International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Bibliometric Analysis of Sustainable Development Goals 9 Industry, Innovation and Infrastructure Using Vosviewer

Mridu[1], Prince[2]

[1]Assistant Professor, School of Commerce, Graphic Era Hill University, Dehradun-248002, Uttarakhand, India
[2]Assistant Professor, Department of Commerce, Dolphin PG Institute, Dehradun-248007, Uttarakhand, India

Abstract
This study employs bibliometric analysis to examine research on Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure) in India. Using the Vosviewer software, it analyzes publication patterns, citations, and collaborations, drawing from the Dimensions database with the keyword "India." The research aims to uncover insights into scholarly communication dynamics, including key trends, influential authors and institutions, and collaborative networks. By visualizing bibliometric data, the study provides a comprehensive understanding of industry, innovation, and infrastructure research in India. It seeks to inform policymakers, researchers, and stakeholders about the current landscape and future directions, contributing to sustainable development initiatives both within India and globally.

Keywords: SDG-9, Industry, Bibliometric, Innovation, Infrastructure

1. Introduction

Sustainable Development Goal 9 (SDG 9) is one of the seventeen interlinked goals established by the United Nations in 2015 as part of the 2030 Agenda for Sustainable Development. SDG 9 specifically focuses on "Industry, Innovation, and Infrastructure" and aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation to support sustainable development worldwide. In this essay, we will explore the significance of SDG 9, its targets, and the challenges and opportunities associated with achieving these targets.

First and foremost, SDG 9 recognizes the critical role that infrastructure, industry, and innovation play in driving economic growth, creating employment opportunities, and enhancing societal well-being. Infrastructure, including transportation, energy, and information and communication technology (ICT), forms the backbone of modern economies, enabling trade, facilitating access to essential services, and connecting people and markets. Sustainable infrastructure development involves investing in resilient and environmentally sound infrastructure that can withstand natural disasters, mitigate climate change impacts, and ensure access for all, particularly in rural and marginalized communities.

Moreover, sustainable industrialization is essential for promoting economic growth, job creation, and poverty reduction while minimizing environmental degradation and resource depletion. SDG 9 emphasizes the need to foster inclusive and sustainable industrialization by promoting sustainable

practices, enhancing resource efficiency, and encouraging the adoption of clean technologies. By investing in sustainable industries, countries can achieve economic diversification, increase productivity, and enhance their competitiveness in the global market while minimizing negative environmental and social impacts.

SDG 9 aims to enhance industry, innovation, and infrastructure through specific targets. It emphasizes building resilient infrastructure such as transportation and energy systems to support economic development. Promoting inclusive and sustainable industrialization involves increasing manufacturing's GDP share in developing countries while enhancing resource efficiency and minimizing environmental impacts. Encouraging innovation entails promoting research and development, expanding access to technology, and facilitating technology transfer to foster entrepreneurship. Upgrading infrastructure and retrofitting industries for sustainability underscores the need to make existing infrastructure and industries more environmentally friendly. Lastly, enhancing scientific research focuses on strengthening research and development efforts, increasing expenditure, and fostering international cooperation to support sustainable development.

2. Research Methodology

The objective of this research was to conduct an in-depth bibliometric analysis focusing on Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure) within the context of India. Bibliometric analysis serves as a quantitative approach to scrutinize publication trends, citation patterns, and collaborative networks within a specific research domain or across various fields. By examining diverse bibliographic data such as scholarly publications, citations, authors, journals, and keywords, researchers aim to uncover nuanced insights into the structure, influence, and evolution of scholarly discourse. To commence this analysis, a comprehensive dataset comprising research articles related to Sustainable Development Goal 9 in India was retrieved from the Dimensions database [1]. The selection process was guided by the utilization of the keyword "India" to ensure relevance to the geographical focus of the study. This dataset served as the foundation for conducting meticulous bibliometric exploration and visualization.

The chosen bibliometric tool for this endeavor was Vosviewer, renowned for its robust capabilities in navigating and depicting bibliographic networks [2]. With its intuitive interface and advanced functionalities, Vosviewer facilitates the exploration and interpretation of complex bibliometric data, rendering it a valuable asset for researchers, bibliometricians, and anyone seeking to unravel the intricate dynamics of scholarly communication.

On February 18th, 2024, the bibliometric analysis commenced, encompassing a comprehensive examination of publication patterns, citation behaviors, author collaborations, and thematic trends pertaining to Sustainable Development Goal 9 in the Indian context [3]. Through meticulous data processing and visualization techniques offered by Vosviewer, the study aimed to delineate the scholarly landscape surrounding this crucial area of sustainable development [4].

3. Results and Discussions

3.1 Analysis of Co-authorship Network

(a) Unit of Study – Authors

Co-authorship networks help identify patterns of collaboration among authors within a specific research field or discipline. By analyzing these networks, researchers can understand how knowledge is produced

collaboratively and the extent to which authors work together on research projects. Analysis of co-authorship networks helps identify key authors and research leaders within a field. Authors who are highly connected or act as bridges between different clusters play important roles in facilitating collaboration and knowledge dissemination. Identifying these key authors can help guide research initiatives and foster interdisciplinary collaboration. The minimum number of documents per author was set at four for the purpose of the analysis using Vosviewer. After the analysis, 47 items were extracted and 10 clusters were formed out of them. The figure 3.1 depicts the results of the analysis. The size of each node represents the significance of author in the field under study. It can be visualized through the size of each node (circle) that author named Anil Kumar had significant contribution in the field of SDG 9 with highest number of citations [3]. The papers contributed by the author were titled "Evolution of infrastructure as an asset class: A systematic literature review and thematic analysis" and "Infrastructure financing and development: A Bibliometric review". Sachin Kumar, another author also made significant contribution in this area. His papers were titled "Critical success factors of Block chain technology adoption for sustainable and resilient operations in the banking industry during an uncertain business environment" and "Using emerging technologies to improve the sustainability and resilience of supply chains in a fuzzy environment in the context of COVID-19" [4,6].

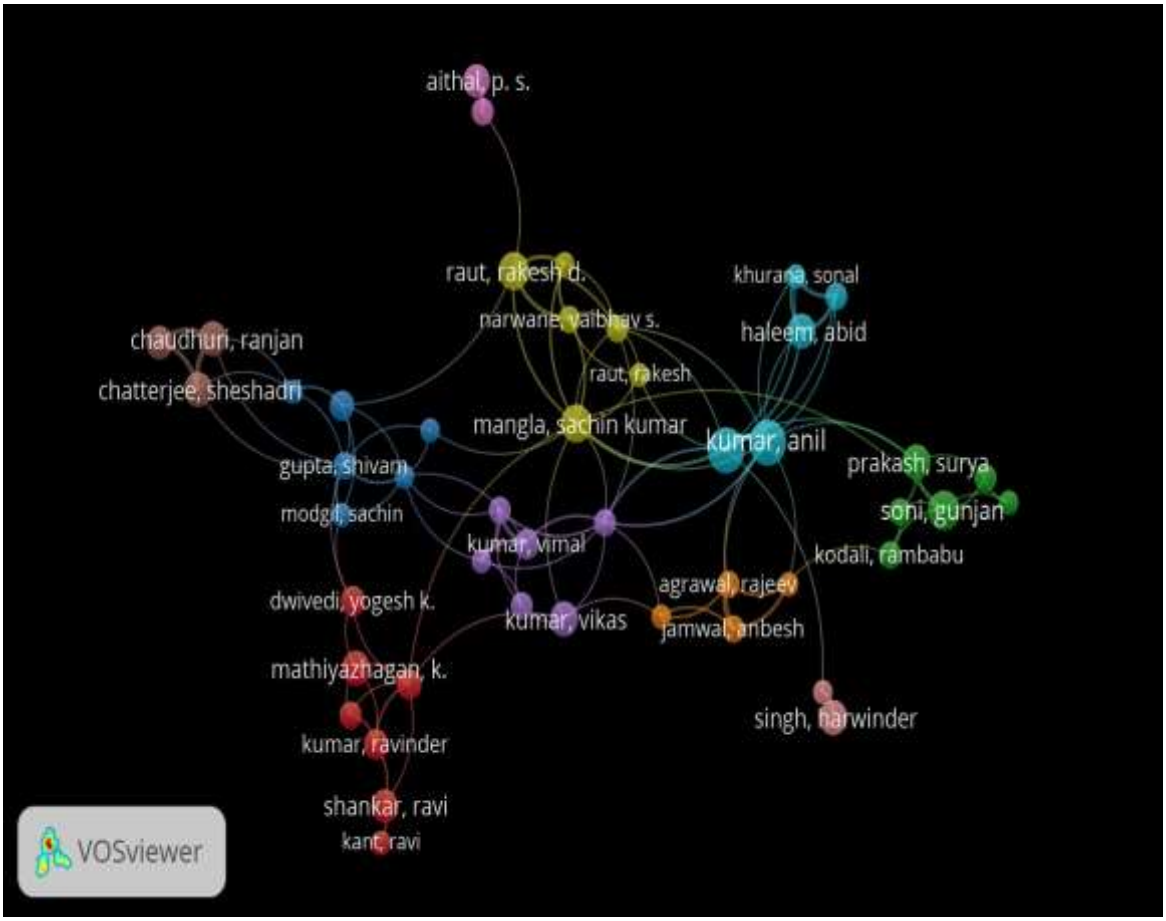

Figure 3.1: Visualization of Co-authorship Network: Authors

(b) Unit of Study – Countries

This analysis contributes in understanding the collaborative dynamics among countries in the field under

investigation, offering valuable insights for researchers, policymakers, and stakeholders involved in international research collaboration and cooperation. The study provides insights into the collaborative landscape of the field at an international level. It highlights the countries that are most active in research collaborations and may inform strategic decisions related to international research partnerships, funding allocation, and policy development. The minimum number of documents per country for the purpose of analysis were set at four. The analysis resulted in the formation of 8 clusters out of 49 items. The results of analysis are shown in figure 3.2 which clearly depicts that the maximum number of publications on the database were from India followed by United Kingdom and China.

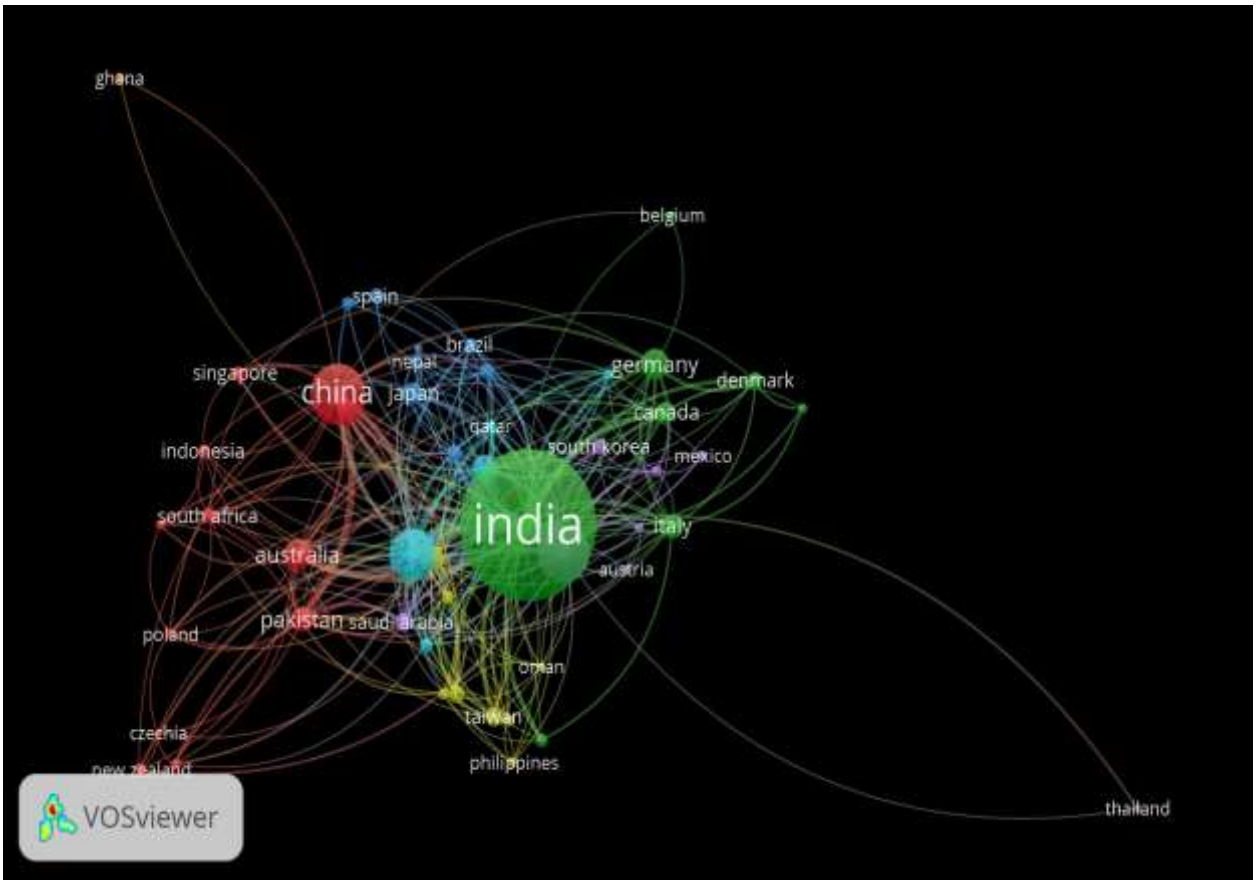

Figure 3.2: Visualization of Co-authorship Network: Countries

(c) Unit of Study – Organizations

Identifying significant collaborations and clusters within the co-authorship network provides insights into the collaborative landscape of the field. It sheds light on the extent of research collaboration among universities, highlights key players in collaborative networks, and may inform strategic decisions related to research partnerships and resource allocation. Overall, this study contributes to understanding the collaborative dynamics among academic institutions in the field under investigation, offering valuable insights for researchers, policymakers, and stakeholders involved in academic research and collaboration. The minimum number of papers from each university were set at four. After the analysis, 17 clusters were formed out of 193 items, it was found that the most significant collaborations in the field, as in the database under study, were made between Delhi University, Amity University, Punjab University, Symbiosis International University, Indian Institute of Management, Indian Institute of

Technology among others. The results of the same can be seen in figure 3.3.

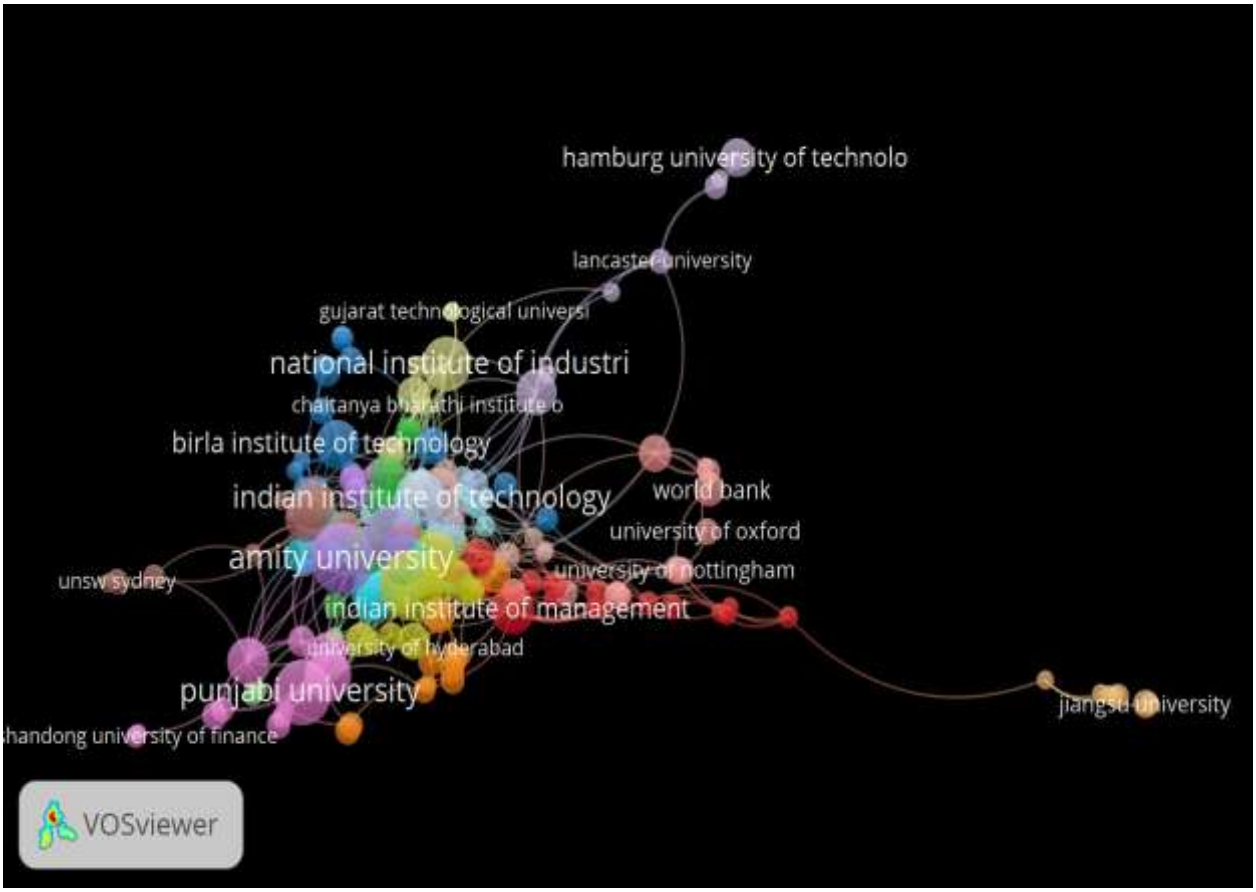

Figure 3.3: Visualization of Co-authorship Network: Organizations

3.2 Analysis of Citation Network

(a) Authors

The analysis of citation networks provides valuable insights into the scholarly impact and influence of authors within a particular research field, helping researchers and institutions identify key contributors and trends in academic literature. Authors with higher citation counts are generally regarded as having made significant contributions to their field, as their work has been widely recognized and referenced by other researchers. These authors may be considered among the leaders in their area of research, and their work may have helped shape the direction of the field. The total number of citations received by an author's publications indicates their overall impact and visibility within their field. Authors with higher citation counts are generally considered more influential or recognized in their area of research. After the analysis, it was found that author Anil Kumar was the most cited and influential author for the purpose of this study as per database under study followed by author Sunil Luthra and Rajnish Tiwari. The same is shown in Figure 3.4.

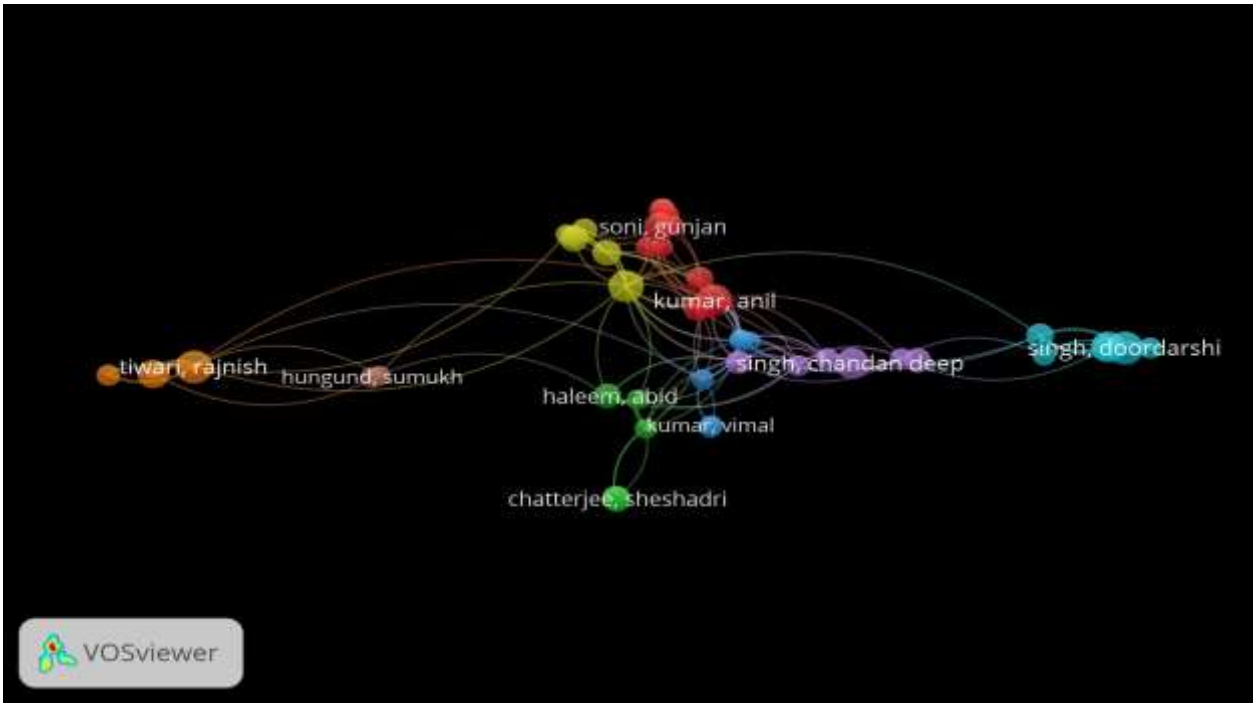

Figure 3.4: Visualization of Citation Network: Authors

(b) Organization

Interpreting citation analysis data from an organizational perspective involves assessing institutional impact, understanding collaboration networks, identifying research hubs, benchmarking performance, tracking trends, informing strategic decisions, and enhancing visibility and reputation within the academic landscape. Institutions with a higher number of citations attributed to their publications are generally considered to have a greater influence within their respective fields. Citation analysis can reveal patterns of collaboration between institutions. Institutions that frequently cite each other's work may indicate strong research partnerships or collaborative networks. This information can be valuable for understanding the dynamics of interdisciplinary research or identifying strategic research alliances. The maximum number of citations in terms of universities are from Delhi University and Amity University followed by Indian Institute of Technology and Indian Institute of Management. For organizations, citation analysis can inform strategic planning and resource allocation decisions. Understanding their position in the citation landscape relative to peer institutions can help organizations identify areas for improvement, leverage strengths, and prioritize research initiatives. Institutions with a strong citation impact often enjoy greater visibility and reputation within the academic community and beyond. Positive citation metrics can enhance an organization's standing in rankings, attract talented researchers and students, and facilitate collaboration opportunities with other prestigious institutions. The results of this analysis can be seen in figure 3.5.

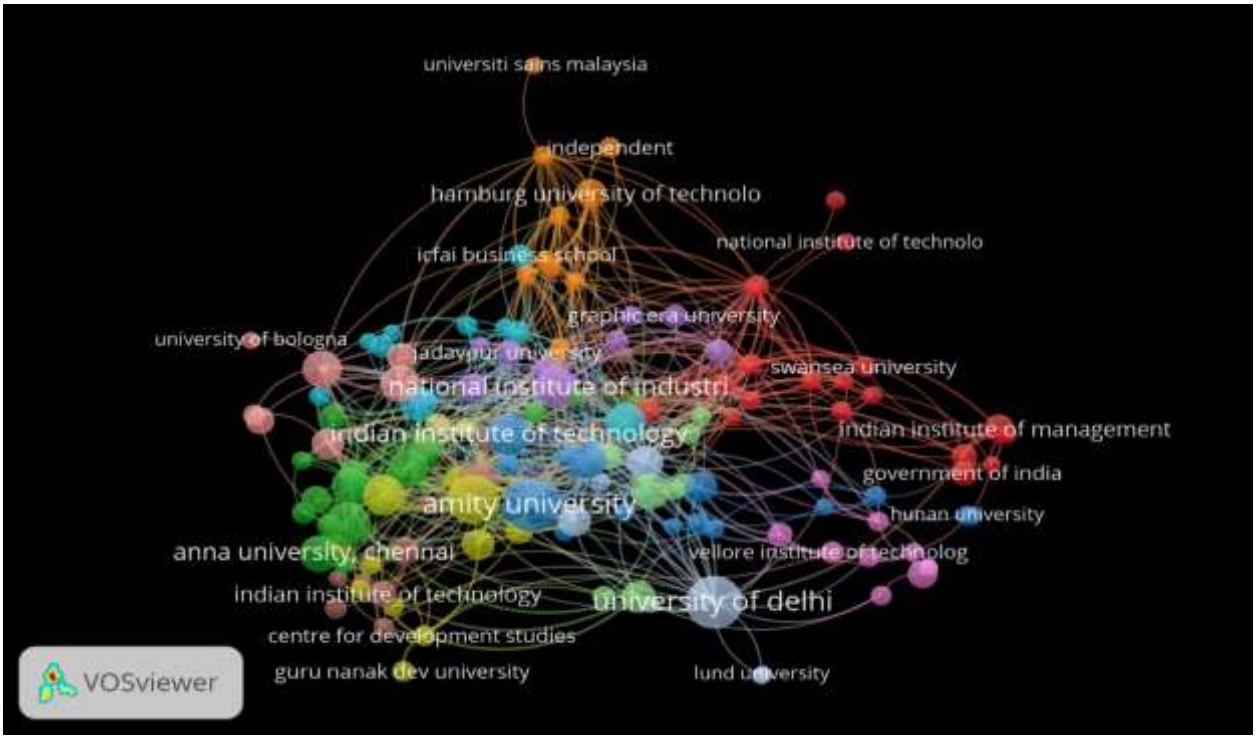

Figure 3.5: Visualization of Citation Network: Organization

3.3 Most Cited Journals

The most cited journals likely cover topics related to industry, innovation, and infrastructure, which are central to SDG 9. These journals may publish research on technological advancements, industrial development, infrastructure projects, innovation policies, and sustainable manufacturing practices, among other relevant topics. Journals with a high number of citations are indicative of their impact and influence within the research community. They serve as important dissemination channels for cutting-edge research and innovative solutions related to the topic under study. Researchers and policymakers often rely on these journals for authoritative information and evidence-based insights. Following table 3.1 shows the list of top ten cited journals on SDG 9 objectives.

Table 3.1: Most Cited Journals

Journals	Times Cited
International Journal of Global Business and Competitiveness	55
Annals of Operations Research	53
Environmental Science and Pollution Research	40
Anais da Academia Brasileira de CiÃªncias	39
Global Journal of Flexible Systems Management	31
Journal of Environmental Management	24
Economic Change and Restructuring	24
Journal of International Business Policy	21
Operations Management Research	21
Journal of Environmental Management	19

Discussion

The discussion highlights the importance of adopting emerging technologies to improve the sustainability and resilience of infrastructure and industrial systems in India. The use of block chain technology, for instance, has been identified as a critical factor in enhancing operational efficiency and resilience in uncertain business environments [5]. Additionally, the role of higher education institutions in promoting sustainable development through research and innovation is emphasized [8]. The review and research agenda for sustainable infrastructure underline the necessity for a strategic approach to achieving long-term sustainability [7].

4. Conclusion

Sustainable Development Goal 9 (SDG 9) aims to "build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation." This goal recognizes the crucial role of infrastructure, industrialization, and innovation in driving economic growth, enhancing productivity, and promoting sustainable development. This research took into consideration research papers of various disciplines which had conducted study on SDG 9. Ultimately, by delving into the wealth of bibliometric data and leveraging the analytical prowess of Vosviewer, this research sought to provide a nuanced understanding of the research landscape concerning Sustainable Development Goal 9, thereby offering valuable insights to researchers, policymakers, and stakeholders invested in fostering sustainable industry, innovation, and infrastructure in India and also made an attempt to understand the landscape of scientific research, enabling researchers and stakeholders to make informed decisions, track progress, and identify opportunities for collaboration and innovation in this area.

5. Conflicts of Interest

The authors have no conflicts of interest to declare.

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