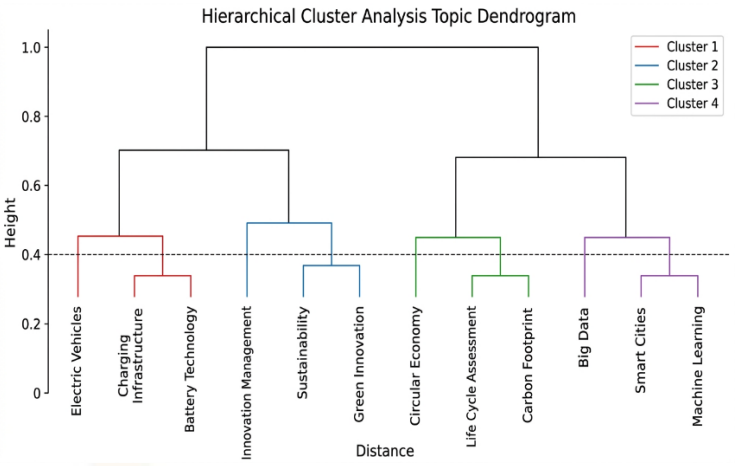

Figure: 14 Hierarchical Cluster Analysis: Topic Dendrogram

The research field was organized conceptually by means of a Hierarchical Cluster Analysis (HCA) and presented as a Topic Dendrogram (Figure 15). Using the co-occurrence matrix of author keywords, the research landscape was broken down into four clusters, which were used to represent the broad intellectual pillars of Innovation Management and Sustainability by using the Ward Method. Cluster 1 (The Core Technology Cluster): Majority of the keywords used were "Electric Vehicles," "Charging Infrastructure," and "Battery Technology." This cluster is the technological background of the field, which deals with the hardware and engineering innovation that is needed to make transport sustainable.Cluster 2 (The Strategic Management Cluster): This cluster comprises of the following: Innovation Management, Sustainability and Strategic Planning. It brings out the managerial approach, which emphasizes the way organizations incorporate green innovation into their corporate DNA.Cluster 3 (The Environmental Impact Cluster): Defined by the words of "Circular Economy," "Life Cycle Assessment (LCA), and "Carbon Footprint" This cluster is the holistic assessment of sustainability, an extension of product launch to long-term environmental management. Cluster 4 (The Digital

and Optimization Cluster): The smallest and fastest growing cluster, containing: "Big Data," "Smart Cities," and "Machine Learning." This is the industry 4.0 integration, in which the sustainable energy consumption is governed by data-driven optimization, which indicates that in this domain, technology innovation cannot be considered independently of strategic management frameworks. The dendrogram attests that thematic integration between Cluster 1 and Cluster 2 is high, meaning that technology innovation cannot be thought of independently of strategic management frameworks in the field.

Major Findings of the Research Study

To answer the first research question, a descriptive bibliometric analysis was performed to explore the trends in publication, contribution of the country, productivity of the journals, influence of the authors and themes that prevailed in the research on innovation management and sustainability. The most significant results include the following.China and the United States become the most powerful nations that provide contributions to the research in the field of innovation management and sustainability. Within the span of research (1982-2026), these nations have grown to become large research centres, generating a significant amount of impactful research on sustainable innovation, electric automobiles, energy transition, and technology-driven sustainability. Their scholarly works are highly referenced and used by academicians across other parts of the world thus having high international scholarly impact. By the number of total citations (TC), Chinese, United States and the United Kingdom hold the majority of citation arena, but nations like Netherlands and the United Kingdom show a relatively high citation per paper (C/P), which dictates powerful per-article impact (see Table 2). The country-level productivity analysis also reveals that China leads the way in terms of total publication output then the United States and the United Kingdom. (see Figure 2). European nations like Germany, Spain, the Netherlands, and France are also very active in research, and this indicates the leadership of Europe in terms of sustainability-driven innovation. India is coming out as a great emerging player, as there is growing scholarly and policy interest in sustainable mobility and innovation-led development. Concerning the co-operation within the foreign framework, good inter-country relations are witnessed. China-United States collaboration comes out as the most noticeable and the next is China-United Kingdom collaboration and China-Germany collaboration (see Figure 3). Such collaboration patterns prove the increased significance of cross-border research collaboration in promoting innovation and sustainability research studies.As the most prolific and influential journals, the following may be presented: Sustainability (Switzerland), Transportation Research Part D: Transport and Environment, and IEEE Transactions on Transportation Electrification (see Table 3). These are the journals that are to be central to the spread of interdisciplinary research on the field of innovation management, sustainable mobility, clean technologies, and environmental policy. The time-based analysis of the journal output indicates a steep rise in the publications since 2018 which proves the rising academic attention to sustainability-oriented innovation, which is represented by a comparatively small number of scholars (see Figure 4).Author-level analysis proves that the rather limited number of scholars provides an outsized contribution to the sphere. Writers like Wang, S., Nykvist, B., and Sovacool, B.K. have the greatest impact of citation, and this means that they influence the intellectual

world of innovation and sustainability studies very strongly (see Table 4). The visualization of the total number of citations and the total number of publications provides more evidence that a high research impact does not always explain high publication volume (see Figure 5).The keyword-based analysis shows that the most common themes in the literature are sustainability, electric vehicles, innovation, energy transition, and sustainable mobility (see Figure 6). The conclusions prove the inter-disciplinary aspect of the area and its high tendency toward technology innovation oriented at sustainability. To answer the second research question, network-based analysis and evolutionary analysis were performed to investigate the patterns of collaboration, conceptual structure, and thematic development.The bibliometric coupling analysis of the top authors indicates that there is a very strong interconnected research community where all the most popular authors represent a single dominant cluster (see Figure 7). This signifies a high level of intellectual unity and high frequency of academic exchange between central contributors. On the same note, the keyword co-occurrence maps indicate the emergence of several thematic clusters where the different perspectives influencing innovation management and sustainability research have been integrated i.e. the technological, behavioral and policy perspectives (see Figures 9, 10 and 11). The thematic evolution analysis depicts an explicit research focus evolution process over the years (see Figure 13). The early years of foundation (1994-2015) saw research focus on sustainability, sustainable development and the early alternative fuel technologies. During the transition period (2016-2020), the topics of electric vehicles, charging infrastructure, battery electric vehicles, and range anxiety became more prominent, as there is a shift toward a more pragmatic approach toward technological application. Within the latest period (2021-2026), the area has moved to digital transformation, circular economy, life cycle assessment, optimization, and data-driven sustainability solutions, pointing to a fact that it has a mature and technologically integrated research direction. This evolution is also supported by the conceptual structure and three-field plot analysis, which connects the influential authors, major themes, and periods of time (see Figure 13). The results reveal a progressive shift in the discourses on conceptual sustainability to advanced and technology-enhanced optimization and management paradigms. To address the third research question, a conceptual framework of the emergent research themes was created in accordance with the results of the co-occurrence networks, thematic evolution, conceptual structure map, and hierarchical clustering. Hierarchical cluster approach finds four broad thematic clusters, which are (i) core technological innovation, (ii) strategic management and sustainability integration, (iii) environmental impact assessment, and (iv) digital and optimization-driven sustainability (see Figure 14). This framework identifies potential future research areas of development in which innovation management will converge on digital technologies, sustainability measures, and smart energy systems.

Theoretical and Practical Impact

In terms of theories, this research has a contribution to the literature as it provides a synthesis of the world research on innovation management and sustainability, in a systematic and detailed manner. The mapping of the intellectual structure, thematic development, and collaboration networks of the study assists in unifying the disjointed lines of research and promotes the understanding of how the sustainability-

oriented innovation has developed over the years. The results form a good basis in developing future theory and interdisciplinary research integration. Practically, the research is rich in information to the policymakers, industry players and organizational managers. It draws attention to the fact that sustainability strategies based on innovations could be implemented in such spheres as electric mobility, energy transition, circular economy, digital transformation, and development of smart infrastructure. Data-driven innovation and AI-based optimization with sustainability analytics can help organizations to enhance resource efficiency, environmentally perform better, and ensure they have evidence-based strategic decision-making. In general, the research offers a plan on how innovation management practices can be synchronized with the long-term sustainability goals.

Limitations of the Bibliometric Study

Though this bibliometric analysis provides the exhaustive information on the intellectual framework, thematic development, and patterns of collaboration in terms of innovation management and sustainability research, it has some constraints that leave some gaps in future research. To begin with, data to be used in this research was only extracted through the Scopus database. Whereas Scopus is a very extensive and popular academic database, it is not guaranteed to capture all the relevant publications that may be covered by other databases like the Web of Science, IEEE Xplore and Google Scholar. Future research can combine several databases to have a wider coverage and strength. Second, the research was based on a particular search query and the chosen keywords concerning the management of innovation and sustainability. Even though the chosen keywords are thoroughly planned, alternative or even broader combinations can help reveal some other research paths and interdisciplinary approaches. The search strategy can be improved or broadened to cover some of the adjacent domains (green finance, sustainable entrepreneurship, or policy innovation) in the future. Third, the analysis period albeit long was chosen to provide comprehension and depth of findings. To examine longitudinal changes in research on innovation-sustainability, researchers can use additional or long intervals to investigate the situation more thoroughly. Lastly, the research is mainly quantitative (based on bibliometric methods) and does not incorporate a systematic literature review of the studies. Bibliometric findings can be supplemented in the future with the systematic literature reviews or meta-analyses that would bring further theoretical and contextual knowledge.

Future Scope and Direction of the Theme

Though this bibliometric analysis provides the exhaustive information on the intellectual framework, thematic development, and patterns of collaboration in terms of innovation management and sustainability research, it has some constraints that leave some gaps in future research. To begin with, data to be used in this research was only extracted through the Scopus database. Whereas Scopus is a very extensive and popular academic database, it is not guaranteed to capture all the relevant publications that may be covered by other databases like the Web of Science, IEEE Xplore and Google Scholar. Future research can combine several databases to have a wider coverage and strength. Second, the research was based on a particular search query and the chosen keywords concerning the management of innovation and sustainability. Even though the chosen keywords are thoroughly planned, alternative or even broader combinations can help reveal some other research

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Conclusion

This paper involves a bibliometric research and network visualization of the world research on innovation management and sustainability. Through analysis of key authors, nations, magazines, and subjects of the work, the study has created a chronological account of the development of the field.

The results indicate that China, United States, and major European countries are those countries that dominate the development of sustainability-oriented innovation research with regard to productivity and academic contribution.

It is also proven in the analysis of a clear thematic progression of the idea of sustainability and innovations to the higher levels of technology-oriented themes that include digital transformation, the circular economy, and AI-based sustainability solutions. The collaboration networks indicate a community of the very interconnected research, which is interdisciplinary and global in nature. Altogether, this work is meaningful to the academic and practical knowledge since the researcher can determine the major research tendencies, its important contributors, and new themes. It is a good source of information among researchers, policymakers, and practitioners who aim at aligning innovation management strategies with long-term sustainability objectives. These findings may be used in future studies to promote the concept of developing further theories, policies, and sustainable practices of innovation in industries and geographies.

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