

**EXPLORING THE CURRENT STATE OF RESEARCH: A BIBLIOMETRIC
ANALYSIS OF BLOCKCHAIN IN LAND REGISTRY****Ankita Goyal**

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In this era of rapidly changing technology and evolving new applications of existing technologies, the application of blockchain technology in land registration is a new topic of interest. This application is fairly new, but it still has some available case studies across the world. The number of publications in the field is currently limited but it is becoming increasingly popular in the research domain. A detailed bibliometric analysis is being conducted in this paper to give future researchers a head start in the field and provide an overview of the current state of research to all researchers. Data was gathered from the SCOPUS database using keywords Blockchain and land registry. This data was then analysed using the Biblioshiny app through the Bibliometrix package of R Studio software. Based on the existing literature, using the software, the most relevant authors, affiliations and sources of publication were identified. The trend of publication of top countries over the years has also been depicted. A Sankey plot has been made to summarise the relationship amongst the top authors, top author keywords and top author

countries. Source clustering has been done through Bradford's law to identify the core sources of production. Thematic evolution in the field of research, word cloud and country collaboration map are also depicted in the paper to get more insight into the current state of research and direction. This paper intends to create better insight into the topic of land registry and blockchain and provide direction to researchers in the field.

Keywords: Blockchain, Land registry, Bibliometric, Biblioshiny

1. Introduction

Blockchain technology is a ground-breaking idea that has swept the world. It is a decentralised, incorruptible ledger system that has the power to revolutionise a number of markets, including banking, healthcare, and real estate. Blockchain, put simply, is a digital database that holds data in cryptographically linked blocks. There is no way to change or tamper with any of the data included in a block since each block has a special code, or hash, which is unique.

The security and transparency of blockchain are what make it so beautiful. Each block has its own distinctive coding, resulting in an unbreakable chain of data blocks that can be relied upon by all parties. This indicates that business deals can be closed without the need for traditional middlemen like banks or governments. Furthermore, because it allows users to authorise access to others on their terms, blockchain technology gives people more control over their personal data.

Blockchain technology is revolutionising how we store information and conduct transactions. Blockchain technology has some of the most potential uses in the land registration industry, where it may be applied to enable safe and transparent ownership transfers. (Anandan et al. 2020) Governments can establish a decentralised, immutable, and verifiable land register by utilising blockchain technology. (Karthika and Jaganathan 2019)

Scholars and academics have given the application of blockchain in land registration a lot of attention, and bibliometric analysis reveals that there is a growing body of literature on the subject. In fact, numerous studies have revealed that over the past few years, the number of research publications relating to blockchain-based land register has grown significantly. (Singh and Vardhan 2019) This suggests that there is rising interest in learning how blockchain technology might be applied to enhance land management systems all across the world.

Blockchain is the technology on which the crypto currency Bitcoin and its likes are based. (Sarpong 2022) Blockchain as used in Bitcoin is a public ledger that shares all transaction data with all the participating nodes on the network. (Niranjanamurthy, Nithya, and Jagannatha 2019) Blockchain links events and transactions through a peer to peer approach in such a way that makes the records immutable. (Dennis, Owenson, and Aziz 2016) Blockchain is a distributed computing and decentralized architecture that offers advantages like time series data and decentralization to its users. A ledger of recorded transactions which is shared by a network of participants is a simple way to define Blockchain. (Fu and Fang 2016) Blockchain eliminates the need of a central trusted third party to control the system. It thus eliminates the risk of manipulation of system by the controlling node and it also removes the possibility of failure of

system due to a single point of failure. The main advantages of using Blockchain include integrity, transparency, data immutability, non-repudiation of transactions and fair access to the participating nodes. (Xu et al. 2017)

Use cases of Blockchain are being researched upon in a number of fields including smart contracts, healthcare and supply chain.(Ahram et al. 2017) Applications of Blockchain are being explored by various governments, start-ups and enterprises in the other fields like voting, energy supply, civil infrastructure protection, banking and management of ownership.(Lutete et al. 2021) The rapid evolution of the Blockchain ecosystem can be credited with the diversity of interest in the technology.(Xu et al. 2017)

The transactions are permitted to occur in a decentralized manner through Blockchain working as an immutable ledger. By using Blockchain in the land registry process to store the data related to land one can remove the possibilities of falsification and manipulation of data. The immutable nature of blockchain will provide authenticity to the data. The records will then become verifiable by any user from the web. The implementation will give public access to records simultaneously eliminating the need for intermediaries.(Yadav and Kushwaha 2021)

In the Scopus database when searching for word Blockchain for the time period of 2016 to 2022 we received 34312 documents. Within the same time period searching for keywords Blockchain and Application gave back 12075 documents. Narrowing the search down to keywords Blockchain and land in the same time frame gave us 259 documents. For the purpose of this study we further narrowed down the search to keywords Blockchain and land registry which gave us 74 documents. This was done to gather data of documents which deal with both land registry and blockchain. To conduct a bibliometric analysis on this data, Biblioshiny app (Aria and Cuccurullo 2017)has been used through R studio software. Detailed research methodology is given in the next section of the paper followed by analysis, conclusion and limitations in the further sections of this paper.

2. Literature Review

Blockchain technology is a distributed ledger system that eliminates the need for middlemen to conduct secure and transparent transactions. (Swan 2015)On a network of computers, it is a decentralised database that keeps track of each transaction. Each transaction is validated by a number of parties before being put to the ledger as a "block" once it has been accepted. Some of the main characteristics of blockchain technology are as follows:

- i. Decentralization: The decentralisation of blockchain technology is one of its key characteristics. Blockchain technology is dispersed among numerous nodes, in contrast to conventional systems where a single entity is in charge of all transactions. This raises the system's security and transparency by making it difficult for any one individual or group to control it.
- ii. Transparency: A feature of blockchain technology is the fact that every transaction is logged and made publicly available to everyone on the network. This indicates that everyone has access to the ledger and can examine all of the transactions that have occurred. This degree of openness can aid in reducing fraud and boosting trust in the system.

- iii. **Security:** The decentralised structure of blockchain technology and the use of cryptographic methods to safeguard transactions are the foundations for its security. A cryptographic hash function is used to safeguard each block in the chain, making it nearly impossible to modify or tamper with the contents. Furthermore, using public and private keys in transactions reduces the likelihood of illegal access.
- iv. **Immutability:** A transaction that has been added to the blockchain cannot be changed or removed after it has been recorded. This is because a cryptographic hash function is used to link each block in the chain to the one before it, resulting in an immutable record of all transactions.
- v. **Smart contracts:** Self-executing contracts that are kept on the blockchain are known as smart contracts. They are an effective tool for automating complex transactions because they can be configured to run automatically when specific circumstances are satisfied.

Just a handful of the main characteristics of blockchain technology are listed above. Blockchain technology has the potential to revolutionise a variety of industries, from finance and banking to healthcare and supply chain management, due to its decentralised and transparent nature.

Due to its capacity to offer safe, open, and decentralized transactions, blockchain technology offers a wide range of use cases across numerous industries. Here are a few real-world examples of its applications:

- i. **Financial Services:** Blockchain can be used to simplify and lower the cost of financial transactions. By doing away with middlemen and offering a tamper-proof record of transactions, it can also increase security. For instance, Santander settled a \$20 million bond deal using blockchain technology, and JPMorgan Chase uses it for interbank payments.(Allison 2019; Morgan 2021)
- ii. **Supply Chain Management:** By creating a permanent, tamper-proof record of each stage in the supply chain, blockchain can increase supply chain transparency and traceability. Fraud can be avoided, waste can be decreased, and productivity can be increased. For instance, Walmart and IBM have partnered to use blockchain to track the sourcing of food.(Gagliardi 2018)
- iii. **Healthcare:** Blockchain can assist in securing and streamlining the management of healthcare data, including clinical trial data and electronic health records (EHRs). This can improve patient results, increase privacy, and lower expenses. To trace medicine supply chains, for instance, the US Food and Drug Administration (FDA) has started a pilot study to investigate the usage of blockchain.(Musiala Jr. 2019)
- iv. **Real estate:** By removing middlemen and lowering fraud, blockchain can facilitate quicker and more secure real estate transactions. Also, it can lower expenses and increase transparency. One blockchain-based network for real estate transactions has been successfully tested by the Swedish Land Register, for instance.(Chavez-Dreyfuss 2016)
- v. **Voting:** By producing a tamper-proof record of votes, blockchain can improve the security and transparency of voting systems. This could aid in reducing fraud and boosting voter

confidence. For instance, in a pilot project to enable overseas military personnel to participate in the 2020 US presidential election, the West Virginia Secretary of State's office deployed blockchain technology.(Nguyen 2018)

Blockchain technology can be applied to land registration to offer a transparent and secure way to record and transfer land ownership.(Garcia-Teruel 2020; Khalid et al. 2022; Yarlagadda and Gampala 2020) Following are some examples of how blockchain is being used in land registration:

- i. Immutable record-keeping: Land ownership can be recorded in an immutable manner using blockchain technology. A record that has been added to the blockchain cannot be changed or removed, making it more difficult for fraud to take place.
- ii. Efficiency improvement: By removing the need for middlemen like attorneys, real estate agents, and government employees, blockchain can assist in streamlining the land registration process. This may speed up and cut down on the expense of land deals.
- iii. Fraud prevention: The use of blockchain makes it more difficult for fraudulent acts like identity theft, double spending, and data manipulation to take place. This is so that only authorised parties may access the data, which is ensured by the blockchain's use of cryptography and consensus techniques to validate transactions.
- iv. Ownership verification: By offering a permanent, tamper-proof record of ownership, blockchain can assist in confirming the legitimacy of land ownership documents. This can diminish disputes and increase land ownership assurance.
- v. Cross-border transactions: By doing away with middlemen and lowering transaction costs, blockchain can make cross-border transactions easier. The effectiveness of international land deals may be improved as a result.

3. Research Methodology

To gather an understanding of the current state of research in the field of land registry using blockchain a bibliometric analysis is being conducted. To conduct the bibliometric analysis Biblioshiny app(Aria and Cuccurullo 2017)through R-Studio has been used in this study. Biblioshiny is a web-base app which is developed in the Shiny environment and is included in the Bibliometrix package of R. Bibliometrix is an open source tool used to study scientific literature by doing comprehensive mapping analysis. The bibliometrix package is being preferred over other tools of bibliometric analysis because it has the versatility of integrating and upgrading swiftly with the rapidly changing science.

Data has been collected from Scopus database. For this study search for documents was conducted using keywords Blockchain and Land Registry. The time period of the study is 2016-2022. The earliest use of Blockchain was in 2008 in the White paper.(Nakamoto 2008)As per Scopus database the earliest document for blockchain and land registry is available of 2016.The search returned 74 documents for the above keywords. The bibtex file containing this data was then analysed using the Biblioshiny app.

4. Analysis

This study is conducted on 74 documents obtained from search of Scopus database. An overview of data of study can be seen in the tables 1 & 2 below.



Table

1: Overview

Publication has seen an annual growth rate of 44.22% over the 8 years from 2016-2022. Total authors in this extracted database are 179 with an average 2.92 co-authors per paper. Co-authorship by authors from different countries accounts to 20.27% of the total publications of this dataset. A total 2517 references are listed in these 74 documents. Average age of documents is 1.86 years and the average citations per document are 11.36.

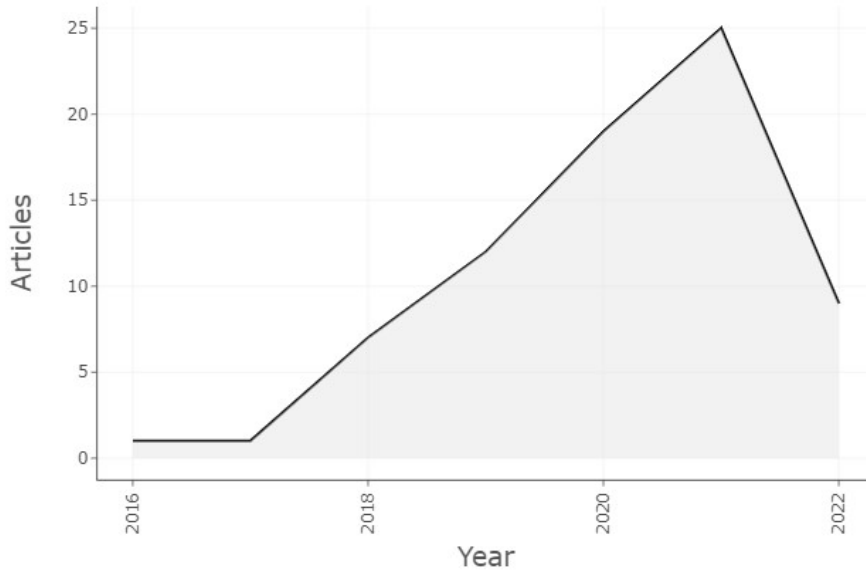
Description	Results
Document contents	
hKeywords Plus (ID)	357
Author's Keywords (DE)	193
AUTHORS COLLABORATION	
Single-authored docs	18
Co-Authors per Doc	2.92
International co-authorships %	20.27
DOCUMENT TYPES	
Article	27
Book	1
book chapter	3
conference paper	38
conference review	2
Review	3

Table 2- Overview

The above table divides the publications into document types. As it is can be seen Articles and Conference papers constitute the largest proportion of the lot. 357 keywords plus and 193

author’s keywords have been identified from the documents which will be later used to generate word cloud and thematic evolution map for the research topic.

4.1 Year as a Unit of Analysis- Annual growth rate of publications is 44.22%. The number of articles published in different years can be seen in the Plot 1 below. The plot shows the compound annual growth rate (geometric progression ratio) of scientific production providing a steady rate over the years. (Bibliometrix) We can see a steady increase in the number of publications over the years. A decline is seen in the current year of 2022 but that can be attributed to the unavailable data for the remaining half of the year.



Plot 1- Annual Scientific Production

In the initial years 2016-2017 there was only 1 publication per year on the specified keywords. In the last year 2021 as many as 25 publications were there on the topic.

4.2 Citation as a Unit of Analysis- Taking the citations received per document as the unit of analysis we have analysed two parameters namely Average citation per year and Most Global cited documents. The average citation per year gives us the mean number of citations received by articles published in different years from 2016 to 2022. The articles published in 2016 have the highest number of citable years with the most citations. The most globally cited documents are Lemieux, 2016 and Kshetri, 2017.

4.2.1 Average Citation per year for the documents in the dataset with the number of articles published in that particular year gives an insight on the citation trends. The following Table-3 depicts the citation trends for articles for different years from 2016 to 2022.

Year	N	MeanTCperArt	MeanTCperYear	CitableYears
2016	1	242.00	40.33	6
2017	1	109.00	21.80	5
2018	7	19.43	4.86	4

2019	12	10.33	3.44	3
2020	19	9.16	4.58	2
2021	25	1.80	1.80	1
2022	9	1.22		0

Table 3- Average citation per year

Mean total citation per year for the publication of 2016 is the highest at 40.33 with 6 citable years. For 2021 the mean total citation per year is 1.80.

Paper	DOI	Total Citations	TC per Year	Normalized TC
Lemieux VL, 2016, Rec Manage J	10.1108/RMJ-12-2015-0042	242	34.57	1.00
Kshetri N, 2017, Third World Q	10.1080/01436597.2017.1298438	109	18.17	1.00
Thakur V, 2020, Int J Inf Manage	10.1016/j.ijinfomgt.2019.04.013	74	24.67	8.08
Tran Ab, 2018, Ceur Workshop Proc	NA	39	7.80	2.01
Chakraborty P, 2018, IntSympEmpirSoftwEngMeas	10.1145/3239235.3240298	27	5.40	1.39
Bosu A, 2019, Empir Software Eng	10.1007/s10664-019-09708-7	24	6.00	2.32
Shuaib M, 2020, TelkomnikaTelecomunComptElectr Control	10.12928/TELKOMNIKA.v18i5.15787	20	6.67	2.18
Benbunan-Fich R, 2018, IntConfInfSyst , Icis	NA	19	3.80	0.98
Garcia-Teruel Rm, 2020, J Prop , Plan Environ Law	10.1108/JPEL-07-2019-0039	16	5.33	1.75
Nasarre-Aznar S, 2018, Administration	10.2478/admin-2018-0018	16	3.20	0.82

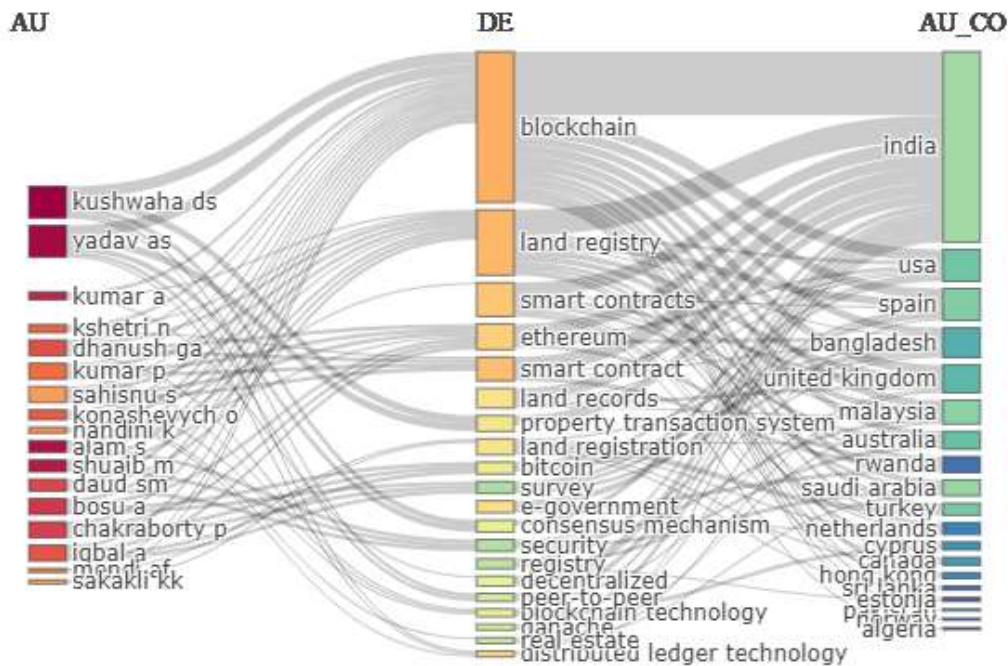
4.2.2 Most Global Cited documents- The most cited document globally from the SCOPUS database was identified as VL Lemieux’s 2016 article in Records Management Journal. The article named “Trusting records: is Blockchain technology the answer?” has been cited a total of 242 times with its Total citations per year being 34.57. This article is followed by N. Kshetri’s 2017 article published in the Third World Quarterly journal with 109 citations. The Table-4 below shows top 10 most cited documents globally.

Table 4- Most Global Cited documents

4.3 Author keyword as the focus of analysis using a Three-field Plot - A three field plot is made using three fields namely, author, author country and keyword. A relation between top authors, top author’s keywords and top author’s country of affiliation is summarized here using a Sankey plot. Here the focus is on the top keywords used by authors and its relation with the other two categories.



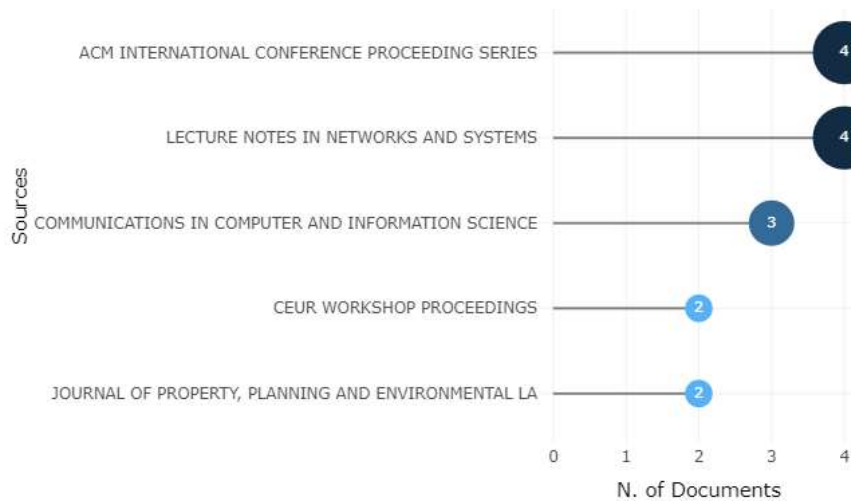
The resultant Plot 2 can be seen below.



Plot 2- Three field plot with Author, Keywords and Author Country

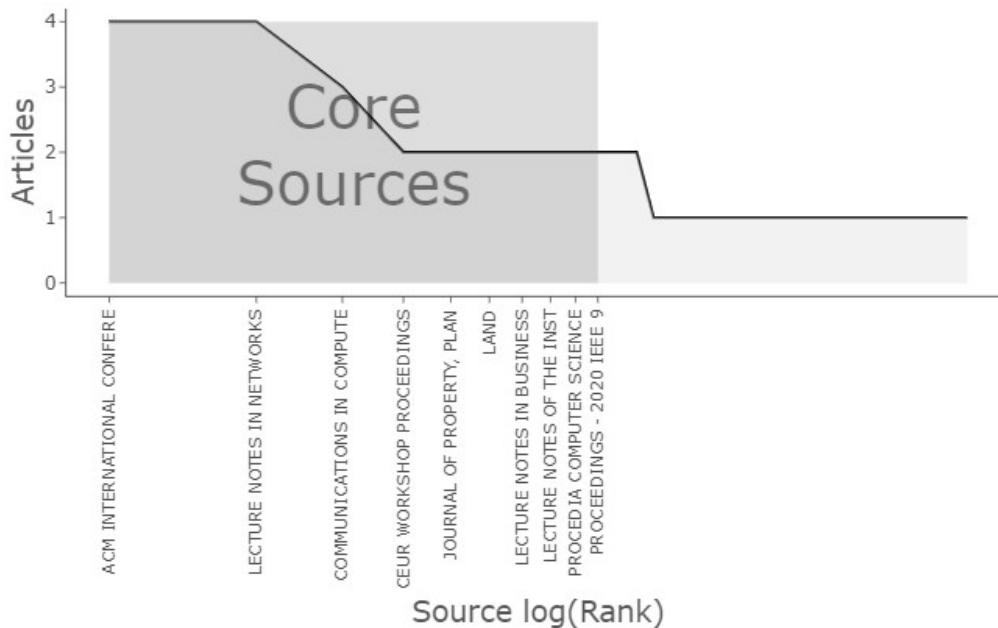
4.4 Source as a Unit of Analysis- Taking the source of document as a unit of analysis we are analysing two aspects namely most relevant sources and core sources of publication. The most relevant sources are the ones from which most documents are recovered in this search. Core sources of publication have been identified through source clustering using Bradford’s law.

4.4.1 Most Relevant Sources-The top 5 sources of research publications in the field can be seen in the Plot 3 below. The top 2 sources with maximum publications were identified as ACM International Conference proceeding series and Lecture notes in networks and systems with 4 publications each. There are a total of 57 sources in this collection which include journals, books and conference papers etc. which published one or more documents in this collection.



Plot 3- Most Relevant sources of publication

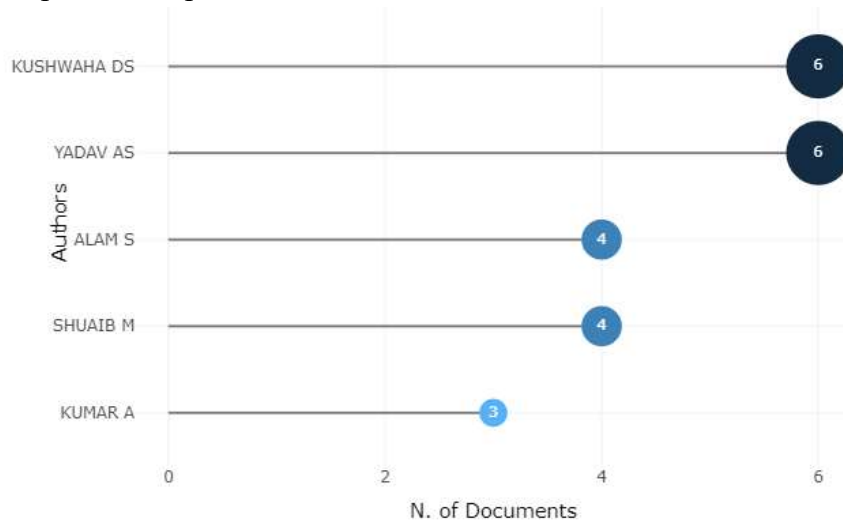
4.4.2 Core sources of publication- By doing source clustering through Bradford’s law; the core sources of publications were identified. Through Bradford’s law we can identify the core journals or other sources which publish the most articles in this specific subject. Here 10 out of 57 sources constitute the core sources. These can be seen in the Plot 4 below.



Plot 4- Source clustering through Bradford's Law

4.5 Authors as a Unit of Analysis- Taking the author of document as the unit of analysis, two parameters have been taken into consideration. First being the most relevant authors and second being the most relevant author affiliations. Most relevant authors can be understood as the top published authors in the field in the database under consideration. Most relevant author affiliations refer to the universities or educational institutions from which the most publications have come. These can be regarded

4.5.1 Most Relevant authors- The top 5 authors of research publications in the field can be seen in the Plot 5 below. These have been identified based on the number of documents authored by the author. Kushwaha DS and Yadav AS are the most published authors in the field with 6 documents each as per the Scopus database.



Plot 5- Most Relevant Authors

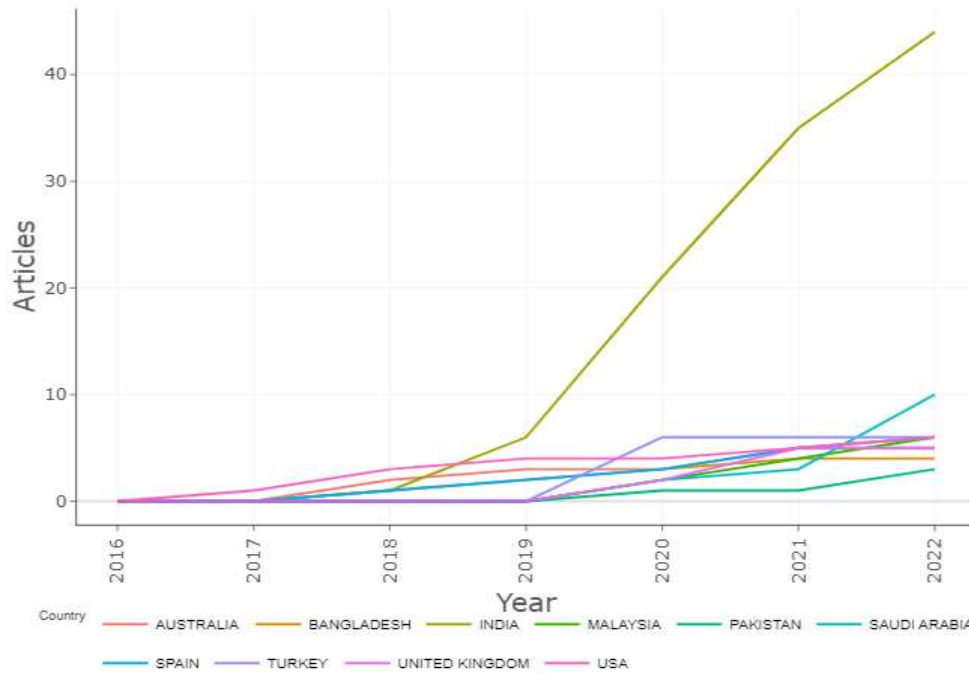
4.5.2 Most Relevant Author Affiliations- The most relevant affiliations can be seen in the Plot 6 below. Motilal Nehru National Institute of Technology, Allahabad can be seen as the most relevant affiliation with 5 articles followed by Jazan University at the second spot with 4 articles. Upon careful observation it was found out that in this list of affiliations two of the affiliations refer to the same organization. Department of Computer Science and Engineering having two publications is a department under the top affiliate Motilal Nehru national institute of technology, Allahabad. So they may be considered as one affiliation having 7 publications.



Plot 6- Most Relevant Affiliations

4.6 Country’s production as a Unit of Analysis with respect to time- The following Plot-7 depicts production of publications from top 10 countries over the years 2016 to 2022. We can see an increasing trend for most countries over the time. For India particularly we can see a steep incline in the number of articles published every year in the past few years. Other countries like

USA, Malaysia and Saudi Arabia also show a steady increasing trend in the number of articles published in a year.



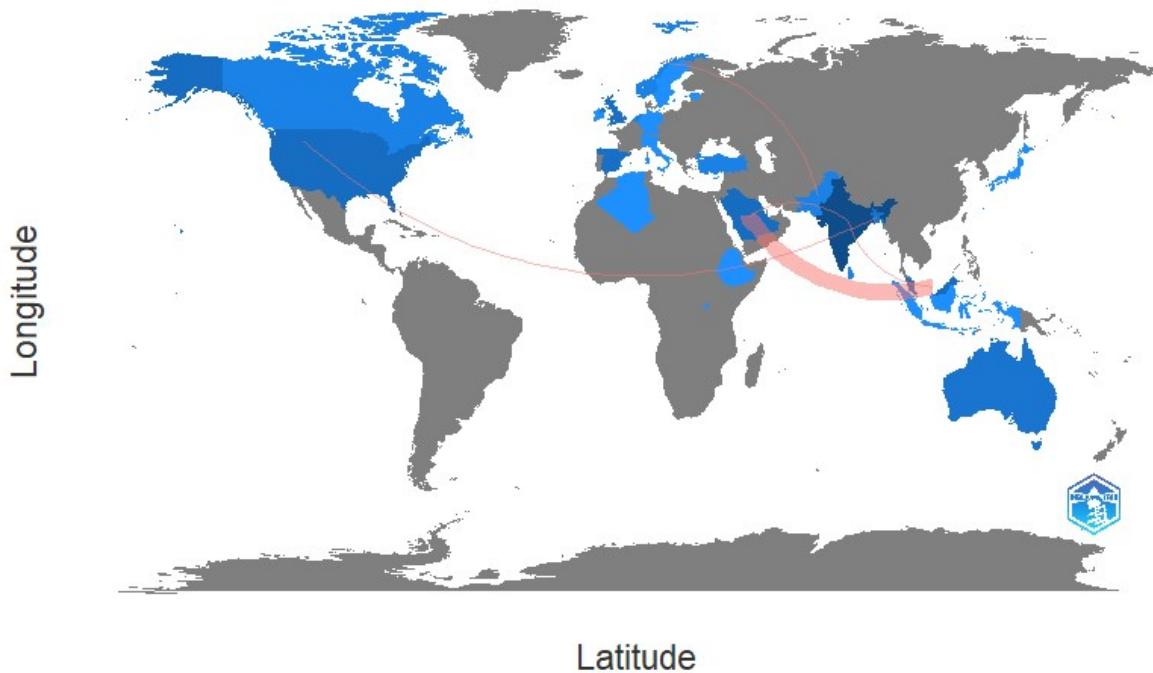
Plot 7- Most Relevant Countries

4.7 Words as a Unit of Analysis- The words which are frequently occurring in this collection of articles can be seen in the word cloud in Plot 8 below. Word cloud is a representation of the text data in a visual form.

The bigger the font size means higher the frequency of occurrence of the word. This word cloud gives us an overview of the related topics and the direction of current research. This word cloud has been generated using keyword plus and it is useful in quickly locating the most prominent terms in the research.

4.9. Collaboration world map

The Plot-10 below shows how authors from different countries collaborate to generate scientific production in the field. The tone of the colour defines the strength of the relations among countries authors based on their collaboration data.



Plot 10- Collaboration world map

5. Conclusion

This study was conducted using the Biblioshiny app through R Studio software. R Studio is open-source software, thus easily accessible to the scientific community. The Scopus database has been used to gather the data for publications. Multiple databases could not be used in the study because it is not currently possible for the software to handle data from different databases consecutively. The study reveals the annual growth rate of production to be 44.22%.

Lemieux (2016) and Kshetri (2017) are the most cited globally. The most popular sources of publications are the ACM International Conference proceeding series and lecture notes in networks and systems. As per the Scopus database, the most published authors in the field were identified as Kushwaha DS and Yadav AS, with six publications each. The most relevant author affiliation is Motilal Nehru National Institute of Technology, Allahabad, with seven publications in the field.

As for the country's production over time, we can say countries like India, the USA, Malaysia, and Saudi Arabia has been increasingly participating in research in this field. In the collaboration

world map, we can see which parts of the world are actively participating in research work and the cross-country collaborations among researchers.

The thematic evolution map shows how the focus was initially on the word blockchain in the research community and how it has shifted to different strengths and applications of the technology like peer-to-peer networks, registration processes, etc. This paper has given a detailed summary of the current state of research in the fields of blockchain and land registry. It is capable of giving insights about the authors and institutions to look out for in the field. It also highlights the countries working in this field and the related keywords being worked on.

6. Limitations and Further Study-

The implementation of blockchain-based land registries is not without risks, despite the potential rewards. Making sure that all parties can use and access the technology effectively is a significant problem.

This study was conducted using the SCOPUS database to gather data on scientific production. This gives us a limitation and also a topic for further study. Further studies can be conducted using one or more of the other databases like Google Scholar, Web of Science, IEEE Xplore, etc. Using multiple databases at a time is a difficult task because of the limitations of software. The data imported from the different databases is very different from each other in terms of both string format and content. Hence, merging them for the purpose of conducting a bibliometric analysis is not currently possible.

7. Conflict of Interests

There are no relevant financial or non financial conflicts of interests to report. No specific funding has been received for this work.

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