Information technology in Healthcare in India: A bibliometric analysis

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Abstract

Purpose – An analysis of information technology's use in Indian healthcare is done using bibliometric methods in this paper. We analysed related publications from the past ten years in an effort to offer both quantitative and qualitative observations. The purpose of this work is to emphasise the most important information by summarising the key publishing trends, performance &co-citation analysis, bibliographic coupling, and other scientific relation among entities.

Design/methodology/approach –This review studies 272 documents for bibliometric analysis, performance analysis, and topic clustering from the Scopus database. The researcher's goal in carrying out this activity is to examine the scientific productivity of publications, prolific authors, most influential articles, institutions, and countries, as well as keyword co-occurrence, thematic mapping, co-citations, authorship, and country collaborations. Performance analysis and topic clustering were carried out using VOS viewer as a research tool.

Findings – With 38 publications related to the research topic, 2020 is predicted to be the most fruitful year. The most impactful institute is the *'London School of Hygiene and Tropical Medicine'*, U.K., and 'India' is identified as the country contributing to maximum amount of publication related to research topic.'The Lancet' was the most influential journal with highest number of citations, and 'PLOS ONE '& 'BMC Health Services Research' are the two most productive journal publishing maximum number of articles related to topic of research over the last decade. "*Assuring health coverage for all in India*" is the most cited research article of the all the shortlisted research papers. Seven different thematic clusters were identified to contribute towards the research topic.

Study Limitations– It provides information on the state of research on the use of information technology in healthcare in India and leads researchers in the right direction. It also indicates the future directions of this field's research.

Keywords: Information Technology, Healthcare, India, Citation analysis, Bibliographic coupling, Scopus.

Paper type: Literature review

1. Introduction

One of the fields where science and IT have advanced significantly over the past century is healthcare (Awasthi et al., 2016).Even though the healthcare industry has always used information technology, diagnostics has grown significantly over the past few decades, leading to better service possibilities. The standard of care has substantially improved thanks to information technology, which has also completely changed the market for healthcare services(Chen et al., 2013). Healthcare professionals and other stakeholders must change the way health services are provided to make it more patient-centred. In order to increase the capacity of healthcare systems, technological integration could offer a potential answer, particularly in low-resource settings and inaccessible places. Therefore, healthcare services must find a balance between efficiency and resilient performance, which are sometimes

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thought of as being in conflicting states. (Rosso and Saurin, 2018). According to (Thimbleby, 2013), one of the best facilitators for successfully managing such a trade-off is information technology.

In order to answer a number of research questions (RQs), the current study uses a systematic approach to literature selection, rigorous bibliometric analysis, and systematic literature review (SLR) to determine the effects of information technology on healthcare in India. Identified research question are as follows:

RQ1. What are the latest research trends in the field of 'Information technology in Healthcare in India'?
RQ2. Which sources and contributors to the extant literature are the most important, significant, and impactful?
RQ3. Which nation and papers have the most sway in this particular field of study?
RQ4. What key topics have been found to be most prevalent in this field of research?
RQ5. What is the potential for further study?

The remaining sections of the research article are organised as follows:

The research methodology and study design are summarised in Section 2. The descriptive overview is presented in Section 3. The qualitative results of the network analyses are presented in Section 4. Section 5 discusses the future directions for research.The conclusion is covered in section 6, and the suggestions of the study are covered in part 7.

2. Research methods and study design

The findings of this study are based on SLR and bibliometrics. The idea of customised SLR has been used to produce bibliographic data (Tranfield et al., 2003). In order to get the necessary findings, the retrieved data was subjected to a variety of bibliometric analysis combinations (Zupic and Cater 2015). Figure 1 provides an overview of the research process and findings.

2.1 Methodology for Searching and data extraction procedure

Table 1 provides a summary of the various procedures that were used for the meta-data retrieval. After many iterations, a broad search phrase for this study was determined using a series of frequently used synonym or related keywords from the primary research topic. It was used to search all types of literature that was indexed in the Scopus database that was published between 2013 and 2022. Instead of limiting the analysis to only A*, A, and B category or WoS journal articles, all category journal articles from the Scopus database are used to offer an unbiased picture of the study (Khudzari et al., 2018).

2.2 Research methods
Bibliometrics is one of the most reliable research methods that completely precludes the possibility of subjectivity bias in qualitative literature synthesis (Nerur et al., 2008). Utilising quantitative methodologies, bibliometric studies generate representative summaries of voluminous bibliographic content (Pritchard, 1969; Broadus, 1987). Extensive use of bibliometrics has been made to evaluate themes (Blanco-Mesa et al., 2017), journals (Donthu et al., 2020), institutions (Merigio et al., 2019), and nations (Mas-Tur et al., 2019) in the existing body of literature.Citation and co-citation analyses are the most prevalent approaches to referencing. This reveals the academic distinctions between the citing and cited sources (Kessler, 1963; Small, 1973).An overview of the literature on the use of information technology in healthcare in India is given in the current study using descriptive and network analysis.The overall number of publications and citations are highlighted in the descriptive analysis performed using bibliometric tools (Tsay, 2009).
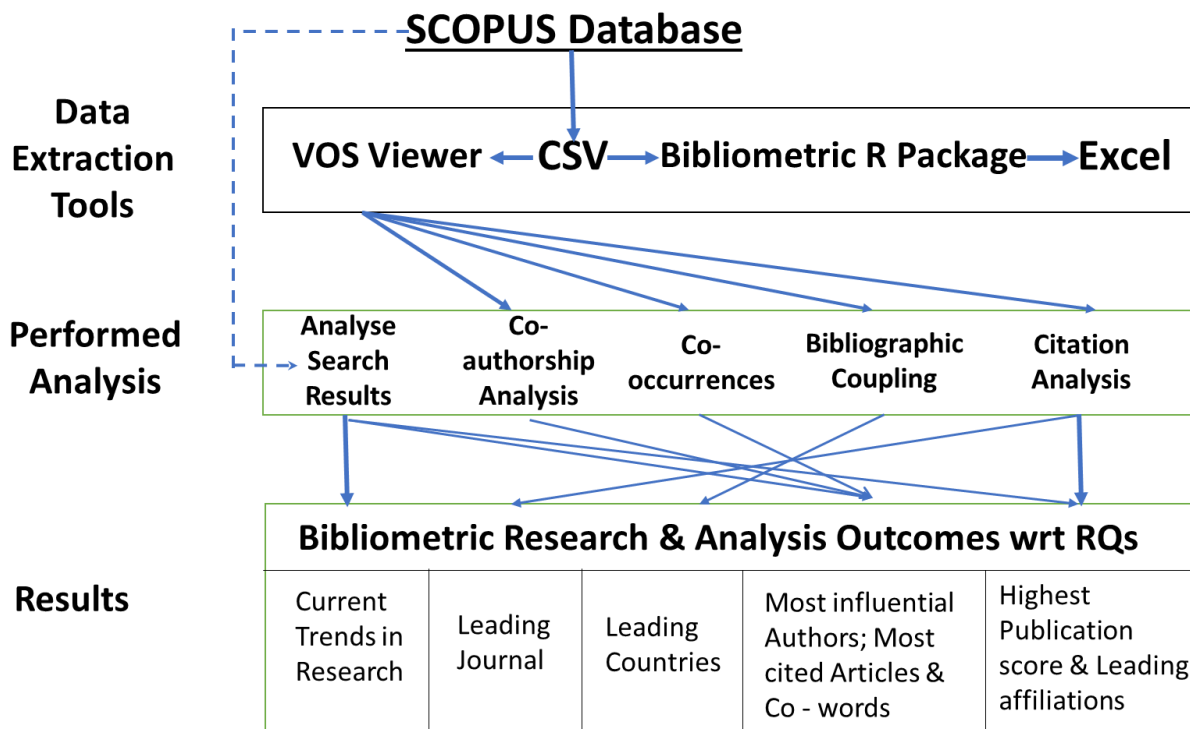
Figure 1. Analytical techniques employed and the anticipated results of the bibliometric investigation.

When using bibliographic couplings and co-occurrences for network studies, keyword analysis provides the knowledge structure, emerging trends, and subjects popular within the research field, whereas co-word analysis reveals the conceptual framework (Hu et al., 2018). A significant portion of the mapping analysis and visualising of the bibliometric networks in our study was done using the VosViewer software and MS Excel. Only on one occasion 'Biblioshiny' using R package was used to extract the local and Global citation during research.

3. Bibliographic Research Technique
3.1 Establishing the proper search terms
The terminology employed in this study is a combination of two cross-disciplinary components: information technology and healthcare, with a binding factor restricted to India. To ensure that all aspects of 'Information technology' and 'Healthcare' were addressed in this study, it was necessary to include synonyms/keywords and related terms associated with each of these two fields. Table 1 displays the three sets of strings and keywords used for data extraction from the Scopus database and document selection. The researcher discovered these terms while conducting a preliminary search of significant, pertinent papers. Various terms which can be used in alias to 'Information Technology 'could be "Infotech, Information Communication System, IT systems and Emerging Technology". Similarly, for 'Healthcare', terms like "mHealth, HealthTech, Healthcare Policy, Health care Management, MOHFA and Ministry of Health and Family Welfare" have been used as related terms.

Table 1: Filtering criteria/search terms and article selection.

Filtering criteria	Reject	Accept
Search criteria		

		606
Search engine: Scopus Search date: 29 May 2023 Search term: ("Information technology" OR Infotech OR "Emerging Technology" OR "IT systems" OR "Information Communication System" OR "Information Systems") AND (healthcare OR mHealth OR "Health 4.0" OR "Medical Health" OR "Health Technology" OR "Health Ministry" OR "Ministry of Health and Family Welfare" OR HealthTech OR "Health care Management" OR MOHFW OR "Health Services" OR "Healthcare Policy") AND (India)		
Year: 2013 – 2022	214	392
Subject Area: Medicine, Computer Science, Engineering, Social Science, Business Management and Accounting, Decision Sciences, Biochemistry, Genetics and Molecular Biology, Pharmacology, Toxicology and Pharmaceutics, Health Professions, Multidisciplinary & Nursing	12	380
Document type: 'Articles (250)'and 'Reviews (22)'	108	272
Documents in English language only	0	272

3.2 Data Collection

Initially three databases i.e., Dimensions, WoS &Scopus was considered to extract the required information. However, Scopus was chosen because it offered a substantial number of double-blind peer-reviewed publications. The majority of these publications have been published in journals with a high impact factor (Groff et al., 2020). We used a methodical approach to arrive at ultimate count of 272 articles in Table 1.Key-words like "Information technology", "Infotech", "Emerging Technology", "IT systems", "Information Communication System", "Information Systems"," Healthcare", "mHealth", "Health 4.0", "Medical Health", "Health Technology", "Health Ministry", "Ministry of Health and Family Welfare"," HealthTech", "Health care Management", "MOHFW","Health Services", "Healthcare Policy" and "India" used to incorporate articles. Only English-language articles were considered, along with a list of diverse'subject areas' as shown in Table 1.

Due to inaccurate bibliographical and bibliometric data brought on by the inclusion of the novel publication in later research publications, data collected from Scopus or any other online database may have mistakes (Donthu et al., 2021). In order to remove all the inaccurate records that could have led to a risky and incorrect diagnosis, this recovered database was manually refined. As a result, we took numerous steps to clean and organise the data. This inspired us to follow the recommendations of (Zupic and Cater, 2015; Donthu et al, 2021) and undertake a search for bibliographic and bibliometric data, as well as the visualisation and analysis of the results.

3.3 Selected techniques for analysis

According to Mishra et al. (2018) and Goyal & Kumar (2021), bibliometric analysis is a set of tools that uses quantitative methods to examine and measure text and information.These techniques allow for the extraction of a fresh viewpoint from the literature review, which can then be applied to improve both ongoing and upcoming studies (Suominen et al., 2016; Groff et al., 2020). To achieve this, it is required to create and publish biographies on a certain topic, identify trends within a research area, and assess previous research to determine the current state of the field. (Gao et al., 2021; Hossain et al., 2022). For analysing the extracted data, researchers employ bibliometric analysis techniques such as authorship, citation, bibliographic coupling, co-citation, and co-word analysis. (Donthu et al. 2021).
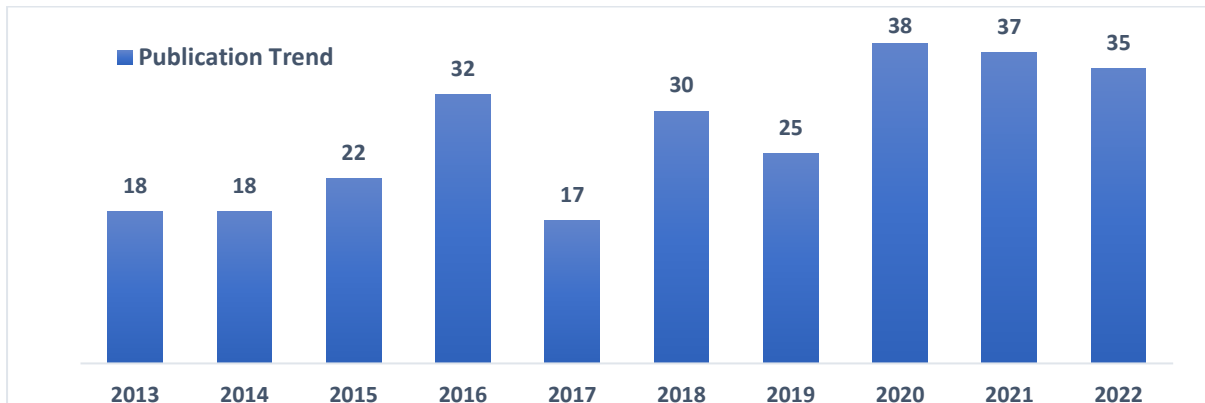
4. Findings

4.1 Performance analysis

Figure 2: Publication trend of 'Information Technology in Healthcare' research in India.

The above bar diagram(figure2)reflects the publication tendencies in the subject area 'Information Technology in Healthcare' research in India. The journey of research in this domain has started much earlier.However, from the time period analysed, 2020 was identified as the most productive year with 38 publications. Now the publications have gradually fallen to 35 publications in 2022.

For the first time, Chawla (1997), published a research paper on the topic and acknowledged that inclusion of information technology in healthcare in India will revolutionise the healthcare industry. Steadily there had been limited publications in the research area. However, with the increase in IT literacy and wide spread adoption in industry, healthcare industry also witnessed foray of IT in it. After the covid 19 pandemic, the number of publications on related topics has increased dramatically, as has their annual production rate. Considering the present trend, the number of studies in this field will enhance overtime.

4.2 Notable authors, organizations, and nations for Information Technology in Healthcare' research in India

The most significant researchers, organisations, and nations for "Information Technology in Healthcare" research in India are listed in Table 2 below. Patel (2015) is the most significant writer with 249 citations and 5 publications of research papers. Shidhaye(2016) has published 10 papers and have 185 citations. Similarly, the most influential institutions are 'London School of Hygiene and Tropical Medicine, United Kingdom' and 'Department of Paediatrics', 'AIIMS, New Delhi, India ' with 190 and 147 citations achieved out of 2 & 1 documentation publication by the institute respectively.

Table 2: Leading Authors, Institutions and Nations'Information Technology in Healthcare' study in India.

TC	Author	TP	TC	Institution	TP	TC	Country	TP
249	Patel V.	5	190	London School of Hygiene and Tropical Medicine, United Kingdom	2	2171	India	239
185	Shidhaye R.	10	147	Department of Paediatrics, AIIMS, New Delhi, India	1	774	United Kingdom	44
148	Narayan K.	2	147	Independent researcher and policy analyst, New Delhi, India	1	478	United States	45
147	Nandraj S.	1	147	Lok Swasthya Health Cooperative, Ahmedabad, India	1	167	Switzerland	12
147	Parikh R.	1	147	Public Health Foundation of India, India	1	118	Ethiopia	6

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147	Paul V.K.	1	147	Public Health Foundation of India, India	1	117	Netherlands	7
147	Reddy K.S.	1	147	SEWA, Ahmedabad, India	1	115	Sweden	8
128	Ahuja S.	7	147	Vimosewa co-op, Ahmedabad, India	1	106	Nigeria	6
118	Thornicroft G.	8	147	World Heart Federation, India	1	106	South Africa	8
111	Semrau M.	6	113	People's University, Bhopal, India	1	98	Australia	5
110	Schellenberg J.	5	91	London school of hygiene and tropical medicine, London.	3	90	Italy	5
103	Kumar S.	5	65	Kovai Medical Centre and Hospital, Coimbatore, TN, India	1	89	Uganda	4
94	Wickremasingh E D.	3	65	Madras Medical Mission, Chennai, TN, India	1	84	Nepal	4
89	Gureje O.	4	65	Stanley Medical College & Hospital, TN, India	1	50	Japan	4
89	Banlon C.	4	65	Kovai Medical Centre & Hospital, TN, India	1	40	France	2
89	Kigozi F.	4	65	Michigan Centre for Health Analytics Medical Prediction, University of Michigan, United States	1	39	Norway	4
89	Lund C.	4	65	Department of Internal Medicine, University of Texas, US	1	35	Qatar	2
89	Mullasari A.S.	2	65	ICAHN School of Medicine, NYC, US	1	32	Canada	7
89	Veerasekar G.	2	63	MSIT, New Delhi, India	1	27	Pakistan	3
89	Victor S.M.	2	63	Society for applied studies, India	1	26	Malawi	1

Note(s): TC= 'Total Citation' & TP= 'Total Publication'

With 2171 citations from 239 documents, India is deemed the most influential country, followed by the United Kingdom with 774 citations from 44 document publications. In addition, Shidhaye(2016) is the most prolific author with 10 publications, and India is the most prolific nation in terms of publication on the topic of 'Information technology in Healthcare in India'.

4.3 Utmost significant journals for Information Technology in Healthcare in India
The leading and most influential journals of 'Information technology in Healthcare in India' are listed in Table 3. The most influential source for Information technology in Healthcare in India is 'The Lancet' with 147 citations and only 1 publication followed by 'Health Policy and Planning' journal with 120 citations and 5 publications. 'Plos One' can be categorised as the most prolific journal with 7 research papers closely followed by 'Global Health Action' with only 6 publications.From 2016 to 2018 has been the most productive year for the influential journals. The most productive journal in 'Healthcare' category is 'Plos One' with 7 publications and 'Journals of Medical Systems' as the most productive in 'Information Technology'.

Table 3: Top Journals about Information technology in Healthcare in India

Journal	TC	TP	HC	IT	ABDC	2013-15	2016-18	2019-21	2022-23
The Lancet	147	1	X		NA	1			
Health Policy and Planning	120	5			NA		4		1
Diabetes and Metabolic Syndrome: Clinical Research and Reviews	113	1			NA			1	
Plos One	103	7	X		NA	3	2	2	
Global Health Action	95	6			NA	3	2	1	
Vaccine	85	2			NA	1	1		
Jama Cardiology	65	1			NA		1		
Journal of Medical Systems	57	2		X	NA		2		
International Journal of Nursing Studies	52	1	X		NA		1		
Journal of Clinical and Diagnostic Research	52	3			NA	1	2		
BMC Health Services Research	51	7	X		NA	1	1	5	
BMC Pregnancy and Childbirth	51	4			NA	1	1	1	1
Benchmarking: An International Journal	50	1			NA	1			
Information Systems Frontiers	44	1		X	NA		1		
JMIR mhealth and uhealth	44	2			NA		1	1	
British Journal of Psychiatry	43	1			NA		1		
Bjpsych Open	42	3	X		NA			3	
Globalization and Health	42	2	X		NA		1	1	
Human Resources for Health	38	2			NA	1	1		
Government Information Quarterly	37	1			A	1			

Note(s): ABDC = Australian Business Deans Council 2019 Journal Ranking List. TC = total citations. TP = total publications. HC = X if a journal as classified as 'healthcare' journal and IT =X if the journal is classified as "Information Technology" journal. The journals appear according to total citations in this table.

Additionally, out of the list of top 20 most impactful journals, only 'Government Information Quarterly' is the journal which qualifies in the ABDC journal ranking list in 'A' category. Rest none of the journals are a part of ABDC list.

4.4 Utmost Significant work of Literature (articles) on Information Technology in Healthcare in India

The most popular and influential papers on India's use of information technology in healthcare are listed in Table 4. The most cited article is "Assuring health coverage for all in India" by Patel (2015), which has 147 citations. The research paper discusses about the state of healthcare in 2015, and discusses at length the identified limitations which are acting as an hinderance in the improvisation of healthcare and access of quality healthcare for all. The authors' main point is that India has to construct an integrated national health-care system based on a strong public primary care system and a clearly defined supportive role for the private and indigenous sectors. They also explore the new distinct architecture for the country's health-care system.This system must meet both short-term and long-term healthcare needs, offer logical, easily accessible, high-quality treatment options, facilitate cashless payment at the point of service, and ensure accountability through sound regulatory oversight. During the process, a number of significant concerns required to be taken care off, particularly low public spending levels, inadequate guideline, the quick commercialization of healthcare, corruption, and fragmented governance.

Table 4: Most Influencing Articlesabout Information technology in Healthcare in India

Author	Title	TC
Patel V. et al. (2015)	"Assuring health coverage for all in India"	147
Ghai S. (2020)	"Teledentistry during COVID-19 pandemic"	113
Alexander T. et al. (2017)	"A system of care for patients with ST-segment elevation myocardial infarction in India: The Tamil Nadu ST segment elevation myocardial infarction program"	65
John J. et al. (2014)	"Rotavirus gastroenteritis in India, 2011-2013: Revised estimates of disease burden and potential impact of vaccines"	63
Wickremasinghe D. et al. (2016)	"District decision-making for health in low-income settings: A systematic literature review"	56
Malik N. et al. (2016)	"Authentic leadership and its impact on creativity of nursing staff: A cross sectional questionnaire survey of Indian nurses and their supervisors"	52
Ranjan Debata B. et al. (2013)	"Evaluating medical tourism enablers with interpretive structural modelling"	50
Nedungadi P. et al. (2018)	"Personalized Health Monitoring System for Managing Well-Being in Rural Areas"	49
Zayapragassarazan and Kumar (2016)	"Awareness, knowledge, attitude and skills of telemedicine among health professional faculty working in teaching hospitals"	46
Seethamraju R. et al. (2018)	"Intention to Use a Mobile-Based Information Technology Solution for Tuberculosis Treatment Monitoring – Applying a UTAUT Model"	44
Shidhaye R. et al. (2016)	"Development and piloting of a plan for integrating mental health in primary care in Sehore district, Madhya Pradesh, India"	43
Sharma A. et al. (2016)	"Quality of health management information system for maternal & child health care in Haryana state, India"	37
Kaushik and Raman (2015)	"The new data-driven enterprise architecture for e-healthcare: Lessons from the Indian public sector"	37
Modgil S. et al. (2022)	"Has Covid-19 accelerated opportunities for digital entrepreneurship? An Indian perspective"	35
Jat and Sebatian (2013)	"Technical efficiency of public district hospitals in Madhya Pradesh, India: A data envelopment analysis"	35
Muke S.S. et al.	"Acceptability and feasibility of digital technology for training	31

(2019)	community health workers to deliver brief psychological treatment for depression in rural India"	
Bassi A. et al. (2018)	"Current status and future directions of mhealth interventions for health system strengthening in India: Systematic review"	31
Limaye T. et al. (2017)	"Efficacy of a virtual assistance-based lifestyle intervention in reducing risk factors for Type 2 diabetes in young employees in the information technology industry in India: LIMIT, a randomized controlled trial"	31
Upadhaya N. et al. (2016)	"Information systems for mental health in six low- and middle-income countries: Cross country situation analysis"	30
Jordans M.J.D et al. (2016)	"Indicators for routine monitoring of effective mental healthcare coverage in low- and middle-income settings: A Delphi study"	29

Note(s): TC= 'Total Citation'

Similarly, with 113 citations, Ghai(2020) conducted the second influential study on "Teledentistry during COVID-19 pandemic". The author has proposed to restart dentistry function without raising infection risk. The suspended dental practise during the COVID-19 era requires innovative adjustments. Teledentistry refers to the distant provision of dental care through information technology rather than face-to-face contact. During the present epidemic, teledentistry can supplement the existing weakened dental infrastructure and that teledentistry can be considered a novel alternative for resuming dental practise during the epidemic. Thus,teledentistry must be integrated into routine dental practise. If not completely replacing, teledentistry can at least supplement the current weakened dental system during any future epidemic.

4.5 Top references for Information Technology in Healthcare in India

Based on local and global citations, Table-5 below shows the top referenced articles for information technology in healthcare in India.'Local citations' refers to the number of times an article is cited by other articles within the same field of study, whereas 'Global citations' refers to the number of times an article is cited, perhaps outside of the field of study.

The paper authored by Sharma(2016) titled "Quality of health management information system for maternal & child health care in Haryana state, India" is the highest referred paper having 5 (local) and 37 (global) citations respectively. The research paper is an effort by the authors to highlight the quality of HMIS system employed by Haryana state.

Table 5: Top referred research articles for Information technology in Healthcare in India

Author & Journal	Topic	Year	LC	G C
Sharma A, Plos One	Quality of health management information system for maternal & child health care in Haryana state, India	2016	5	37
Jordans MJD, Health Policy Planning	Indicators for routine monitoring of effective mental healthcare coverage in low- and middle-income settings: A Delphi study	2016	4	29
Ahuja S, Bjpsych International	Mental health information systems in resource-challenged countries: Experiences from India	2018	4	10
Wickremasinghe D, Health Policy Planning	District decision-making for health in low-income settings: A systematic literature review	2016	3	56
UpadhayaN, Int Journal Mental Health System	Information systems for mental health in six low- and middle-income countries: Cross country situation analysis	2016	3	30

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Bhattacharyya S, HealthPolicy Planning	District decision-making for health in low-income settings: A case study of the potential of public and private sector data in India and Ethiopia	2016	3	23
Shidhaye R,BR J Psychiatry	Development and piloting of a plan for integrating mental health in primary care in Sehore district, MP, India	2016	2	43
Gera R, BMC Health Service Res	An in-depth assessment of India's Mother and Child Tracking System (MCTS) in Rajasthan and Uttar Pradesh	2015	2	16
Faujdar DS, International Journal Medical Informatics	Field testing of a digital health information system for primary health care: A quasi-experimental study from India	2020	2	15
Gautham M, Health Policy Planning	District decision-making for health in low-income settings: A qualitative study in Uttar Pradesh, India, on engaging the private health sector in sharing health-related data	2016	2	12

Note(s): LC= Local citation & GC = Global citation

Despite the rising importance placed on the use of everyday data to arrive on a decision, it has frequently been observed to be problematic. Employed health management information system (HMIS) is known to be subpar, but there has been no thorough examination to ascertain the level of inaccurate it comprises. Author and team have analysed the empirical data and have shared the lacuna in HMIS and ways to overcome it. Achievement of this completeness and quality of HMIS with thus ensure complete reporting of maternal and child health data and hence adherence to it for providing required medical services. Similarly, Jordans (2016) authored "Indicators for routine monitoring of effective mental healthcare coverage in low- and middle-income settings: A Delphi study" is the second most referred article with 4(local)&29(global) citations. This study provides policymakers and other decision makers with new and relevant information about critical metrics to be considered for capturing the efforts made in progress in the direction of universal mental health care. This is especially important in light of the global push to expand mental health services. As a result of the study's widespread agreement on the most crucial metrics, national health information systems may more effectively consider and report on the functioning of the world's mental health systems.

4.6 Analysis of thematic and impact structure using bibliographic coupling

Theme clusters are displayed in table 6 through bibliographic coupling of Information technology in Healthcare in India. 'Mixed methods of Care System', 'Health Study and Analysis', 'Study of Low-cost health decision making', 'Patient Prevention Program', 'Future Health interventions', 'Information Infrastructure and Health', and 'Health Systems & Solution' are identified seven grouping into which Vosviewer has categorised the entire data. These seven clusters have been achieved after maintain a minimum threshold of 12 citations.

Table 6: Thematic cluster of Information technology in Healthcare in India

Theme	Author	Title	TC
Mixed Methods of Care System	Gera R. et al. (2015)	An in-depth assessment of India's Mother and Child Tracking System (MCTS) in Rajasthan and Uttar Pradesh	16
	Datta S.et al.(2014)	Case-finding for hepatitis C in primary care: A mixed-methods service evaluation	15
	Lall D. et al. (2019)	Challenges in primary care for diabetes and hypertension: An observational study of the Kolar district in rural India	15

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Health Study & Analysis	Patel V. et al. (2015)	Assuring health coverage for all in India	147
	Kumar and Dansereau (2014)	Supply-side barriers to maternity-care in India: A facility-based analysis	27
	Dror D.M. et al. (2016)	Impact of community-based health insurance in rural India on self-medication & financial protection of the insured	17
Study of Low-cost health decision making	Wickremasinghe D.et al.(2016)	District decision-making for health in low-income settings: A systematic literature review	56
	Sharma A.et al.(2016)	Quality of health management information system for maternal & child health care in Haryana state, India	37
	Bhattacharyya S.et al.(2016)	District decision-making for health in low-income settings: A case study of the potential of public and private sector data in India and Ethiopia	23
Patient Prevention Program	Alexander T.et al. (2017)	A system of care for patients with ST-segment elevation myocardial infarction in India: The Tamil Nadu-ST-segment elevation myocardial infarction program	65
	Alexander T.et al. (2015)	Framework for a National STEMI Program: Consensus document developed by STEMI India, Cardiological Society of India and Association Physicians of India	24
	Mohan S. et al. (2018)	UDAY: A comprehensive diabetes and hypertension prevention and management program in India	22
Future Health interventions	Zayapragassarazan and Kumar (2016)	Awareness, knowledge, attitude and skills of telemedicine among health professional faculty working in teaching hospitals.	46
	Bassi A. et al. (2018)	Current status and future directions of mhealth interventions for health system strengthening in India: Systematic review	31
	Limaye T. et al. (2017)	Efficacy of a virtual assistance-based lifestyle intervention in reducing risk factors for Type 2 diabetes in young employees in the information technology industry in India: LIMIT, a randomized controlled trial	31
Information Infrastructure and health	Kaushik and Raman (2015)	The new data-driven enterprise architecture for e-healthcare: Lessons from the Indian public sector	37
	Upadhaya N. et al. (2016)	Information systems for mental health in six low- and middle-income countries: Cross country situation analysis	30
	Aanestad M.et al.(2014)	Infrastructuring work: Building a state-wide hospital information infrastructure in India	20
Health systems & Solution	Liu G. et al. (2015)	Antenatal corticosteroids for management of preterm birth: A multi-country analysis of health system bottlenecks and potential solutions	26
	Neogi S.B. et al. (2018)	Risk factors for stillbirths: How much can a responsive health system prevent?	19

Note: "TC = Total Citations."

The above table 6, consist of all the most influential articles of each cluster. These identified seven groups/cluster are supposed to cover all the different aspects of information technology in health inIndia.

Cluster 1(represented by red nodes in figure3) discusses about 'Mixed Methods of Care System' under the role of information technology in healthcare in India. According to Gera (2015), ICT advancements that are better conceptualised and put into practise may be used to lessen the workload of Front-line health workers (FHWs). It is important to do in-depth study on existing ICT developments for 'Health Information Systems'(HISs) in order to draw practical lessons and provide a basis for assessing potential technologies. It is important to look at the possibilities of e-learning programmes to enhance healthcare workers' continual learning. Direct and regular capacity-building communication with healthcare professionals can be facilitated through e-learning.Similar to this, Datta (2014) suggests that ICT and General Practitioner (GP) intervention will help in identifying individuals on whom testing for the hepatitis C virus need to be undertaken. Including information about drug use and country of origin on the new-patient questionnaire may help identify hepatitis C virus (HCV) cases.Lall (2019) argues that the service delivery system must cultivate bettercommuniqué to cater the needs of patient- and family-centred care which is supportive and responsive in nature. Improving information systems will significantly facilitate visiting schedule that are convenient for patients and do not overburden doctors. Improvement of therapy decisions based on evidence and tailored to the patient's requirements can be achieved. The significance of utilising these improvements in the field for chronic patients in health care delivery organisations appears to be important.
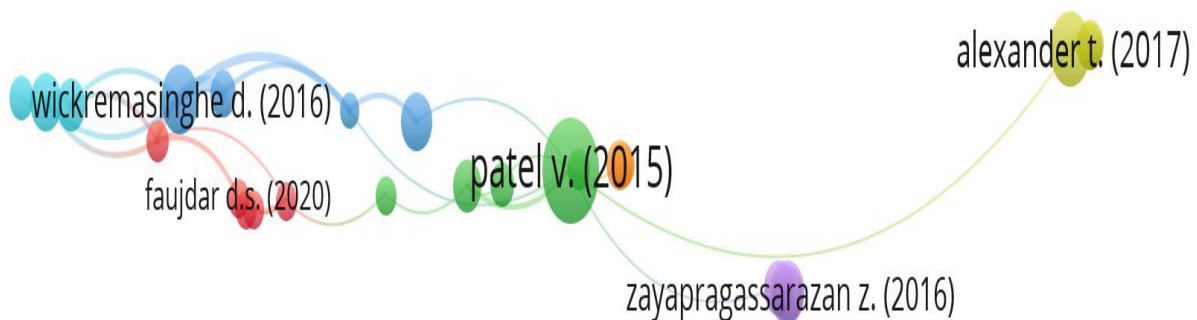

Figure 3: Visualisation of bibliographic coupling (documents) as a network. (min. citation set to 12to achieve 7 cluster)

Cluster 2 (represented by green nodes in figure3) includes research on 'Health Study & Analysis' of information technology in India. Patel (2015)which is also the most cited article out of all the clusters, discusses about the state of healthcare in India, and identified limitation which are acting as an hinderance in the improvisation of healthcare and access of quality healthcare for all. Fundamentally, the authors discuss about the new different framework for India's healthcare system i.e., India must establish a unified pan India system for health care and clearly defined role for the private and indigenous sectors.Discussed system should address both severe and enduring health care needs, provide rational, accessible, and high-quality care options, facilitate payment through digital service, and ensure culpability through robust regulatory oversight.Many important issues needaddressal during the process, especially the relatively minimal levels of government spending; insufficient guideline, rampant commercialization, dishonesty in medical field and governance disintegration. Kumar and Dansereau (2014)emphasises the significance of supply-side constraints to health-care utilisation. The author suggests that to accomplish desired 'Millennium Development Goal' of reducing deaths during pregnency, authorities should invest more in enhancing the availability of primary-care information technology infrastructure, such as labour rooms and operating hours so that, the health service delivery level can be enhanced and with time almost all the limitation can be overcome.

Cluster 3(represented by blue nodes in figure3) is related with the 'Study of Low-cost health decision' making under the Information technology in healthcare in India. Wickremasinghe(2016)suggest that 'Health management information systems' (HMIS) deployed systems generate vast quantities of information about medical care delivery and people well-being. This offers an opportunity to make data-driven decision making in distributed health care delivery regime. However, this statisticisnot utilised to its full potential locally. Thus, a precisemethodof choice depending upon utilisation of medical data at district-level will offerimprovedaidto satisfy the requirements of the resident public. Sharma(2016)discuss that the research paper is an effort by the authors to highlight the quality of HMIS system employed by Haryana state. Despite the rising importance placed regarding the utilisation of repetitive statistics for deciding, the statistics is regularly noted to be fraught by issues. There is evidence that the HMIS lacks quality, but there has been no vigorous investigation for determining the degree of its erroneousness. Author and team have analysed the empirical data and have shared the lacuna in HMIS and ways to overcome it. Achievement of this completeness and quality of HMIS with thus ensure complete reporting of maternal and child health data and hence adherence to it for providing required medical services. Bhattacharyya(2016) suggest that even though health data is captured at district level, it cannot be used efficiently at the district level. This limitation is due to non-providence of health data by private players. Thus, the existing platform should be strengthened so that health data in holistic perspective should be captured as is done in Ethiopia so that better choicefor health services can happen at the regional level.

Publications on 'Patient Prevention Program' under the information technology in healthcare in India are included in cluster 4(represented by yellow nodes in figure 3). Alexander (2017) suggests that 'Low- and Middle-income countries'like India, the hub-and-spoke structure for a heart condition monitoring structurefor upkeepwhich joinstangentiallyconnected medical care unitsto big heartcare expert facilities is a possible and operative paradigm for prevention of any challenges for the patients with existing heart problems. This methodology helps in increasing access to correct healthcare support in time of crisis and it may reduce mortality rate in such patients. According to Alexander (2015), India needs an organised system of care to improve key process followed in the care of heart problem related patients. This can be achieved by looking into numerousmedical, logistic and socialaspects, execution of validated treatment procedures, as well as effective and speedy inter-hospital movement within integrated hospital networks.Utilising novel PPP (public-private partnerships), high-tech invention in device monitoring, ever growing ambulance support system, and new approaches for reperfusion treatment and initial hostile risk evaluation, this method is particularly advantageous. Depending upon the outcome, the system can be protracted to other developing nations. Similarly, Mohan (2018) conducted one of the prime community-based intervention studies established in Indiato develop and assess a multicomponent, multilevel, profitable, complete intrusion proposal to enhance the deterrence, discovery, and efficient supervision of diabetes and hypertension. (India's leading non-communicable disease).In order to effectively resolve these 'non communicable diseases'(NCDs) as envisioned in UDAY, low-cost publicbased measures to reinforce the medical care structure are needed. Through it, the high and rising cost associated with the enormous expenditures of healthcare can also be curtailed and brought under control.

The studies on 'Future Health interventions' under the information sector in healthcare in India are included in cluster 5 (represented by purple nodes in figure3). Zayapragassarazan and Kumar (2016) research is one of the most well-known studies in this cluster.The study's findings imply that while many of the respondents have a favourable attitude towards telemedicine, their experience with and awareness of the technology is limited. Edificationwith training, the demand for information regarding telemedicine and the issues related to its use is critical forthe teaching staff, working physicians, residents, medical students, and other health workers. As per Bassi (2018), many communitywellbeing projects remain using technologies of the digital age and portable electronic devices to deliver healthcare due to the meteoric rise of people who use mobile phones in India. It is

crucial to determine how they help to make healthcare systems stronger. mHealth programmes are being tested more and more to enhance the quality of healthcare in India. Furthermore, Limaye (2017) suggest that young workers in the information technology sector who were at risk for diabetes were successfully treated with the help of a virtual assistance that works upon the improvisation of lifestyle of the young worker. This intervention by the virtual assistant can be scaled depending upon the requirement and have resulted in impressive results.

Cluster 6 (represented by sky blue nodes in figure3) is related with the study of 'Information Infrastructure and healthvertical'under the Information technology in healthcare in India. Kaushik and Raman (2015) highlight the importance of health management system and enterprise architecture framework for the efficient working of Health management information systems (HMIS). It is proposed that a new data driven EA to handle healthcare which an organisation will adopt in future as it will result in precise and necessity based efficient schedulingof medics and management of medicines. The expected outcomes and benefits are also enumerated. Through its unified operational model, the study presents a health information management system method. Although the EA-focused method to medicalcare is discussed in the study, there is still a need for improvement.Upadhaya(2016) propose that in order to improve repetitive HMIS and produce standardised HMIS pointers for intellectualwellbeing, there is a need for more technical and financial support. It has been suggested that we pay special attention to the pointers of reporting and value in order to make it simpler for us to put the World Health Organization's Mental Health Action Plan 2013-2020 into action. Aanestad(2014) mentions that work processes and organisations will be significantly impacted by technologies of information and communication that enhance governments based on a greater use of knowledge in developing countries (LMIC). In contrast to high-income nations, resource-constrained situations present demands on public sector organisations that are distinct. According to this paper, a software program formanaging information and other hospital systemswhich is free for use and built upon open-source codeand is intended for use at district hospitals was designed, developed, implemented, and scaled up for the Indian public healthcare sector. The focus of the article is about the consequences of labor, abilities, organisation, expanding on and automating the notions of "automate" and "informate." Ideas of "infrastructuring of work" and "work of infrastructuring," which are represented by the organisation authenticities of a regional medical facility in an LMIC context, are used to focus upon the growing and repetitive interaction amiddatastructure and work.

Cluster 7 (represented by orange nodes in figure3) discusses about Health systems & Solution under the role of information technology in healthcare in India. Liu(2015) highlights through their research paper that while ACS has been a standard to preventative measures for the treatment of premature birth in wealthy nations for more than 20 years, it is significantly underutilised in low-resource nations, where preterm birth complications have lately surpassed all other causes of death in children under the age of five. With data from 11 countries, this systematic bottleneck analysis pinpoints key points of emphasiswhich offers few doable resolutionsaimed at expanding this low-cost, high-influenceinterference while equallyencouraging following for security, which could possibly save numerous lives annually. Also, Neogi(2018) through their research articles share that a solid health system with adequate prenatal care coverage and prompt implementation regarding urgent obstetric care services can enable a sizeable proportion of stillbirths which can be avoided. Utilising the health information system in daily routine would also strengthen procedures to enhance regular monitoring of stillbirths for the purpose of detecting contributing variables which can be used for the recording and reportage of miscarriages, including statistics about the weight of the baby at birth.

4.7 **Bibliometric Maps**
The co-occurrence analysis for, bibliographic coupling for documents, co-citation analysis, author keywords and maps of co-authorship for authors and nations were all developed.

(i.)   **Co-citation analysis (Cited References):** refers to the citations of two documents by a third document. We conducted the co-citation analysis of 79 articles by keeping a threshold of minimum 2 citations.
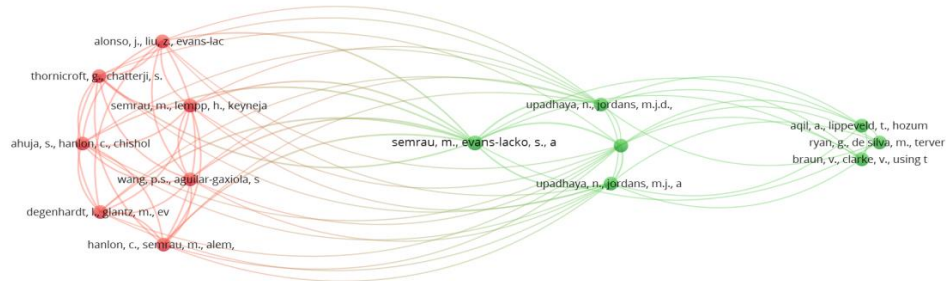

Figure 4: Co-citation analysis as a network visualisation, based on references

From the above fig. 4, its visible that Semrau, M. is ahead of all with 23 as link strength and 3 citations. Murray, E. is 2nd in number with 18 link strength and 3 citations and closely followed by Ahuja, S. with 17 link strength and 2 citations.

(ii.)   **Bibliographic coupling (documents analysis)**: refers to the referencing of third document by two documents together (Van and Waltman2013), (VanEck and Waltman, 2017). We performed bibliographic coupling by keeping minimum citation of documents as '0' and thus 272 documentswere included. It was concluded that only 123 documents are connected and rest 149 were not connected. However, results showed that Ahuja (2019) with total link strength (TLS) of 41 and 9 citations followed by Semrau(2019) with 31 TLS and 21 citation and Thornicroft (2019) with 26 TLS and 12 citations.
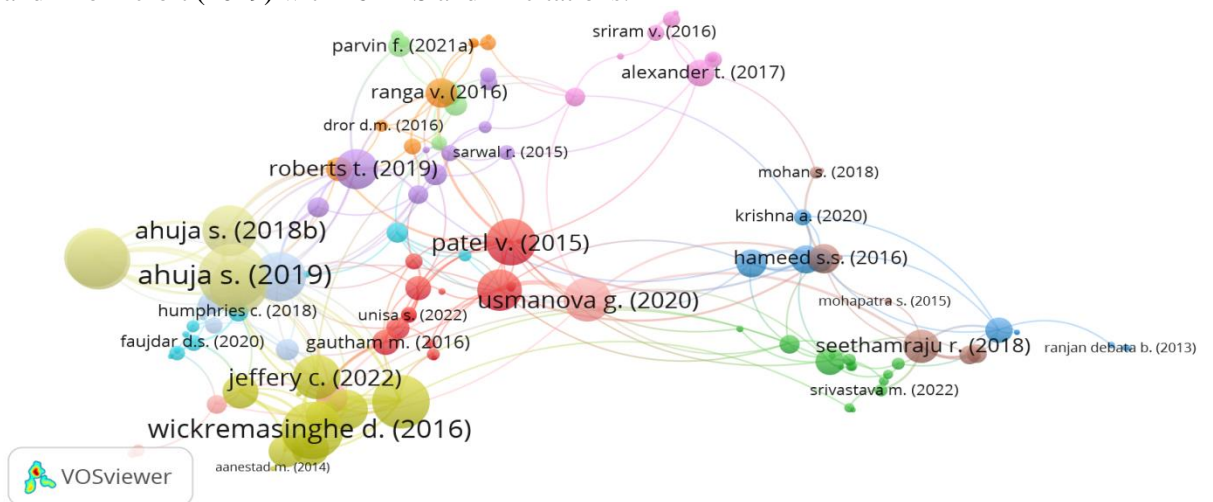

Figure 5(a): Network visualization of bibliographic coupling (documents) for all based on total link strength (TLS)
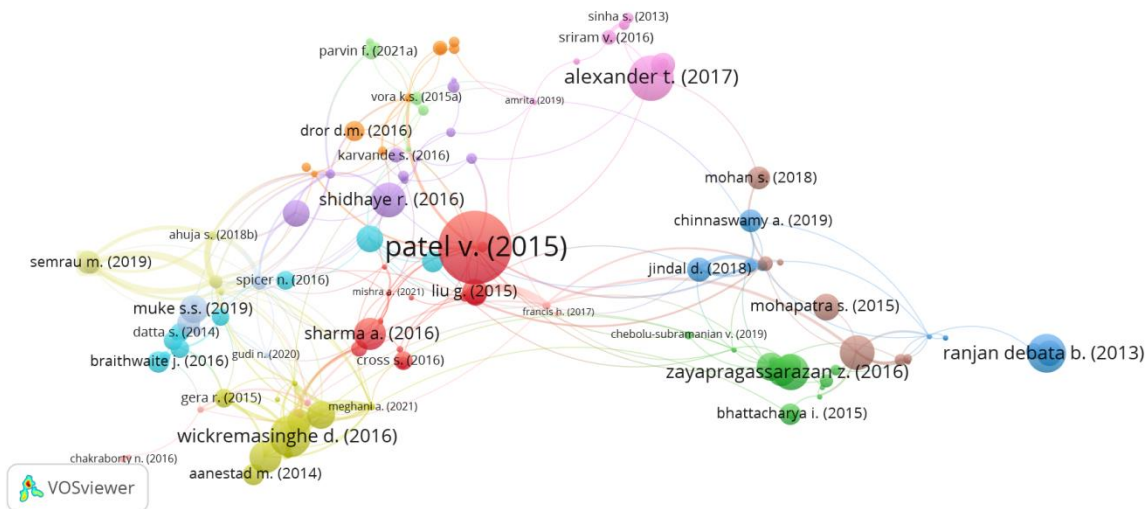
Figure 5(b): Network visualization of bibliographic coupling (documents) for all based on total citation.

The above figures 5(a) and 5(b) represent the network visualisation of bibliographic coupling for all the components as explained above depending on '*total link strength*' (5(a)) and on the basis of 'total citation'(5(b)).

(iii.)   **Co-authorship (Authors).**With the co-authorship option in VOSViewer, authors who have co-authored the documents can be examined. The relationships between the items (like authors) are represented using the co-authorship analysis. The link strength is used to indicate the relationship between the authors. As a result, the total link strength (TLS) is a parameter of measurement of the overall strength of the co-authorship between two authors. (VanEck and Waltman, 2017). Following diagram (figure 6) is received when the publication number per author is restricted to 4 with minimum citation of 1only. A total of 22 authors were selected under the designed criterion.
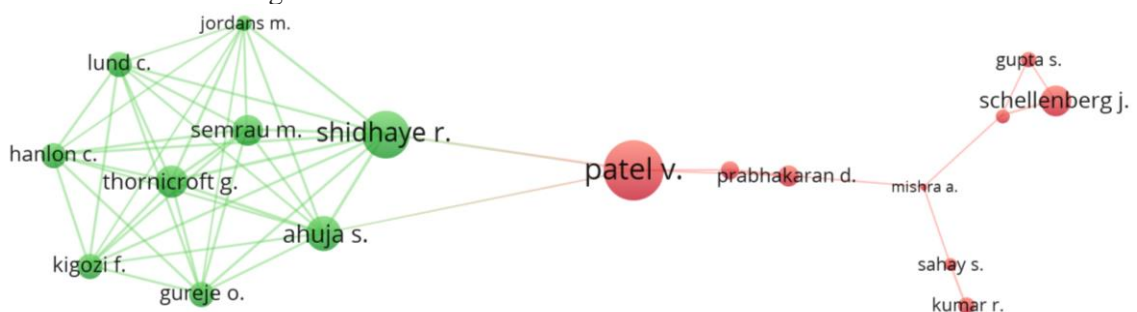

Figure 6: Co-authorship analysis presented as a network visualisation, based on the authors

Shidhaye, R. had the maximum link strength of 43 through 10 publication and a total of 185 citations. Thornicroft, G. was next in the queue with 40 TLS, 8 publications and 118 citations. 3rd in the line was Ahuja,S. with 34 TLS, 7 publications and 128 citations.

(iv.)   **Co-authorship (nations).** The retrieved database has details of researchers from 48 different countries who contributed towards the publication. Figure 7 presents co-authorship network among different countries generated with the help of Vos Viewer. A minimum threshold of 2 publications and single citation was kept as an eligibility for selection of a country. A total of

24 countries got selected under the scheduled criterion. India was ranked first with a total of 239 documents followed by the United Kingdom
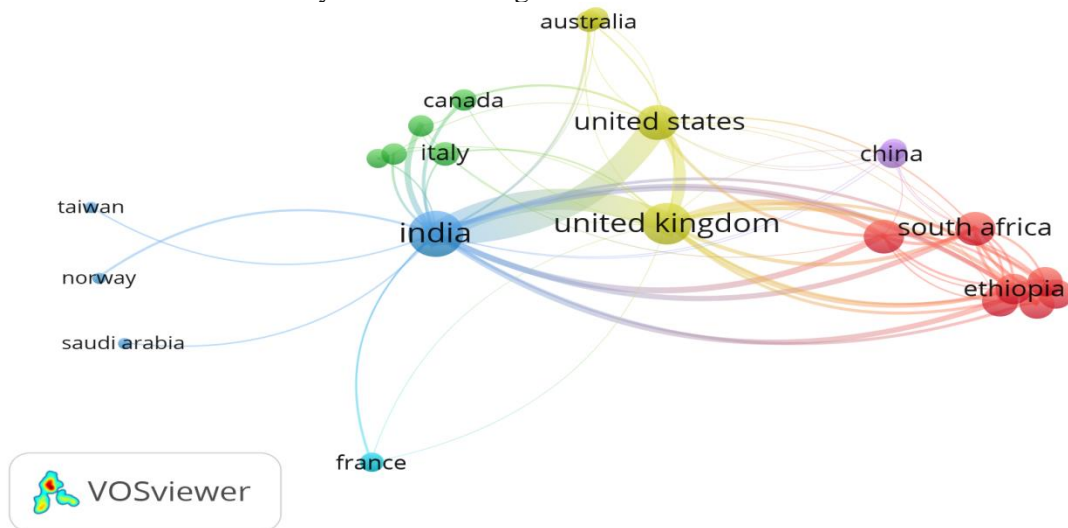

Figure 7: Co-authorship Network based on participation of Countries

(UK) with 44 and United states with 45 documents.On the map, the twenty-four countries were arranged in six distinct groups, each of which was represented by a different colour. The following pairs of countries had the most fruitful working relationship together: India-USA (link strength = 31); India-UK (linkstrength = 28); UK-USA (link strength = 12); India-Switzerland (link strength = 8); India-South Africa (link strength =7).

(v.) **Co-occurrences (Author Keywords).**Author keywords are the prominent words usedby authors in its research paper. These keywords are helpful in the selecting a research paper during reviewing process. Through the 'Author Keyword' analysis, we can understand the most repeated words used by various authors and they can help us understand the direction of the future research.
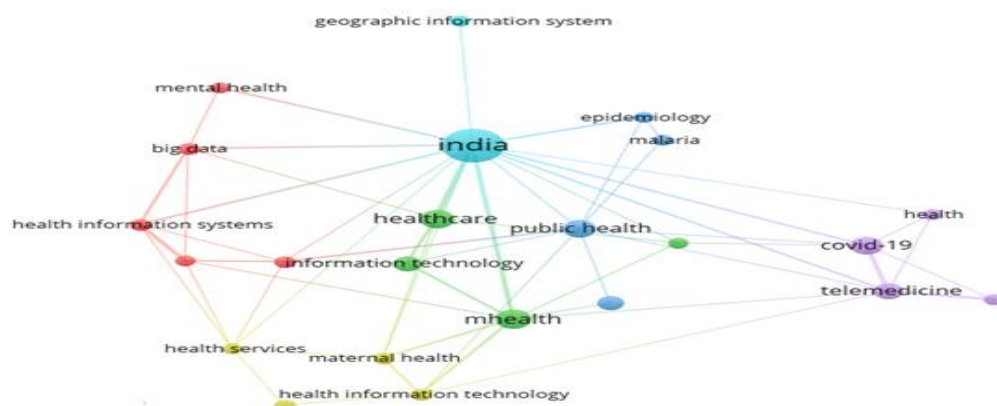

Figure 8: Co-occurrences Network based on Author keywords

After a few permutations and combinations, minimum occurrence of the keyword was limited to 4 and from it 24 keywords were shortlisted which could meet the threshold. Few prominent keywords like, 'India', 'mHelath', 'public health', 'Covid -19' etc were identified. All connected objects were used to build the map as represented figure 8, which was based on network visualisation. Total link strength was used as the weighting factor and association

6595

strength served as the analysis's unit of measurement. The dominance of keywords with higher TLS relative to other keywords was depicted on the map.

5. Future Research Directions

Evaluating the contribution of information technology in healthcare in India from a historic perspective is critical to analyse the long-lasting effects it has in present and for future research. This study may create a benchmark for this developing field by looking at pertinent papers, enabling other researchers to look at usage and benefits.

Future research could examine how the latest technology influences information technology in healthcare in India to offer cost effective and omnipresent quality medical services. Earlier the studies were focused upon different type of health studies and their analysis.However, it matured into introduction of new ways of providing healthcare with limited role of information technology. During and after the occurrence of COVID-19, major emphasis has been upon the inclusion of information technology to the maximum possible extent along with the introduction of new emerging technologies so that quality healthcare is accessible for all and everywhere in the country.

Recent research has shown a growing interest in the application of artificial intelligence (AI) in healthcare. The term "artificial intelligence" (AI) refers to a set of capabilities that can be implemented in a variety of settings and applications, such as machine learning, text mining, neural networks, big data, and artificial humans.Forthcomingstudy on healthcare besides IT-related topics will utilizeleading-edge tools like algorithm-based health evaluation and artificial intelligence. Current technologies will be utilised in future directions of study in healthcare and information technology. There are many studies on AI-enabled healthcare activities, but there are few that specifically focus on AI-enabled healthcare. Future research on this topic will change the course of healthcare and enable providers to leverage cutting-edge technologies in the growth of their industry.

The process of data gathering, adoption problems, and technology integration for comprehending patients' requirements and behaviour for individualised healthcare services are also future study objectives for technology adoption and healthcare. Future studies will also concentrate on the economic, technological, and psychological elements of information technology adoption and implementation in healthcare in India. The same will, in turn, with commensurately improve with the growth of inclusion of technology in healthcare. Lastly, participative government programmes, supportive laws, and financial & technical assistance for the inclusion of new technology stack with respect to healthcare services are also necessary to encourage and promote the use of information technology in the healthcare industry.

6. Conclusion

Bibliometric analysis offers a unique opportunity to decipher potential information development, represent institutional collaborative strengths, citation patterns, and evaluations established through informed techniques and procedures.The current investigation is an attempt to analyse the evolving themes, research trends, and influential studies. The study data has been extracted from Scopus database for reviewthat contains the most biographies. Thiswork presentsavenues in the studydevelopmentand related sub-areasfor information technology in healthcare in India. Researchers may carry out research in the newly growing field that could give practitioners and policymakers better understanding. In this approach, the current study has helped to clarify the state of developing fields, and future research focus in the application of information technology to medical practise in India.

As the study was conducted using the information taken from the database provided by Scopus, the next study might be conducted using merged information gleaned from Scopus and the Web of Science's bibliographies. In the future, investigations may only focus on articles that are included

indexed in the SCI, the SSCI, and the ABDC lists in order to comprehend the research perspective that can be gleaned from these prestigious publications.

7. Suggestions of the research

The current research has a variety of implications for the academic community, policymakers, businesspeople and scholars. They ought to learn about the general studies that have been done in this field. They can use these papers to address the current issues in academia and policy making by being aware among the most significant donors to this field of study and the motivations behind it. Additionally, it would help them understand the limitations of the existing works and possible routes for impending study, which would greatly help them carry out future investigations. Additionally, the scholar will benefit from having their work published in high-impact journals.

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