

Exploring the Dimensions of Industry 4.0: A Bibliometrix Analysis

Dr. Manju¹, Dr. Disha Rani Yadav², Dr. Suraj Patel³

¹Assistant Professor, Govt. College, Chandrapur, Sakti, Chhattisgarh, India

^{2,3}Assistant Professor, MATS University, Raipur, Chhattisgarh, India

ABSTRACT

This paper represents the application of Industry 4.0 in the field of Business Accounting & Finance, economics, Psychology, Arts & Humanities and in multidisciplinary subjects. Literatures and primary analyses help in finding out the key changes and need for more improvements in the field of Industry 4. The purpose is to analyse the application of Industry 4.0 in various fields for the information on the basis of their application, dimensions, experiences and knowledge. Paper provides a simple bibliographic information based on the Scopus database. Papers also presents the demographic variables presenting the secondary data based on Scopus database from the period of 2012-2024. Data structured a **TITLE-ABS-KEY** method for search protocol in English language only which include the data sets from all the open sources and various authors subscription including research paper, conference paper, chapter in edited book. Before adding limitations, database was able to recognised 35,286 then after limit to the above subjects authors concluded with 4205 documents. Authors show secondary database bibliometrics analysis through Biblioshiny and VOSviewer software. Bibliometrics research in industry 4.0 in respect of various avenues of research fields and bibliometric technique such as descriptive as well as network analysis. Research also shows the bibliographic coupling of authors and countries with network overlay, visualization overlay and density visualization. Research paper discussed the databased information of bibliometric analysis through Scopus database which includes the latest information by May, 2024. Its shows the various research dimensions of the authors through network analysis.

INTRODUCTION

The emergence of Industry 4.0 signifies a transformative period in the industrial realm, marked by the convergence of technologies that erase the boundaries between the tangible, digital, and biological domains. This study is dedicated to a bibliometric examination of Industry 4.0, providing an extensive survey of existing research, key themes, and nascent trends within this groundbreaking field. By methodically charting the academic terrain, this analysis will not only illuminate the conceptual framework defining Industry 4.0 but also shed light on the cooperative networks and pivotal regions driving this sector. Through this bibliometric analysis, we aim to uncover publication patterns, citation trends, and the thematic evolution over time, equipping stakeholders with a strategic perspective to anticipate future developments and possibilities in Industry 4.0. This introduction paves the way for a

detailed investigation into the complex web of research that forms the foundation of Industry 4.0, establishing a basis for comprehending its influence on the industrial model and its role in fostering innovation, productivity, and sustainability in the Fourth Industrial Revolution.

The Fourth Industrial Revolution, or Industry 4.0, heralds a major shift in industrial operations, integrating advancements in artificial intelligence (AI), robotics, the Internet of Things (IoT), genetic engineering, quantum computing, among others. Beyond intelligent manufacturing, it envisions a smart ecosystem where human and machine collaboration reaches new heights of efficiency and output.

Central to Industry 4.0 is the **concept of "smart factories,"** which utilize cyber-physical systems and

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KEYWORDS: Industrial Revolution, Industry 4.0, Sustainable Development, Transformation and Information

advanced data analytics to optimize manufacturing processes and enhance decision-making capabilities.

The opening section provides a detailed examination of the diverse research that forms the foundation of Industry 4.0. It prepares the reader to grasp its influence on the current industrial model and its role in fostering innovation, operational efficiency, and ecological sustainability during the Fourth Industrial Revolution. Industry 4.0 signifies a pivotal shift in industrial operations, characterized by the integration of advancements in artificial intelligence, robotics, the Internet of Things, genetic engineering, quantum

computing, among others. This revolution transcends intelligent manufacturing, envisioning a world where human and machine cooperation culminates in extraordinary efficiency and output. At the heart of Industry 4.0 is the idea of “smart factories,” which leverage cyber-physical systems and big data analytics to streamline production processes and decision-making. This enables a level of automation and customization that was previously unattainable. For instance, with IoT devices, manufacturers can monitor and optimize their operations in real-time, leading to reduced downtime and increased throughput.

Search Protocol



- **Search strategy:** Keyword and reference searching through bibliometric databases **Scientific databases and search field:** Scopus (in "Abstract title or keywords ") **Keywords:**,
- **Scientific databases and search field:** Scopus (in "Abstract title or keywords ")
- **TITLE-ABS-KEY** ("Industry 4.0")
- **Searching Approach:** Search protocol - **TITLE-ABS-KEY**("Industry 4.0") AND (LIMIT-TO (LANGUAGE,"English")) AND (LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"ECON") OR LIMIT-TO (SUBJAREA,"PSYC") OR LIMIT-TO (SUBJAREA,"ARTS") OR LIMIT-TO (SUBJAREA,"MULT")) AND (LIMIT-TO (SRCTYPE,"j") OR LIMIT-TO (SRCTYPE,"d"))

- **Initial search hits:** 35,286
- **Inclusion / exclusion criteria:** include academic studies in the economic and finance domain. exclude book chapters , review papers, conference proceedings and trade journals, include research papers written in english, exclude non-contextual and duplicate research studies. From the year 2012.
- **Final result:** research studies left after initial screening. And the full number of 35,286 documents from remain in the data sheet. Therefore, final bibliometric corpus consist 4205 research papers.

- **Bibliometric analysis:** 4205 documents various bibliometric techniques such as journal quality analysis, author influence, chronological trend analysis, citation analysis, affiliation analysis has been employed to identify key trends in field of Financial behaviour studies.
- **Narrative Synthesis:** Narrative synthesis has been employed to categorize the scientific literature in various core and emerging themes.

Source 1 Authors Search Protocol for Scopus

Descriptive Analysis

In the realm of bibliometrics, descriptive analysis serves as a cornerstone technique, concentrating on the consolidation of data and metrics, including the progression of publication counts, frequency of citations, and particulars of authorship. It captures an overview of the scholarly terrain, shedding light on the extent and influence of academic endeavors in a given domain. This analytical method is indispensable for discerning patterns, pinpointing prominent scholars, and gauging the dissemination of diverse scholarly subjects. Utilizing these bibliometric instruments, scholars are equipped to assemble detailed summaries of scholarly contributions, vital for strategic planning in the spheres of research governance and policy development.

Overview

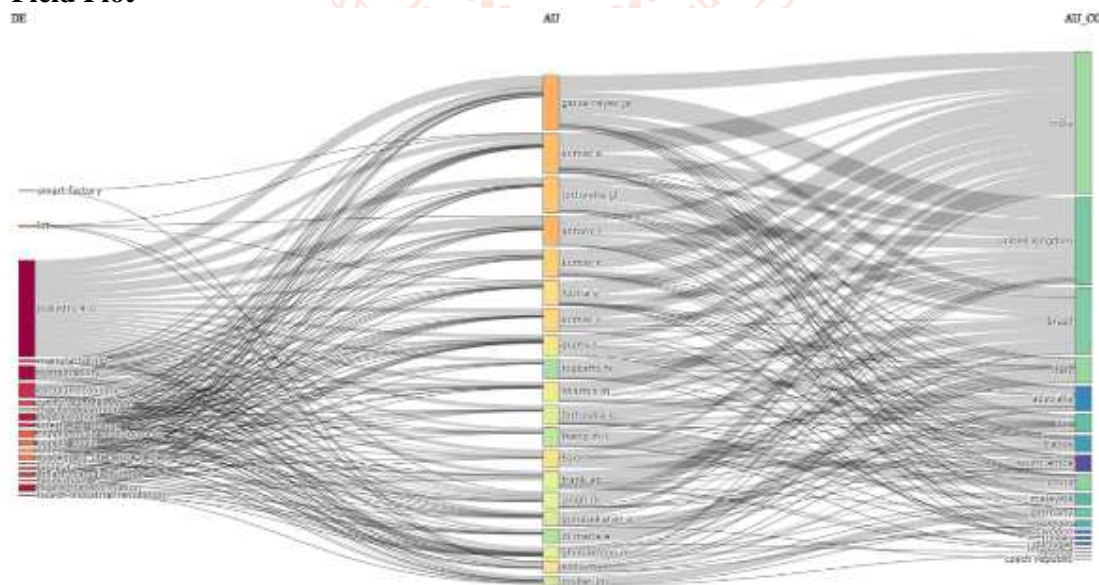
Main Information



Source 2 Biblioshiny Results through RStudio

The records indicate a publication timeframe for the papers ranging from 2012 to 2024. A search within the Scopus database reveals 827 sources and 4205 documents, reflecting an annual growth rate of 67.51%. The database encompasses contributions from 9896 authors, which includes 420 documents authored by a single individual. The data suggests that the publication of research papers on Industry 4.0 has been consistent within this specialized database during the mentioned period. Indicators such as the average age of documents and citations per document suggest a promising future for research in the field of industrial development.

Three – Field Plot



Source 3 Biblioshiny Results through RStudio

Three- field plots show the statistics and relations between three Terms selected by researcher. In their above figure researcher has selected the author's keyword, author and author's country. It can be seen there, India has the highest producer of research paper in the field of industry. 4.0. using the keyword as industry 4.0.

Sources Descriptives
Most relevant Sources

Table 1 Most Relevant Sources of Industries 4.0

Exported data						
Element	h_index	g_index	m_index	TC	NP	PY_start
International Journal of Production Research	61	138	6.778	19396	193	2016
Technological Forecasting and Social Change	59	114	8.429	13637	164	2018
Journal of Cleaner Production	55	95	7.857	9340	131	2018
International Journal of Production Economics	38	81	4.75	9599	81	2017
Journal of Manufacturing Technology Management	36	72	5.143	5393	113	2018

Documents Descriptives

Document descriptives provides various bibliographic information of the published research papers. Under these documents descriptives, there are mainly three kinds of submitters that provides the wholesome. Data under. The database, namely documents, cited references and words. Document refers to the global citation and global citations. Similarly, cited reference says. Provides most locally cited references. And references spectroscopy. Words references provides most frequent used words, word clouds, stream map and trending topics.

Most frequent words



Source 4 Biblioshiny Results through RStudio

A bow figure named as the word cloud depicting that the larger figure has the highest number of word usability. Whereas the smallest number refers to the smallest usability. Above. We can see industry 4.0 has the larger impact than other words, like sustainable development, industrial research, decision making, supply chain, industrial revolution, digital transformation, Internet of things, etc.

Table 4 Exported data of keyword PLUS

Terms	Frequency
industry 4 0	1110
sustainable development	282
decision making	226
supply chains	221
industrial research	189
industrial revolutions	183

Bibliometrics tools identify 'keyword' as the term most frequently appearing in academic papers. This term, when specified by authors, offers insights into the prevalent themes within their work, referred to as 'author's keyword'. The provided table illustrates the frequency of keywords, with 'industry 4.0' leading, followed by 'sustainable development', 'decision making', 'supply chains', and other related terms. Additionally, the term 'industry 4.0' appears 2678 times, 'sustainability' 238 times, and 'digital transformation' between two to five times, among others.

Table 2 Exported data of Author’s Keywords

Terms	Frequency
industry 4 0	2678
sustainability	238
digital transformation	225
digitalization	188
internet of things	178
circular economy	173
smart manufacturing	143
artificial intelligence	138
innovation	136
fourth industrial revolution	126

Network Analyses

Network Approach

VOSviewer is equipped with a trio of distinct visual representations: the network, overlay, and density visualizations. Illustrated in Figure 1, these visual representations are accessible through their respective tabs—Network Visualization, Overlay Visualization, and Density Visualization—located in the primary interface of VOSviewer, allowing users to toggle among the different views seamlessly.

Co-Authorship

Unit of Analysis through Authors

Network Overlay



Source 5 VOSviewer Result from Scopus Database of Industry 4.0

Figure 1 Co-authorship Network Visualization of Authors in 5 Clusters of 5 documents suitable for out of 4205 documents published in Scopus from 2012 – 2024

Above figure depicting the unit of analysis under co-authorship network through number of citation of authors. **Rajput s.; singh s.p., Citations: 722, Avg. citations: 144.40, then Tripathi, nimawat, Brodny**, got the highest citations out of 4205 documents and 5 clusters.

Unit of Analysis through Organisation

The Unit of Analysis through Organisation in VOSviewer is a methodological approach that focuses on analysing and visualizing the relationships and performance metrics of different organizations within a specific field. By utilizing VOSviewer, one can generate maps that display the most cited organizations, revealing patterns of collaboration and impact within the research community.

Network Overlay

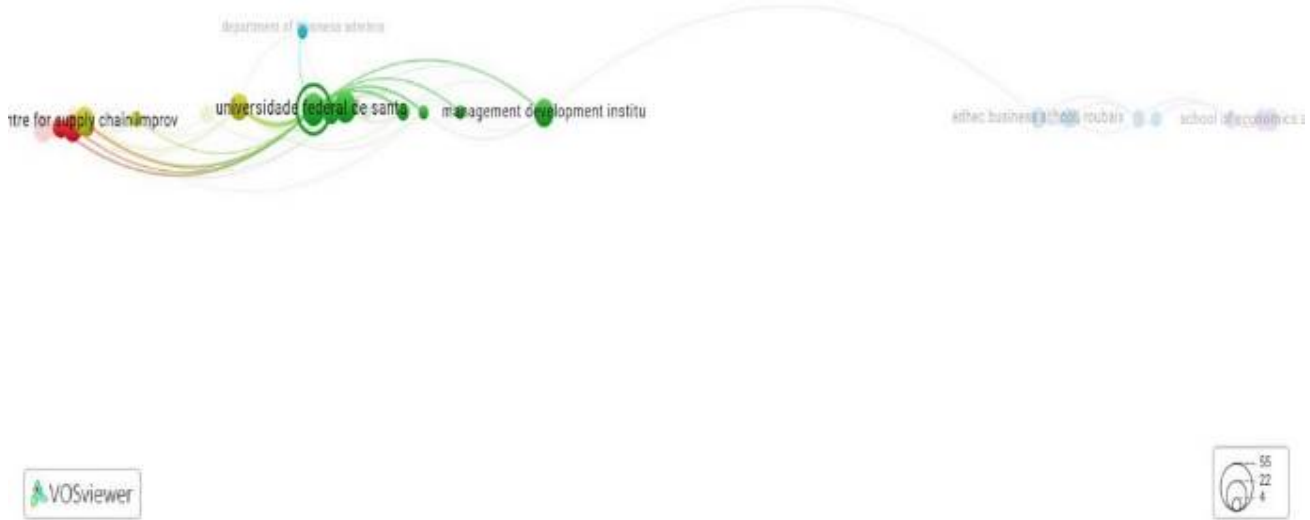


Figure 1 Co-authorship Unit of Organisation Network Visualization of Authors in 6 Clusters of 42 documents suitable for out of 4205 documents published in Scopus from 2012 – 2024

Above figure depicting the network links and clusters of co-citation author analysis of organizations. A total link strength developed in 276 with 111 links under 6 clusters of 42 items. Under the provided strength Universidad federal de santa has the highest no. of links with other organisations.

Unit of Analysis through Country Network Overlay

Within the graphical depiction of networks, each element is identified by a unique label and, typically, a circular icon. The dimensions of both the label and the icon correlate with the element's significance within the network, quantified as its 'weight'

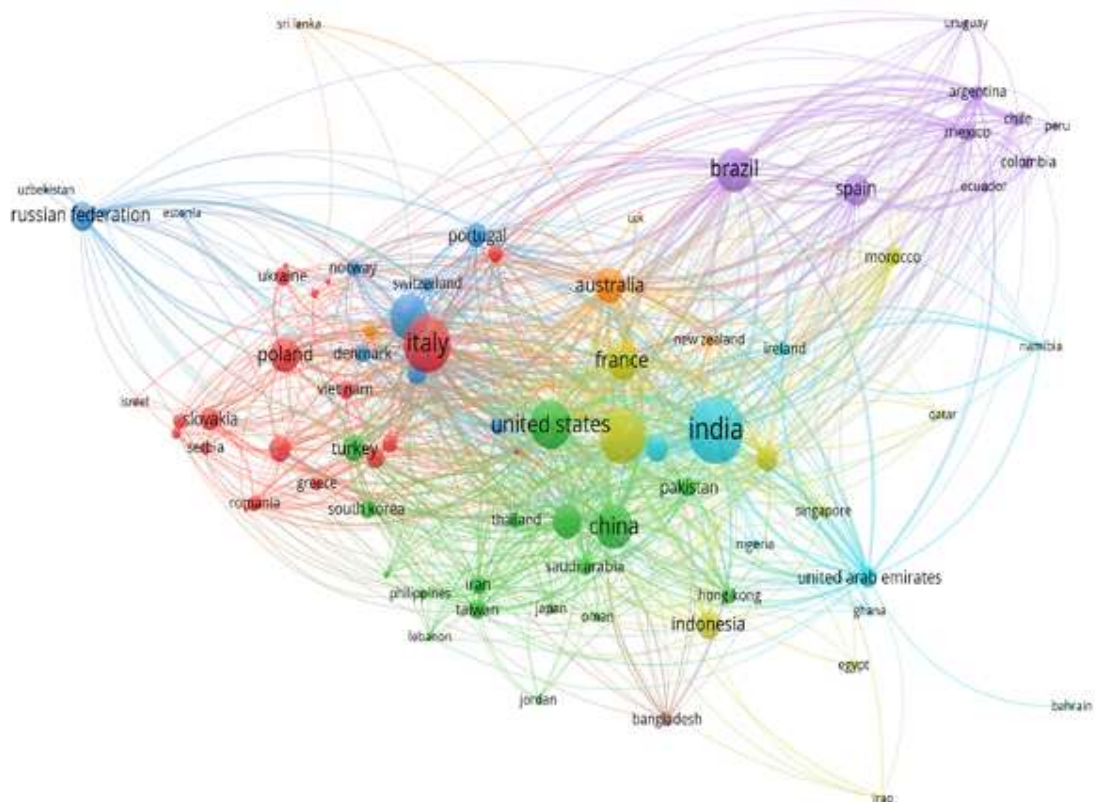


Figure 2 Co-authorship Network Visualization of Countries in 8 Clusters of 81 documents suitable for out of 4205 documents published in Scopus from 2012 – 2024

Above network visualization (Figure) depicting the co-authors networks in 8 cluster out of 81 countries in decreasing order in India, Italy, United Kingdom, United States, Germany, China, Brazil and Poland. These order of countries in a network analysis selected on the basis of total number of documents from the countries. India (608 documents), Italy (444), United Kingdom (424), United States(335), Germany (297), China (293), Brazil (273) and Poland (187). mentioned only belongs to the number of documents though their links and citation differs in terms of network.

Clusters	Colour	Label
1.	Red	Italy, Poland, Slovakia, hungary
2.	Green	United States, China, Malasiya, South Korea, Turkey
3.	Sky Blue	Germany, Russian Federation, Portugal.
4.	Yellow	United Kingdom, France, Indonesia.

Figure and Table are significantly showing the cluster and the highest number of documents producer country in terms of co-authorship.

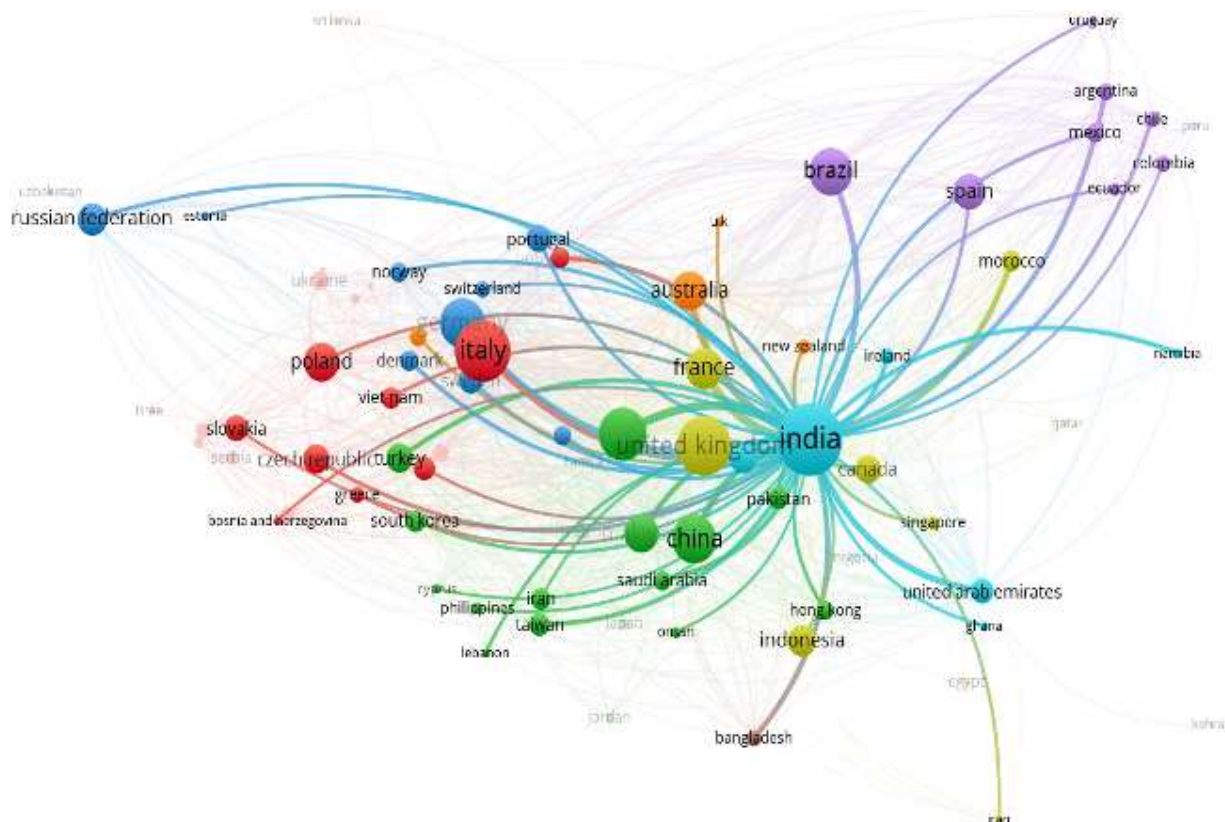


Figure 4 Co-authorship Network Visualization of Countries in 8 Clusters of 81 documents suitable for out of 4205 documents published in Scopus from 2012 – 2024

The network overlay of India has been shown in above figure. India has been connected. To connected with the highest strength with various countries such as United Kingdom, Italy, Brazil, China, Russian Federation and Australia.

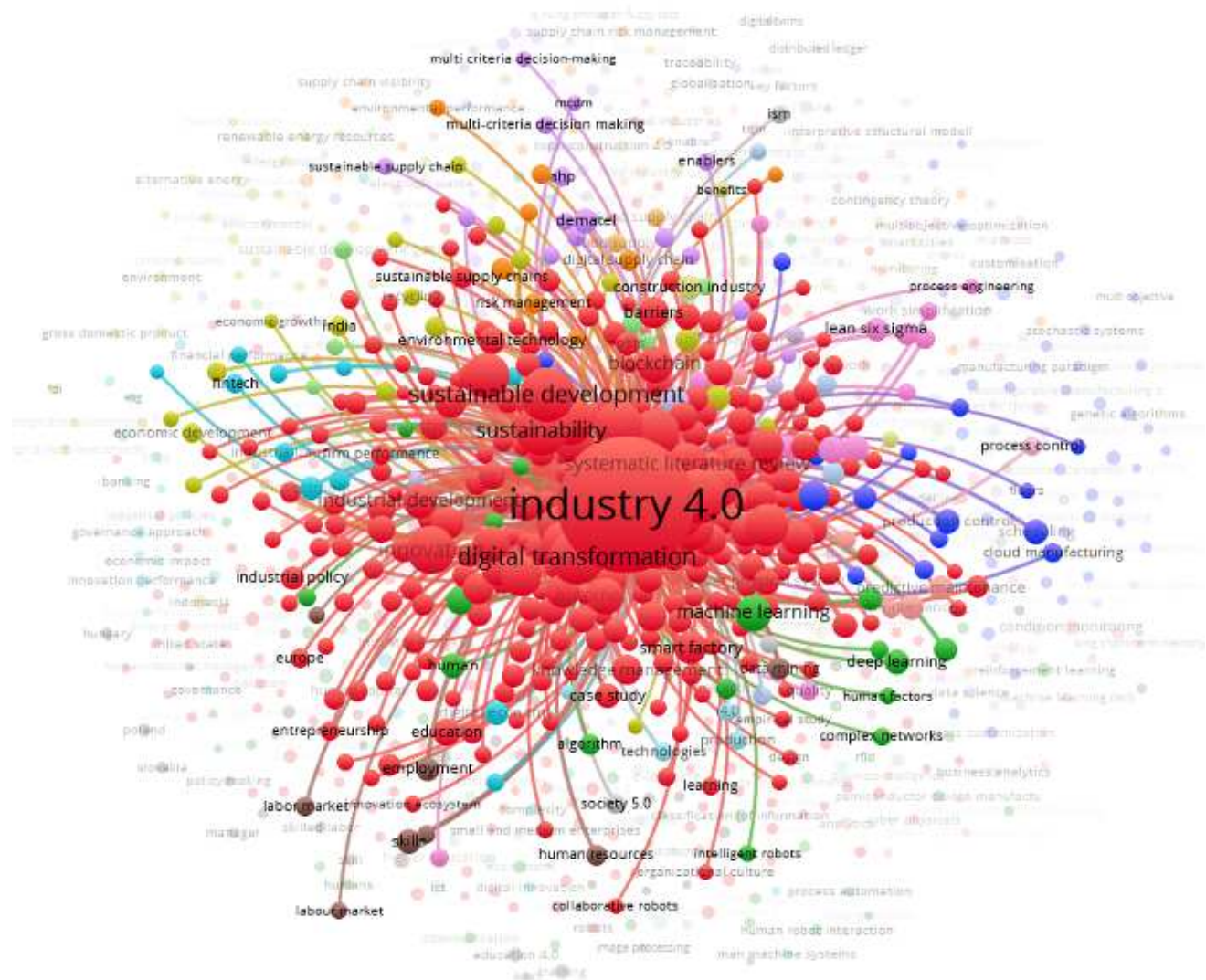
Co-occurrence Network

A co-occurrence network in VOSviewer is a visual representation that maps the relationships between items, such as terms, keywords, or publications, based on how frequently they appear together within a dataset. In this network, nodes represent the items, and the edges reflect the strength of the co-occurrence relationships. The size of a node often indicates the occurrence frequency of an item, while the thickness of an edge shows the co-occurrence strength. Such visualizations can help identify clusters of closely related items, revealing patterns and trends in the data that might not be apparent from a simple list of items.

All Keywords

In VOSviewer, a co-occurrence network of all keywords provides a visual representation of how often each pair of keywords appears together within a set of documents. This analysis helps in identifying the most central and connected terms, which often represent the core concepts or themes in a research area.

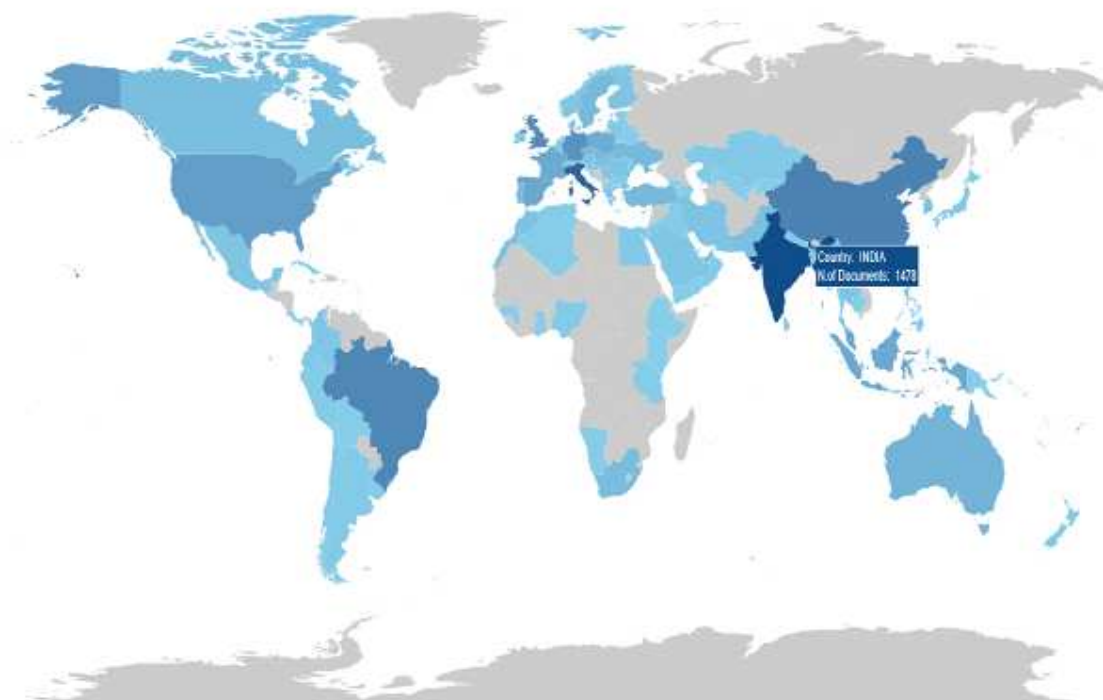
Network Overlay



Source 5Co-authorship Network Visualization of Countries in 8 Clusters of 81 documents suitable for out of 4205 documents published in Scopus from 2012 – 2024

The network visualisation creates a very beautiful. Right angle of network analysis including 1000 items with nine clusters. The total main strength was 980 9 21 with the links of five to 172. Industry’s 4.0 has the highest link strength with others of 995 with the co-occurrence of 2892 under 5 clusters.

Countries’ Scientific Production



Source 6 Biblioshiny Results through RStudio

From source 18 we can find that from 2012 to 2016 publication journals were produced almost nil from. 2016 there. Are four journals who has been published research paper in the subject domain.

Discussion & Conclusion

In summary, Industry 4.0 is not just about technological changes; it's about a comprehensive transformation affecting all aspects of society, including business, psychology, finance, economics, arts, and the humanities. This revolution is creating opportunities for innovation and challenges that require a multidisciplinary approach to navigate successfully.

Moreover, Industry 4.0 is not confined to the manufacturing sector alone. It permeates every industry, reshaping how businesses operate, enhancing customer experiences, and creating new business models. From predictive maintenance to autonomous logistics, Industry 4.0 is paving the way for a more resilient and flexible industrial ecosystem.

The transition to Industry 4.0 offers incredible opportunities for businesses to thrive in the digital age. However, it also presents challenges, such as the need for upskilling the workforce and ensuring cybersecurity. As we embrace this new era, it's crucial for companies to adapt and innovate to remain competitive in the ever-evolving industrial landscape. The current era, known as Industry 4.0 or the Fourth Industrial Revolution, is significantly altering the dynamics across various sectors by incorporating cutting-edge technologies like artificial intelligence, the Internet of Things (IoT), and advanced data

analysis. The impact of Industry 4.0 is evident across multiple domains:

In the realm of business accounting, the onset of Industry 4.0 has revolutionized traditional accounting methods. Technologies such as AI and IoT enable the real-time gathering and examination of financial information, which enhances the precision of predictions and decision-making processes. The automation of repetitive tasks minimizes mistakes and allows accounting professionals to focus on more strategic initiatives.

The field of psychology is utilizing Industry 4.0 technologies to gain deeper insights into human behaviour and mental well-being. For instance, AI's analysis of data from wearable technology can identify behavioural patterns indicative of stress or depressive states, paving the way for interventions that are both more individualized and timelier.

The finance industry has experienced a profound transformation due to Industry 4.0, with financial technology advancements like blockchain and AI altering the execution of transactions and the provision of services. These innovations have resulted in quicker, more secure, and more cost-efficient financial operations.

Economic models are being reshaped by Industry 4.0, which facilitates more effective production methods

and fosters the creation of innovative business models. This revolution has the capacity to boost manufacturing productivity and sustainability, potentially spurring economic expansion and progress.

The arts sector is also feeling the influence of Industry 4.0, as digital technology becomes increasingly integrated into creative practices. Artists are employing AI and virtual reality to forge novel art forms and interact with audiences in unprecedented ways.

Lastly, the humanities are actively engaging with Industry 4.0, delving into the ethical, cultural, and societal ramifications of these technological progresses. This engagement is crucial for understanding the broader impact of these advancements on society

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