Advancing Smart and Sustainable Transportation: A Systematic Literature Review and Analysis

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Abstract. Sustainable, intelligent transportation systems are essential to combating global pollution, urbanization, and traffic congestion. Smart technology and green transportation infrastructure are examined in this academic essay. A 1990–2024 scholarly article review is done using reliable academic databases and publications. Research methods, conclusions, and concepts were similar throughout the literature review. Transport networks discuss IoT, Big Data analytics, and AI to improve safety, efficiency, sustainability, and accessibility. Exploring sustainable methods including public transportation optimization, electrified automobiles, and alternative fuels is helping reduce carbon emissions and promote environmentally sustainable transportation. A comprehensive literature review illuminates intelligent and eco-friendly transportation's benefits, drawbacks, and developing patterns. Academics, businesses, and government officials must collaborate to solve complex transportation issues. The research shows that regional socioeconomic and geographical strategies are important. Investigating transportation networks' ecological soundness, resilience, and equality improves policy and research. Studio R. We use Biblioshiny to analyse publication patterns, key publications, collaborators, and significant contributions to efficient and sustainable transportation. This issue has raised concerns, according to data. We establish a solid foundation for comprehending this field's continuing research by thoroughly analysing, clarifying, and evaluating significant publications.

Keywords: Sustainable Transportation, smart city, Electric vehicles, Urban mobility, Smart Transportation

1   Introduction

Imagine a society in which there is no longer any pollution in the air or backups in traffic, and where environmentally friendly transportation is entirely integrated into

the landscapes of cities. This would be a world that eliminates pollution and traffic congestion. The concept being discussed here is not science fiction; rather, it is the promise of environmentally sensitive and intelligent transportation; it is an innovative idea that is driven by both technological advancement and creative thinking. The electric vehicle (EV), which is at the core of this movement, is a strong instrument that has the potential to lead to a future that is both cleaner and more efficient. This future might be achieved through the use of electric vehicles. It is no longer the case that combustion engines are the ones responsible for the production of pollution that is harmful to the environment. Carbon-neutral electricity is something that electric vehicles (EVs) require, and it is possible to generate this kind of electricity by utilizing renewable energy sources like the sun and the wind. As a result of this shift, the air has gotten cleaner, particularly in areas that are densely populated and where pollution is a common occurrence. Nevertheless, the benefits are not restricted to a decrease in the number of pollutants it produces [1]. The ability of electric vehicles to link to infrastructure is one of the ways that smart technologies improve traffic flow and minimize congestion. Imagine streets where vehicles are able to anticipate when the lights will turn on and off, adjust their speed on the fly, and reduce the number of instances in which they are required to stop and go because of traffic. In addition to reducing the amount of time spent traveling and the amount of energy consumed, this is even more environmentally friendly. Electric vehicles also contribute to the reduction of noise in urban areas. Is it possible for you to imagine a future in which the roar of engines on the roads is replaced by the gentle whirr of electric motors? [2]. This makes the area more peaceful and enjoyable for the people who live there, which is good for their physical and mental health.

To be sure, the advantages are not limited to being beneficial to both people and the environment. People will have an easier time getting around if electric vehicles are available. As a result of their lower operating costs in comparison to gasoline-powered automobiles, they are a more suitable option for those hailing from a wider variety of economic backgrounds [3]. In order to make progress toward a transportation system that is completely intelligent and kind to the environment, which is powered by electric vehicles, collaboration is required. There is a requirement for the development of new battery technologies, the growth of charging infrastructure, and the upkeep of regulatory systems that are durable. In addition, recycling the batteries that are used in electric vehicles and solving the problems that are associated with energy sources are both essential steps toward attaining long-term sustainability. It is not enough to simply replace autos with forms of transportation that are more intelligent and less harmful to the environment; we also need to rethink the way in which we travel around. As a result of this voyage, there is a possibility that our lives will be improved, that our impact on the environment will be reduced, and that the future will be more equal for all people everywhere. This revolution is being driven by the electric automobile, which in addition to being a tremendous symbol of advancement, is also a huge driving force for a more favorable future. During this revolution, the electric car is currently in the driver's seat. Figure 1 illustrates that in the near future, there

will be widespread adoption of autos that are both environmentally conscious and have advanced intelligence [4].

Fig. 1.   Adoption of Smart and Sustainable Transportation (CC by 4.0) [5]

1.1   Importance of Smart and Sustainable Transportation

The wheels of our world are stalling because of a transport system that is gasping. Smog from greenhouse gas emissions covers towns that are already crowded. The human costs are huge amounts of wasted fuel, lost work time, and deaths on danger-ous roads. Many people can get to it, but those who really need it have a hard time getting important services. Can we go in a different direction? Yes, we should. No longer is smart, eco-friendly travel just a dream. Think about switching busy streets. Electric cars use clean energy and don't release any pollution, so the future will be better [6]. Smart sensors built into infrastructure can predict how traffic will move, which can cut down on delays and increase output. By connecting towns easily, pub-lic transport makes getting around cheap and easy. This idea must be shared around the world. This feeling is a call to action against climate change, for better lung health in crowded places, and for more fair distribution of opportunities [7]. But this move-ment needs more than just slogans. To make implementation work, people need to be willing to spend money on research and development, build an infrastructure that is reliable and easy to use, and be brave enough to accept new rules. On the other hand, the benefits are huge. There will be plenty of fresh air in cities, businesses will grow without traffic, and everyone will be able to move around freely. This changes how people move and how the planet is built. This hard trip is being driven by the desire to make the world a cleaner, healthier, and fairer place for everyone [8]. The question is whether we can afford to forgo this change, not whether it is affordable. Together, we can reimagine mobility and build a smarter, more sustainable future.

1.2   Current Status and Needs of Transportation

A big change is coming for the tourism and hospitality businesses, which are very adaptable. Technology adds virtual experiences and extreme personalisation to guests' journeys, but as tastes change, they need to be immersed in the real world and care about the surroundings. EVs are changing the industry and making the future better and more sustainable. Imagine driving quiet electric vehicles through beautiful scenery, lowering the carbon footprint of places you love. Hotels carefully place charging stations that are good for the environment to attract eco-friendly travellers. Less pollution from emissions and noise is good for the towns nearby, making the experience last. Leisure travellers who are becoming more environmentally conscious see EVs at hotels and sites as a way to combine work and play more smoothly while also lowering their impact on the environment [9].

However, issues still persist. Robust infrastructure growth is required to enable seamless electric vehicle travel to various locations. Automobile manufacturers, charging networks, and tourism industry personnel need to collaborate. To make neighborhood transportation accessible to everybody, include electric cars (EVs). More than just charging stations are required to participate in the EV revolution. Educating tour guides on ethical charging, endorsing environmentally conscious companies, and designing EV-friendly routes is crucial. Open and easily accessible cost and carbon balance data promotes confidence and assists consumers in making informed travel decisions. There is more to this sustainable shift in travel and hospitality than merely using electric instead of gas-powered vehicles. It also entails altering the ways in which we journey, investigate, and communicate with one another globally. By carefully integrating them, cooperating, and adhering to responsible practices, electric vehicles (EVs) may make travel safer, more enjoyable, and better for the environment for everyone. Let's convert to electric cars in order to improve and purify our business going forward while also being ecologically conscious [10].

1.3   Novelty of Study

The study looks at research patterns and trends from 1990 to 2024 using longitudinal analysis. This big picture view helps you understand how study into smart and sustainable transport has grown.

- International partnerships look at how experts in smart and sustainable travel tend to work with others in other countries. By focusing on teamwork, the study sheds light on the global sharing of knowledge and skills that leads to new ideas in different fields.
- Smart and sustainable transport research themes and areas of focus are found through phrase analysis in the study. This method finds research trends and hotspots that can help with future research and policymaking.
- A look at research from different fields of research from planning transportation, building infrastructure, and making policies. This all-around method sheds light on the tricky questions and solutions surrounding sustainable transportation.

- To find out what is the same, what is different, and what is coming together, the study looks at its results in light of other important studies in the same field. The comparison makes the study's results stronger and draws attention to its unique advances to smart and sustainable transportation research.

2   Literature Review

Kraus et al. (2021) have performed a systematic literature review and analysis of sustainable transportation criteria. To achieve this, they utilized 21 papers published between 2010 and 2020 that are part of the journals enumerated in the German rating system JOURQUAL3 (JQ3) and established a hierarchical unified vocabulary for elements of sustainability measurement [11].   Şengül et al. (2021) have explained studies in the fields of e-scooters and e-bikes through a systematic review that intends to provide a comprehensive overview of the effects of e-micro mobility by the PRISMA framework, which included identification, screening, eligibility, and inclusion [12].   Sun et al. (2021) have provided exhaustive overviews and quantitative insights into the present and forthcoming research domains of sustainable logistics in the era of Industry 4.0. Future recommendations include a human-centric technological transformation, system integration, digital twin, semi-autonomous transportation solutions, intelligent reverse logistics, and so forth, to address the existing research gaps more effectively by conducting a systematic literature review of 115 papers spanning the years 2012 to 2020 [13] . Pereira et al. (2021) have proposed a generic road map containing guidelines for the formation of SSC initiatives. By employing design science research methodology, this study constructs a road map by analyzing key governance aspects of 12 smart city initiatives in Europe and Latin America and identifying antecedents that may impede or facilitate the development of SSC initiatives through a systematic literature review [14].   Bi et al. (2023) distinguish between fundamental research and frequently encountered knowledge regarding sustainable urban transportation. Indicating that multidisciplinary, multiprotection, and multiangle cooperation and analysis will emerge as the prevailing pattern in this domain, these facets furnish readers with an initial comprehension of the evolution of sustainable urban transportation [15].

Golińska-Dawson et al. (2023) have conducted a literature review to determine which hardware and software innovations utilized by logistics service providers (LSPs) in sustainable urban freight (SUF) are appropriate for facilitating the shift to energy-efficient smart cities and examined various modes of transportation, which include autonomous vehicles, cargo bikes (including e-cargo bikes and e-tricycles), electric vehicles (primarily trailers), and rapid-transit systems that combine passenger and cargo transportation [16]. Archi et al. (2023) have completed a systematic literature review (SLR) to examine the historical accomplishments and prospective trajectories of intelligent tourism destinations within the framework of sustainable development. The current state of research on SLRs in smart tourism destinations and their implications for sustainable development is identified and analyzed [17]. Mansouri et

al. (2023) have explained that Urban distribution centres (UDCs) have surfaced as a solution to the adverse effects of urban freight transportation on air quality and traffic congestion, which have been exacerbated over the past decade. An examination of its conformity with corporate social responsibility (CSR) and corporate governance (CG) endeavors was undertaken. This encompasses the policies and strategies of the shareholders' governance, in addition to environmental, social, and economic metrics. The systematic literature review is comprised of the following stages: The initial study conducts a quantitative analysis of the existing literature by employing bibliometric tools [18]. Bibri et al. (2023) have explained the emerging paradigm of urbanism inherently signifies a substantial research void. To address this deficiency, delineate the driving forces behind environmentally sustainable smart cities and chart their thematic progression. A thorough examination of VSM-based intelligent, sustainable development from a triple-bottom-line standpoint requires a comprehensive literature review [19]. Ouni et al. (2023) have offered valuable insights that empower policymakers and decision-makers to develop sustainable transport strategies that sustainably address energy and environmental concerns over the long term. The objective of this systematic literature review is to illustrate the sensors that are employed in the Internet of Things (IoT) to manage urban disasters [20].

2.1   Objectives of the Study

- Analysing term co-occurrence patterns and citation networks can reveal research trends, subfields, and changes in focus in the hotel and tourism industry for sustainable and intelligent transportation. This shows how significant research topics have changed throughout time.
- Analyse co-authorship networks and institutional collaborations to discover famous authors, research groups, and critical knowledge centres. Doing so reveals potential hubs of excellence and discipline-wide collaboration.
- Analyze research contribution distribution by country, institution, or region. This will reveal knowledge gaps in underrepresented regions, local expertise, and international collaboration biases.

2.2   Gaps and Challenges in Existing Literature

Smart and environmentally friendly travel in tourism and hospitality has some problems that keep it from reaching its full potential. There is a big problem with research groups. Environmental studies, transportation, and tourism are all important, but technology, public health, urban planning, and transportation must also be covered. Breaking down these walls could lead to new ideas and perspectives that look at the changes in a more complete way, taking into account the environmental, social, and economic effects. It's still not clear how users behave and how many of them there are. Literature often misses people and focuses on technology. What do tourists do with these new choices? What they like and don't like about certain features? To design solutions that meet the needs and habits of users, we need to learn more about these issues. Taking care of different types of visitors is another gap. Many studies

use a "one-size-fits-all" method that doesn't take into account the needs and interests of adults, eco-tourists, and people who like to go on adventures. More environmentally friendly ways to move can be made possible by smart mobility solutions that are tailored to these groups and take into account their needs and limitations. Another problem is making these tools work with infrastructure and on a larger scale. Studies usually look at specific technologies, but they don't look at issues like large-scale adoption, infrastructure compatibility, or system conflicts very often. It's important to look at these problems as a whole, including the technology and the transportation system it needs to work with. To move beyond theory, we need strong assessments of the effects on the economy and the environment.

How will these measures change the economy and tourism in the area? To make well-informed decisions, you need to do thorough analyses that look at possible downsides and long-term effects, even though most study points to environmental benefits. Lastly, data-driven smart movement makes people worry about privacy and ethics. As data collection and AI grow, worries about their proper use and abuse grow. Ethical frameworks and data safety need to be looked into in order to build trust and lower risks with these technologies. Smart transport solutions have effects that last longer than they happen. More study needs to be done on long-term environmental issues like battery life, resource extraction, and effects that were not expected. These holes and problems need to be fixed so that smart and sustainable transport makes the tourist and hospitality business cleaner, fairer, and more resilient. With examples, this longer answer fills in each gap and shows how these problems are linked. It also stresses how important it is to have a complete plan that takes into account the social, economic, and moral effects of technology.

3   Methodology

Your journey toward data-driven research can get off to a good start with this comprehensive literature review. Through the use of Biblioshiny and R-Studio, we will learn how to improve the efficiency and environmental friendliness of services about tourism and hospitality. We take great effort in putting together our search phrases for both Scopus and Web of Science. The use of essential phrases such as "transport innovation" and "tourism experience" will direct us to relevant material. The data will be merged and cleaned up once the catch has been received, and we will make certain that it is accurate and complete. Biblioshiny is a tool that can transform information into usable images. The tendencies of new releases indicate how the industry is evolving. Finding new subfields and big subjects is the goal of keyword co-occurrence networks.

The method that we conduct research is altered as a result of the citation analysis that throws light on significant researchers and papers. How research teams might improve their ability to work together is illustrated by collaboration maps, which show where information is shared. In order to identify regions in which we are lack-

ing information and places in which we excel, we perform a study of geography. Insufficient information is provided by the data. Combining qualitative and quantitative analyses of large-scale research will allow us to have a comprehensive understanding of the area. Our story will be improved by the use of biblioshiny visualisations, and it will be simpler to comprehend the significant outcomes. Findings and their implications for research, policy, and practice will be presented in the next section. With the assistance of data and research, the sector of tourism and transportation will evolve toward a more sustainable future. An example of a technique flow chart is presented in Figure 2, which illustrates the process of data collection in a staged manner.
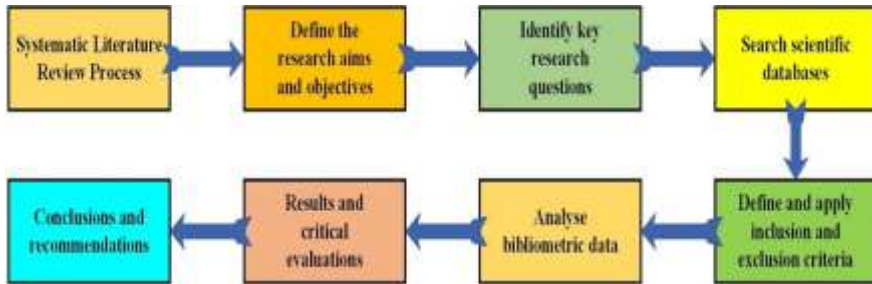

Fig. 2. Methodology Flow Chart

3.1   Selection Criteria for Bibliometric Survey

The literature search was performed using keywords "Sustainability" and "Tourism" in the Scopus database. The subsequent search was executed:

- The subsequent inclusion and exclusion criteria were implemented during the search phase.
- The sources of research articles were limited to Source type like "Journals", "Conference Proceedings", and "Book series". Grey literature materials such as book chapters, and technical reports were excluded.
- The inclusion criteria were restricted to Research articles published from 1990 to 2024.
- Only journal articles preferably written in the English language were incorporated.

3.2   Bibliometric Techniques and Tools Required

For analyzing and evaluating scholarly literature, bibliometric methods and approaches are indispensable. These methods and approaches provide academic institutions and researchers with substantial insights into the academic publication landscape. This study has made use of several different tools, one of which is Biblioshiny, which was developed by R-Studio.

3.3   R-Studio (Biblioshiny)

Modern science relies on bibliometric analysis to find patterns, trends, and links in scholarly literature. R-Studio's Biblioshiny module simplifies and democratizes bibliometric exploration using R. Researchers of all technical backgrounds can enter the complex realm of bibliometrics with Biblioshiny's accessible R-Shiny-based graphical user interface [21]. It handles the whole analysis pipeline, from importing data from Web of Science and Scopus to cleaning and pre-processing it for uniformity and correctness. Co-citation analysis, bibliographic coupling, and keyword co-occurrence analysis are available, along with comprehensive visualization tools that reveal scholarly networks and trends [22]. Additionally, Biblioshiny provides scholars with a variety of performance metrics, from citation counts to the h-index and impact factor, to evaluate authors, journals, institutions, and research fields. Biblioshiny helps scholars investigate bibliometric environments and share their findings with the scholarly community by providing smooth export options. As a light of accessibility and efficiency in bibliometric analysis, Biblioshiny catalyzes discoveries and drives comprehension in the ever-changing world of scientific investigation. Figure 3 below shows the features of the Biblioshiny extension that is used in R-Studio software [23].

4   Patterns and Trends in Smart and Sustainable Transportation

Smart and environmentally friendly travel patterns and trends have changed a lot between 1990 and 2024, according to statistics. This collection has 3041 documents from 742 books, journals, and other sources. It shows a lot of research in the area. With an impressive growth rate of 8.29% per year, this problem is getting more attention and concern from people. There are a lot of keywords in the document, including ones from Author's Keywords (DE) and Keywords Plus (ID). This shows how complicated smart and sustainable transportation study is.
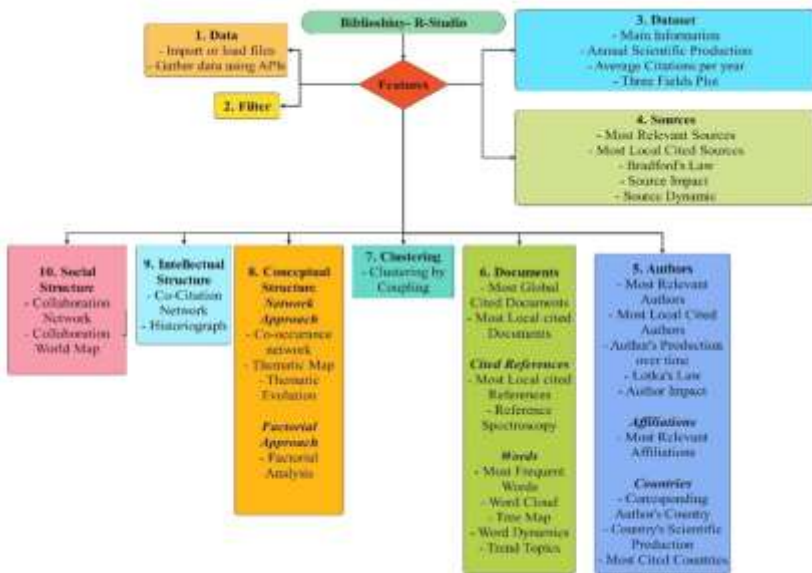
Fig. 3. R-studio (Bibiloshiny) Features

With 8208 authors participating, it's clear that a lot of work has gone into making this subject clearer to us. You wrote a lot of the stories with other people. The foreign co-authorship rate of about 20.91% also shows how people from around the world work together and share ideas to solve transportation problems. Scholarly communication and distribution can happen in a number of ways. The most popular are articles, conference papers, and reviews. The average age of the papers is 6.77 years, which shows that the focus on smart and sustainable transport is fairly new. This is because the industry is always getting better. The average number of citations per document (14.18 in this case) shows how important and influential study is in this field. The dataset is a great way to learn about smart and sustainable transport patterns and trends. It shows how this field is always changing, with new ideas coming up and more people working together to fix the problems that modern transport systems have so that they are more efficient and better for the environment. In Table 1, you can see the statistical data from the Scopus database that was used in this study. It shows the time frame of the articles.

Table 1. Main Data of Scopus Database

Description	Results
Main Information About Data	
Timespan	1990:2024
Sources (Journals, Books, Etc)	742
Documents	3041
Annual Growth Rate %	8.29
Document Average Age	6.77

Average Citations Per Doc	14.18
References	138888
Document Contents	
Keywords Plus (Id)	7578
Author's Keywords (De)	7433
Authors	
Authors	8208
Authors of Single-Authored Docs	508
Authors Collaboration	
Single-Authored Docs	543
Co-Authors Per Doc	3.12
International Co-Authorships %	20.91
Document Types	
Article	2398
Conference Paper	505
Review	138

4.1   Annual Scientific Production

Figure 4 shows the annual scientific production data from 1990 to 2024. It shows the number of articles released each year. This information helps us understand the patterns and changes in the study that has been done over the years. There is a more variable pattern to the data generally, with some years having much higher production than others. It came out once a year, and in the early 1990s, there were only a few pieces. Production slowly went up in the early 2000s, but really took off in the mid to late 1990s. Production goes up and down during this time, which could be because of changes in the priorities of study or something else. Between the late 2000s and early 2010s, there was a big jump in the number of papers released each year. The biggest jumps happened from 2010 to 2014. During this time, the number of publications may go up because study is getting more attention and money in many fields. The fairly high number of papers published each year in the scientific literature shows that research interest and activity will stay high from 2015 to 2022. However, the sharp drop in output in 2023 and 2024 points to a possible break from the previous trend. This drop might be caused by changes in funding, study priorities, or events outside of academia that have an effect on work. Over the years, the number of scientific papers published has grown, stayed the same, and maybe even changed. The yearly data on scientific production show these changes.
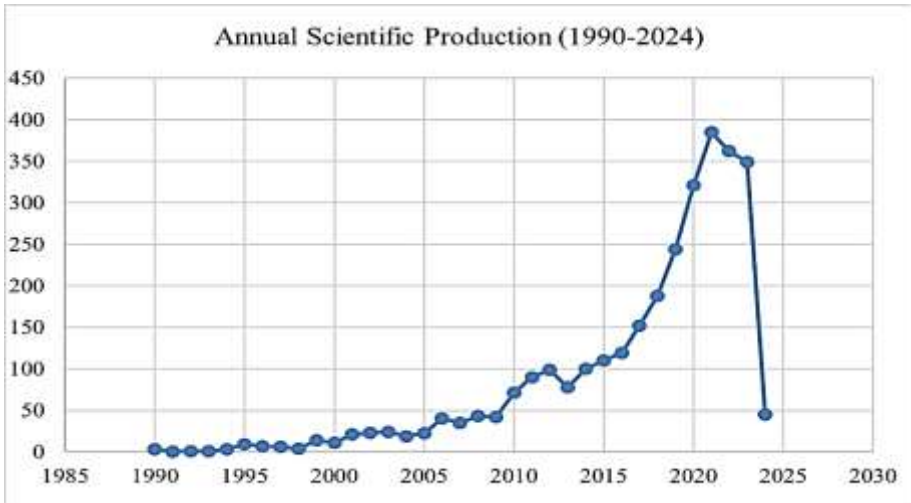
Fig. 4. Annual scientific production of articles from 1990 to 2024.

4.2   Most Relevant Sources

A lot of academic journals and books are some of the best places to find information for writing about sustainability and similar topics, as shown in Figure 5. In terms of number of pieces, the Swiss magazine "Sustainability" has been the most productive, with 417. This shows how important meeting proceedings are for sharing research results in this field: the "IOP Conference Series: Earth and Environmental Science" comes right after it with 182 papers. There are many fields of study that contribute to sustainable development. For example, "The Geojournal of Tourism and Geosites" has published 90 papers and "WIT Transactions on Ecology and the Environment" has published 142 pieces. "E3S Web of Conferences," "Land," and "Environmental Science and Pollution Research" are three important additional sources. With 58, 56, and 54 papers, they provide a space for people to share ideas and information. There have also been big steps forward by journals like "Journal of Environmental Management," "International Journal of Sustainable Development and Planning," and "Sustainable Development." These journals show how important it is to have specialised places to promote sustainable practices and move research forward in many areas. Sustainability study has a big impact on environmental science, policy, and planning. The fact that the articles are spread across these different sources shows that it is collaborative and crosses disciplines.
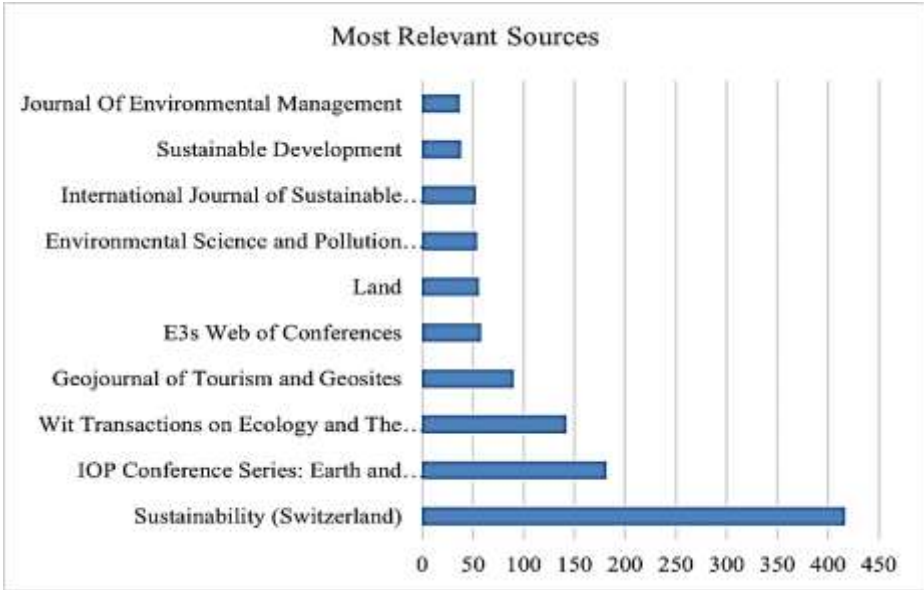
Fig. 5. Top 10 Most relevant sources

4.3   Keywords

Keywords are short descriptions of the main ideas, concepts, and topics in a piece of writing, usually a research paper. In bibliometric analysis, keywords help researchers find relevant material by summarizing the text and topic of a document. Authors give their work keywords so that libraries and search engines can find it. Keyword analysis can show patterns, trends, and new problems in an area of study. This can help you understand how people communicate in school and find important topics. Keyword analysis can group or label papers, which lets researchers look at how topics and sub-fields are related.

Author's Keywords
    . The authors' keywords, of which the top 25 are shown in figure 6, give a brief outline of the main ideas and themes that the authors think are important in their scholarly papers. "Sustainability" appears 656 times, making it the most common keyword among the commonly occurring terms. That's what this observation means: the main focus in academic discussions about sustainability is on how to implement it in different areas. The fact that the words "tourism" and "sustainable tourism" are used so often in the same sentence shows how sustainability principles and the tourism business are connected. Notable keywords include "climate change," "sustainable development," and "ecotourism," which show that sustainability study is multidisciplinary and can help with things like community development, protecting the environment, and making the world a better place. Current events continue to shape academic debate and study priorities, as shown by the use of keywords like "COVID-19."
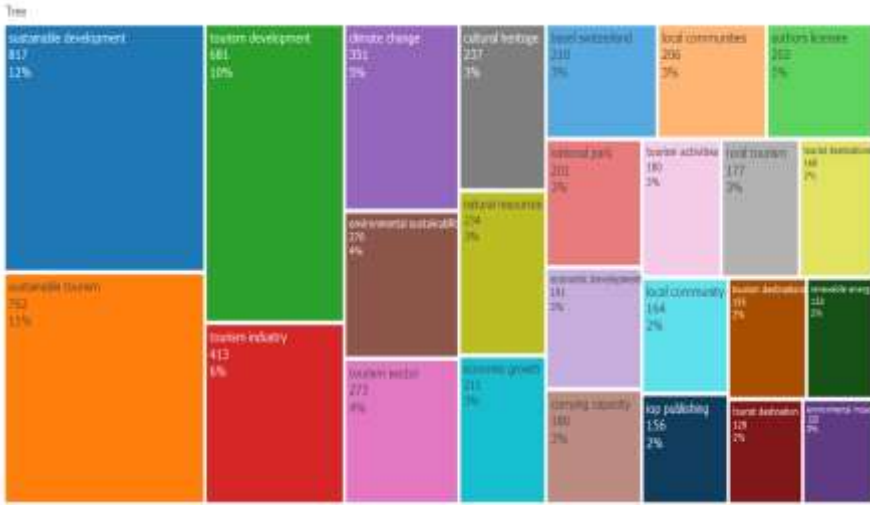
Overall, looking at the keywords the writers used gives us a lot of useful information about the most common topics, patterns, and focus points in the fields of sustainability and tourism research.

Fig. 6. Top 25 Author Keywords

Abstract Keywords Tree Mapping

. In research abstracts, the tree map representation of field keywords gives a complete list of the most popular terms, as seen in Figure 7. With 817 appearances, "sustainable development" is the most common of these words. Clearly, this shows how important sustainable development principles are in many academic areas. Topics like "tourism development" and "sustainable tourism" come up a lot in the conversation. This shows that people are paying more attention to environmentally and socially responsible tourism practices. The use of keywords like "climate change," "environmental sustainability," and "natural resources" also draws attention to how important it is to use sustainable management practices and how tourism can help solve serious environmental problems. Furthermore, words like "national park" and "cultural heritage" stress how important nature and cultural resources are for promoting tourism and protecting these resources. Overall, the tree map visualization is a nice way to show the main ideas and topics that are studied in the abstract field. Getting useful information about the study environment for sustainable tourism and development is made easier by this.

Fig. 7. Tree Mapping of Top 25 Abstract Keywords

Keyword Dynamics

. The given data shows how the popularity of a number of keywords changed from 1990 to 2024. Tracking keyword rates once a year gives us a look at how they've changed over time. A lot of different keywords are being watched, including "Climate Change," "Tourism," "Tourism Development," "Ecotourism," "Tourist Destination," "Tourism Management," and "Environmental Protection." The data shows that the frequency of most terms has steadily grown over time. This is in line with the growing interest among scholars in sustainability, tourism, and related topics. The large rise in the number of mentions to "Sustainability" and "Sustainable Development" from the early 1990s to now shows that these ideas are becoming more important. The fact that more and more people are searching for tourism-related keywords, like "Tourism" and "Tourism Development," shows that research in this area is becoming more and more important and interesting around the world. Also, there is a clear upward trend in the use of keywords like "climate change" and "environmental protection," which shows that environmental issues are getting more attention and concern in academic talks.

Thematic Evolution

. Keyword themes show how research, priorities, and trends change over time in a certain area. Scholarly research has changed over time, as shown in Figure 9 by how often and where keywords appear. At first, terms may be the most important thing, reflecting the wants and needs of the time. The way people use keywords changes over time as society, technology, and the surroundings change. As new problems or lines of study come up, some keywords may lose their shine or be absorbed into bigger theoretical frameworks, while other keywords may become more important. The

use of certain keywords may also show how policy priorities are changing, how countries are working together, or how paradigms are shifting in the area of study. By tracking how keyword themes change over time, researchers can learn more about how their field works, find new study areas that haven't been explored yet, and see how changing trends affect scholarly discourse.
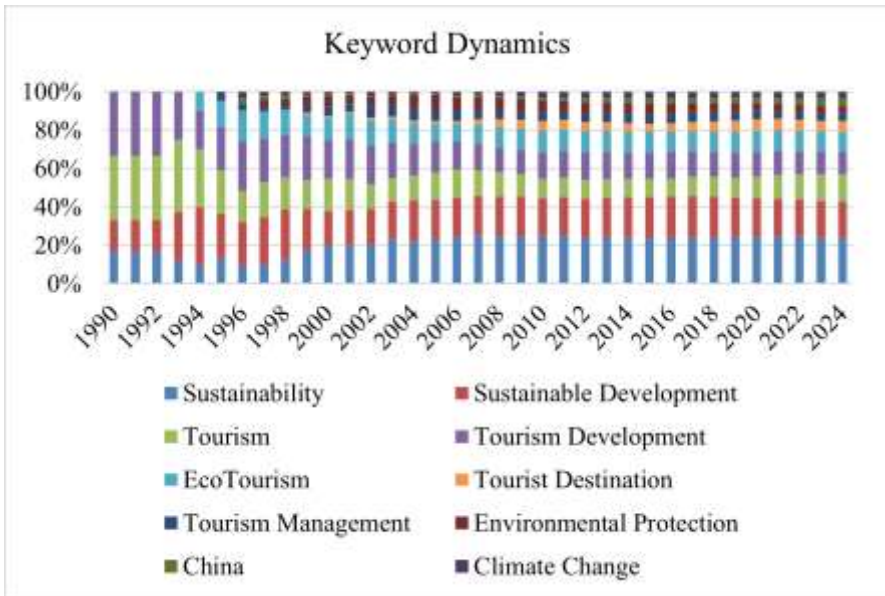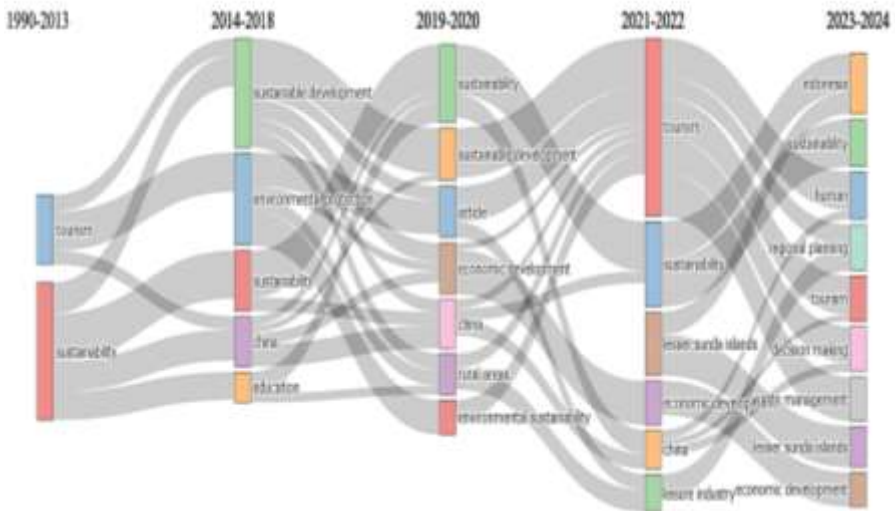

Fig. 8. Keywords Dynamics for the Year 1990-2024

Fig. 9. Thematic Evolution of Keywords

4.4   Scientific Production of Countries

The records give us a look into the scientific work of many countries and regions. The top ten countries in terms of scientific output are made up of a wide range of scholars and experts from different countries. With 950 scientific efforts, Indonesia is now the country with the most scientific output. Two countries that are very good at science are China and Spain. They have 922 and 892 results, respectively. The United States and Italy both make 524 research contributions, which is about the same. The fact that Malaysia is being closely watched in this area shows how important Southeast Asia is to scholarly study. The last ten countries are Portugal, Turkey, India, and the United Kingdom. All of these countries make important contributions to the creation and sharing of information. These countries' ongoing involvement in academic research shows how research projects are spread out around the world and how different points of view help science move forward on a global level. The process of writing study articles is shown in Figure 10.
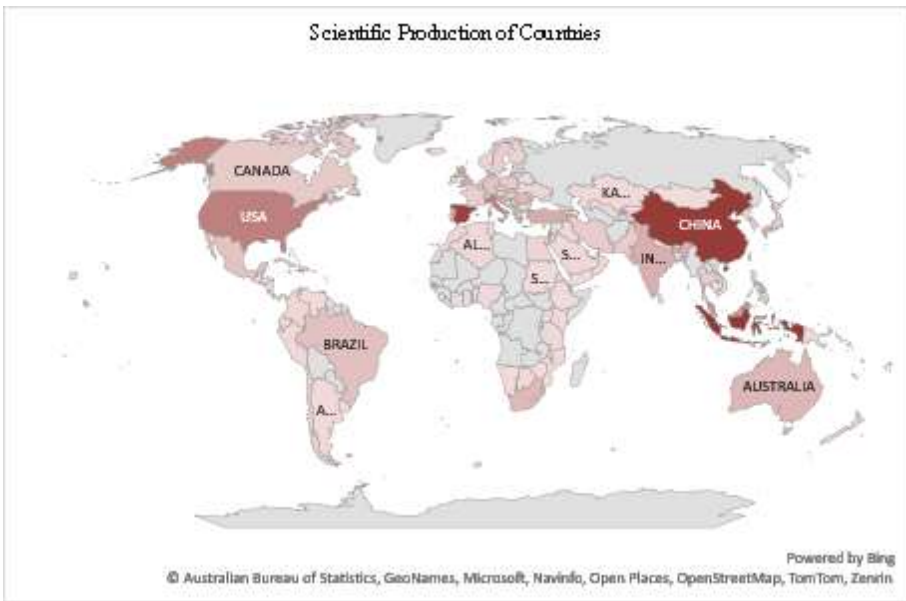

Fig. 10. Scientific Production of Countries worldwide

Country Collaboration Network

    . The country's collaboration network in academic research is a complicated web of partnerships and collaborations that bring researchers and institutions from all over the world together to work on projects. This network shows how collaboration is becoming more important in science and how study is spreading all over the world. A lot of countries work together to solve tough global problems that need answers from different fields and across borders. They do this to share resources and learn from each other's knowledge and experience. Working together and using different points

of view, methods, and data sets can help researchers do better work that has a bigger effect. International collaborations also help share information, improve understanding between cultures, and come up with new ideas by bringing together people with different skills and knowledge from around the world. International conferences, co-authored publications, collaborative finance initiatives, and joint research projects are all common ways that people work together. By looking at this network, we might be able to figure out how international research partnerships work and where things are happening as well as who the main players are. It is better for the world and people when scientists from different countries work together to solve big problems and learn new things. Figure 11 below shows how the country works together to do study on smart and environmentally friendly transport for tourists.
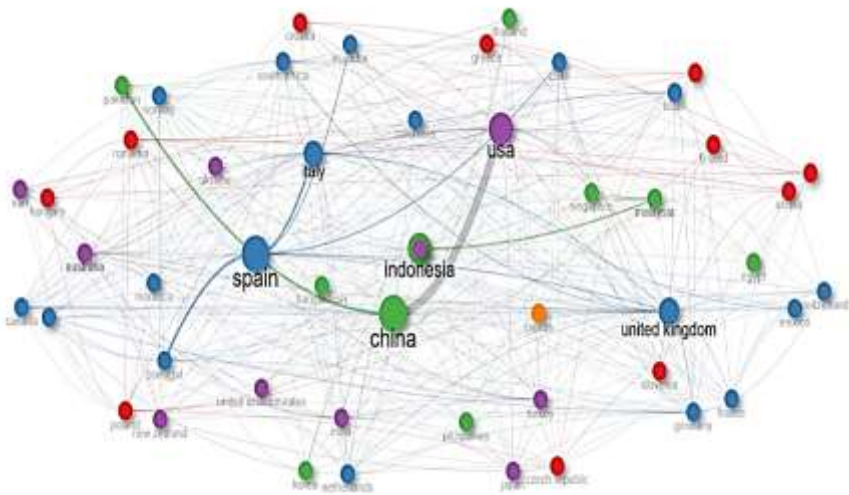
Fig. 11. Country Collaboration Network

4.5   Topics in Trend

The information given can help us understand how different topics have changed and grown over time. In order to make this point, the word "developing country" was first used seven times in the mid-1990s (see Figure 12 for an example of this trend). Similarly, the term "watershed management" became more popular from the late 1990s to 2018. This shows that there is a constant need for methods for managing the environment. Between 2001 and 2016, the word "wood" was used a lot, which shows that people became more interested in or had new ideas about these materials. The Indian region called "Himachal Pradesh" became well-known in the early 2000s and again in 2017. This was probably due to events or studies that focused on the region. The words "environmental engineering" and "environmental planning" have been used more often over the last ten years, which suggests that these areas are still being researched and improved. The words "Eurasia" and "Europe" were used a lot between

2006 and 2017, which shows that people were interested in regional issues and build-ing relationships. The words "marine park" and "coastal zone management" became very popular in the late 2000s and early 2000s, at the same time that people all over the world became more interested in protecting marine ecosystems. Between 2010 and 2021, the terms "environmental impact" and "environmental protection" were used a lot more. This shows that people are paying more attention to and working to solve environmental problems. From the beginning of the 2010s to the beginning of the 2020s, "sustainable development" and "sustainability" were common words used to talk about going green. The terms "tourism" and "economic development" have become more common in recent years, which shows how important they are in decid-ing the goal of both government and academic projects. Finally, at the beginning of the 2020s, "carbon dioxide" and "internationality" became important themes. This was likely because people were becoming more worried about climate change and needed to work together around the world. In the end, the data paints a clear picture of how study topics and methods change over time.
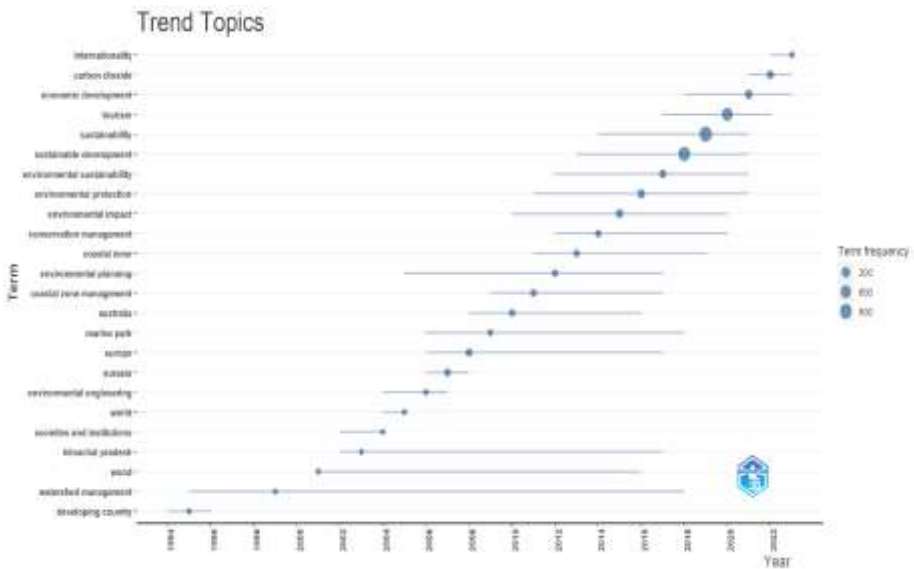

Fig. 12. Topics in Trend from 1990-2024

4.6   Authorship Patterns

Look at Figure 13 to see the trends in authorship in the dataset and see which authors are the 15 most active by number of publications in a given year. We begin with Liu J, who is in the lead. He is followed by Zhang J, Wang Y, Hall CM, Li J, and Li X. Their consistently high level of productivity is shown by the large amounts of study they have produced over the years. Their long list of publications shows that they are deeply involved in and make important additions to the academic fields they have chosen. By looking at patterns of authorship and finding out who is leading the aca-

demic talk, researchers can find possible partners or experts in the field. Knowing the patterns of authorship makes it easier to judge the quality of research, figure out how well people work together, and recognize important people in academic groups. Figure 13 shows the top writers and what they've done, which helps us understand the study scene and the people who are making it happen.
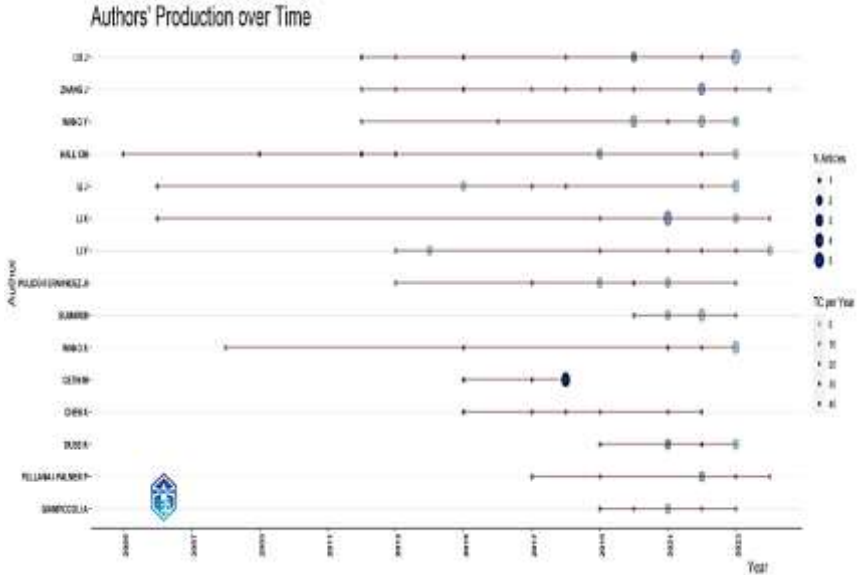

Fig. 13. Authorship Patterns of Article Production over time

5 Future Directions in Smart and Sustainable Transportation

Future progress in smart and sustainable transport will be driven by two main goals: making life better in both cities and rural areas and solving urgent environmental issues. One of the main goals of the next technology age is to make transport networks smarter and more connected. Data analytics, artificial intelligence (AI), and machine learning are likely to play big parts in improving transportation networks, managing traffic in real time, and predicting when to fix infrastructure. These technologies can use huge amounts of data from sensors, GPS devices, and other sources to make roads and public transit networks safer, improve traffic flow, and reduce traffic jams [24]. Using electric vehicles and other fuels is also a good way to cut down on pollution from traffic and lessen the effects of climate change. The move towards greener and more sustainable ways to get around will happen faster because more people will use electric cars (EVs), battery technology will get better, and charging stations will be built in more places [25].

In the same way, creating transportation options powered by renewable energy and hydrogen fuel cell cars could lead to better air quality and lower greenhouse gas emissions in cities. It will also be emphasized that people use public transportation, bike,

and walk more in future transportation plans and infrastructure building. Investing in public transportation facilities like intermodal terminals, bus rapid transit systems, and high-speed rail networks will make it easier for commuters to get to work, make it more affordable, and connect them to other areas. This will also cut down on the use of private cars and vehicles that run on fossil fuels [26]. Smart cities and smart mobility ecosystems of the future will also focus on combining transport with other city systems, such as water, energy, and garbage management. Smart infrastructure includes things like connected cars, smart traffic lights, and automated transit systems. These will make journey more comfortable, safe, and efficient while also reducing pollution and waste. Communities, governments, and industry partners will need to work together to spur innovation, make things more acceptable to the public, and get around problems that stop people from adopting them. Thinking ahead and using new technology in the transport sector is a great way for them to help make communities more sustainable, fair, and strong [27].

5.1   Recommendations for Future Research

Future study on smart and sustainable transport in the tourism and hospitality industries could help improve the experiences of tourists, protect the environment, and make communities stronger. When building sustainable transport networks, it is very important to include new technologies so that they can work for visitors and other people involved in the hospitality business. Before they can be used, smart travel options for tourist spots need to be studied more. Intelligent transportation systems, mobile apps, and digital platforms make it possible to connect multiple modes of transportation, get real-time information about transit, and plan routes more efficiently. Using Internet of Things (IoT) monitors, data analytics, and GPS monitoring can help visitors get around more easily, cut down on traffic, and lessen the damage that transportation does to the environment [28].

Second, eco-friendly shuttles, electric cars, and bikes are becoming more common in the tourism and hospitality business. In the future, researchers should look into new ways to pay for things, make rules, and offer benefits to get people, tourists, and businesses that provide hospitality to use low-carbon transportation. Studying the effects of sustainable transportation on society, the economy, and the environment can help us understand its pros and cons better. A lot of different fields need to work together to study smart transportation, tourism, and hotel management. Part of this effort is to look into how smart mobility might improve the image of a location, make customers happier, and make it more competitive. Personalized travel experiences, smart place branding, and how technology improves hospitality services like door-to-door transport and contactless payments are all things that researchers can look into [29]. Future study should focus on finding transport plans that are good for the environment and welcome everyone. For transport projects to be fair, culturally sensitive, and socially responsible, they need to include local stakeholders, indigenous groups, and people who have been left out. By encouraging people to work together and co-create, researchers may be able to come up with transport solutions that meet everyone's

needs. This would protect local identities and make places better able to deal with global threats like climate change and over tourism [30]. Finally, studies on smart and sustainable transport in the tourism and hospitality industries should look at destination management strategies, participation of stakeholders, sustainability principles, and new technologies. It is suggested that these study suggestions be put into action so that tourist and hospitality systems become more resilient, inclusive, and sustainable [31].

5.2   Evaluation Summary

Bibliometric analysis was used to look at research goals, patterns, and trends in smart and sustainable transportation from 1990 to 2024. The dataset looks at more than 3,000 documents from 742 sources, such as books, journals, and meeting papers. According to the data, scientific output has been slowly rising over the years, with a big jump in recent years, especially after 2010. More attention and money are being put into smart and sustainable transport research. This is part of a global movement to solve important environmental and social problems linked to mobility. The large amount of international cooperation is an interesting result from the study. Twenty-nine percent of the papers had co-authors from different countries. Experts from around the world work together to find solutions to problems they all face and advance study into smart and environmentally friendly transportation. A lot of writers and research teams regularly make good work, and the dataset shows that some of these people have a lot of output and effect. When it comes to moving the field forward and getting useful results from the study, experts working together and sharing information is very important.

A great way to get a sense of the big picture and find hotspots when studying smart and sustainable transportation is to use keyword analysis. Because this is a diverse field of study, some of the main themes that stand out are sustainability, ecotourism, sustainable development, and environmental engineering. These terms show that researchers working on transportation planning, building infrastructure, and making policies have used more than one method to solve tough problems. The fact that the dataset has contributions from many different countries shows that people all over the world are interested in and involved in study on smart and sustainable transportation. This variety makes it important to deal with travel problems in their own unique local settings while also using global knowledge and best practices. All things considered, the bibliometric analysis is a great way to learn about how smart and sustainable transportation research is changing because it shows important trends, well-known writers, and new areas of study. For the sake of society and the environment, these findings can help guide future research, government decisions, and business projects that aim to create transport networks that are fairer and better for the environment.

5.3   Limitations of the Study

. . Although bibliometric analysis provides valuable insights into the objectives, trends, and patterns of research pertaining to intelligent and sustainable transportation, it is not devoid of constraints. To begin with, the analysis is fundamentally constrained by the accessibility and choice of sources incorporated within the dataset. Although every effort is made to include a diverse array of publications, biases may still manifest as a result of particular sources being omitted or specific journals or publishers being overrepresented [32].

Moreover, bibliometric analysis classifies and quantifies research output based on metadata, including keywords and authorship. However, this approach may fail to consider subtleties and intricacies present in the content of specific documents. Furthermore, although it is worth noting that international collaboration is a significant discovery, it is unclear to what degree co-authorship signifies substantial collaboration as opposed to mere affiliation [33]. In addition, it is worth noting that keyword analysis, although providing valuable insights, might oversimplify the interdisciplinary character of research on smart and sustainable transportation. This could result in the inadvertent exclusion of emergent themes and interdisciplinary intersections. In conclusion, although bibliometric analysis offers a momentary depiction of research patterns, it might not encompass the entirety of research endeavors or their practical ramifications [34]. This underscores the necessity for supplementary methodologies and qualitative evaluations to supplement quantitative discoveries. In general, although bibliometric analysis provides valuable insights into the ever-evolving realm of smart and sustainable transportation research, its results must be interpreted with caution, and qualitative evaluations must be incorporated to achieve a comprehensive understanding of the subject [35].

6   Conclusion

A systematic literature analysis is conducted to shed light on the ever-evolving domain of sustainable and intelligent transportation research, which extends from 1990 to 2024. Upon thorough examination of trends, patterns, and research objectives, this exhaustive analysis unveils a substantial and steady increase in scholarly output throughout the years, with particular emphasis on the past few years. This surge highlights the increasing global significance attributed to tackling environmental and socioeconomic obstacles in mobility, as well as the critical need to enhance the efficiency, accessibility, and sustainability of transportation systems. The extensive international collaboration among researchers is a significant discovery, as it underscores a collective dedication to ingenuity and the resolution of shared obstacles in the realm of intelligent and sustainable transportation.

The fruitful output of specific authors and research teams serves as empirical evidence that this collaboration promotes the exchange of knowledge and generates significant research results. The examination of keywords indicates that environmental

engineering, ecotourism, sustainability, and sustainable development are prominent themes, which is indicative of the field's interdisciplinary character. A multifaceted approach is employed by scholars in the fields of transportation planning, infrastructure development, and policymaking in order to address intricate challenges and generate novel resolutions. The significance of the field and the necessity of utilizing local-context-specific methodologies while capitalizing on global knowledge are both highlighted by the worldwide impact of sustainable and intelligent transportation research. In addition, this analysis can provide guidance for future research, policymaking, and industry initiatives that seek to promote sustainable and equitable transport systems for the benefit of society and the environment through the identification of areas for further investigation and comparison with findings from other studies.

Disclosure of Interests

There are no declared conflicts of interest related to the subject matter of this article by the authors.

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