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Blockchain-based Healthcare Portal – A Bibliometric Analysis

Aditi Goyal
Symbiosis International University, aditi.goyal.btech2018@sitpune.edu.in

Aditya Banerjee
Symbiosis International University, aditya.banerjee.btech2018@sitpune.edu.in

Aniket Mulik
Symbiosis International University, aniket.mulik.btech2018@sitpune.edu.in

Yashika Chhabaria
Symbiosis International University, yashika.chhabaria.btech2018@sitpune.edu.in

Sonali Kothari Tidke Dr
Symbiosis International University, sonali.tidke@sitpune.edu.in

See next page for additional authors

Authors

Aditi Goyal, Aditya Banerjee, Aniket Mulik, Yashika Chhabaria, Sonali Kothari Tidke Dr, and Vijayshri Khedkar

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Aditi Goyal, Aditya Banerjee, Aniket Mulik, Yashika Chhabaria,
Dr. Sonali (Kothari) Tidke*, Prof. Vijayshri Khedkar
Symbiosis Institute of Technology, Pune
*sonali.tidke@sitpune.edu.in**

Abstract
User privacy has been a topmost priority and one such domain where this is neglected is the area of healthcare. Our solution focuses on the idea of using blockchain to provide a platform for healthcare experts and patients, giving patients full control over the data that will be shared. This paper focuses on identifying current research that has been conducted in this area in the form of a bibliometric analysis. A bibliometric study on a research area involves a detailed analysis of citations and papers across a domain of study. The purpose of this study is a statistical analysis of publications which is so complex that it is close to impossible to understand trends merely based on knowledge and experience. There are specific tools required to recognize these trends based on the bibliometric data. This paper will give an outlook on the areas of blockchain that were explored by various papers, the criteria and pattern followed by the combination of papers, and a cumulative statistical analysis of the papers that were fetched for the purpose of our study from the Scopus database. The most popular visualization software tool VOSviewer was taken into use.

Keywords: Bibliometric, Blockchain, Scopus database, VOSviewer, Maps, Healthcare, Statistical Analysis

1. Introduction

Looking at the second half of the 20th century and the initial years of the 21st century, we have witnessed various discoveries with the internet being the center of all. Taking a leap forward we have a new buzzword Blockchain. The area of blockchain is so versatile that it can be implemented in a wide variety of domains such as "applications of blockchain technologies for social media"[1] along with healthcare implementations such as "MedicoHealth"[4] which is a blockchain based healthcare portal achieving similar goals as ours, so much more. Many research papers suggested that "Researchers begin to adopt blockchain in healthcare area"[14]. We are aware that the concept of blockchain being implemented for use in the healthcare industry has already been explored to an extent. It "has recently received extensive attention from healthcare academicians and practitioners for several reasons" [11]. However, even after its implementation, there are issues such as "Data integrity issues through concerns of confidentiality and protection, Absence of unified data access to patient data"[4] and there is no visual use-case for the same. People are not aware of this, and this has not been done on a large-enough scale. These are the times when the largest platform for any technological implementation for a particular industry is the key phrase known as digital transformation. This phrase is used very casually when you read the news, stating 'so-&-so' company has invested 'this much' money to shift their processes to a digital platform. Thus, naturally the healthcare system should have a digital platform to function with full operability during these times of lack of physical clinic visits, which is also used by everyone. It is easier for countries like England, where there is one central public body for healthcare, the NHS, and it already has a very complex online platform as a portal for patients' initial interaction with their services. This brings us to our vision, with the added privacy feature as there is no central organization, but rather many different private healthcare institutions, which is where our implementation could bring them all together as we expand, potentially having a centralized portal for all initial contact with healthcare services, reducing privacy concerns and recommending the

patients get the best care they need. This has already been implemented to a very promising scale in Estonia, which gives us validation for our work, with the only difference being the implementation for all private and public healthcare services, and catering the patients specifically according to their needs, almost like a social media for healthcare services. With this brief about our project, let us now talk about the bibliography.

There has been a lot of research in this domain and the literature on its use cases has definitely grown over recent years. It's impact in the healthcare industry is fairly new compared to others, but rising, nonetheless. Blockchain has been discussed in terms of healthcare immensely over the last five years [17], "The evolution of blockchain technology and its application in diverse contexts has occurred in various phases"[3] yet there are not enough proper bibliometric studies that discuss the focal point of the Blockchain Technology and the healthcare industry. Therefore, the aim of this study is to carry out several bibliometric analyses on the scientific research conducted in the field of blockchain and its connection to healthcare. The dataset consisting of scientific articles published between 2016 and 2020 was downloaded from the Scopus database and was analysed using certain bibliometric statistics. In addition to this, an overview of the publication trends over the first three months of 2021 was undertaken to understand the research trend for the current year so far [12]. With the added analytical operations performed on the fetched dataset, various important inferences were made, which will be discussed in more detail throughout the document.

2. Literature Review

As discussed in the introduction, our study's relevance and validity is strong, and to support the claim, the table in the next page reviews 10 recent publications surrounding our topic of study, which is essentially Blockchain applications.

Sr. no.	Author(s)	Journal/Year	Title	Methodology	Key Findings
1	Alexander Pfeiffer, Simone Kriglstein, Thomas Wembacher, Stephan Bezzin	Academic Conferences and Publishing International Limited (ACPIL), July 2020	Blockchain Technologies and Social Media: A Snapshot	The paper focused on collecting data to justify their hypothesis about a potential social media-based application for blockchain technology. The data collection methodology is irrelevant to our work.	Along with functionalities of social media that majority of the people use and how blockchain can have the potential to implement that, it talks about the necessity to consider "applications of blockchain technologies for social media"[1]. This significantly supports the idea we are planning to implement, essentially a social media-like platform for healthcare services.
2	Renita M. Murimi	Ledger Journal April 2019	A Blockchain Enhanced Framework for Social Networking	The paper has proposed an idea that involves generating cryptocurrency as a reward system for user activity on a social media that is based on blockchain itself. The frame proposed will do so, with a	The framework mentioned, BEV-SNS, is very much possible to implement, and with slight manipulation, we can potentially remove the reward system completely, avoiding all the disadvantages of the idea proposed by the paper. The paper also highlights the same point that we want to focus on, which is that "the inherent

				number of limitations involving bots and AI-generated actions, misusing the reward system.	architecture of blockchains ensures that the user can experience a secure, trusted, and rewarding networking experience."[2]
3	Anushree Tandon, Amandeep Dhir, A.K.M. Najmul Islam, Matti Mäntymäki	Computers in Industry, November 2020	Blockchain in healthcare: A systematic literature review, synthesizing framework and future research agenda	This paper is an SLR, also known as a Systematic Literature Review, and it is done for papers involving the study of blockchain applications in the healthcare industry. The methodology of the paper is a standard review method for over 42 well-tested and verified papers.	The paper helps a lot in validating our project and guiding the possible path for a successful implementation. It talks about several concepts derived from the many papers reviewed, each pointing towards the next stage of blockchain applications' evolution. The concepts focus on key blockchain properties, such as data protection, predictive algorithms, and increased storage for increased client concentration. It has also talked about the constraints involving such projects, for example the cost of maintenance and implementation, the performance limitation, and the difficulty in attracting a social presence.
4	Maria Prokofieva, Shah Jahan Miah	Australasian Journal of Information Systems, July 2019	Blockchain in healthcare	This paper is also another literature review paper, reviewing over 200 papers, and simplifying them into generic problems within the healthcare domain and how blockchain solutions have resulted helped resolve the issues in some form or another.	Two of the main problems the paper has explored are "Absence of unified data access to patient data"[4] and "Data integrity issues through concerns of confidentiality and protection"[4]. The respective solutions were "Data storage and exchange"[4] and "Integration of encryption of digital assets"[4]. This is exactly what we will also be working towards achieving, taking an example from "MedicoHealth"[4], an application that has implemented what we

					want to achieve to a very successful scale. Our application will be very similar to "MedicoHealth"[4], however, it will be localised for our location with data relevant to local/national use, i.e., for Indian healthcare system.
5	Asma Khatoon	Electronics Special Issue - Advances in Blockchain and Distributed Ledger Technology (DLT) for Industry 4.0 Technologies, January 2020	A Blockchain-Based Smart Contract System for Healthcare Management	The paper explores the Ethereum blockchain and how its mechanisms relate to solving the various healthcare issues faced otherwise. After reviewing several papers, it specified particular methods of addressing the common problems where blockchain can improve the system as a whole.	One of the key areas they explored was "enabling effective communication between patients and service providers"[5], and how Ethereum smart contracts can define the rules of request, communication, and data access through the blockchain. Since we would be using Ethereum for our project, this find is very-much relevant to our project as we aim to achieve the same result.
6	Yinsheng Li	Service Oriented Computing and Applications, November 2019	Emerging blockchain-based applications and techniques	In this paper, the history of blockchain applications and the respective domains are analysed, resulting in a set of areas where blockchain technology has been implemented, with a lot of potential still to be explored.	The paper talks about "blockchain for public services"[6] as a viable area for further innovation and progress, something we aim to do with our project. This validates our idea and allows the work to not be questioned and in turn deems the project to be feasible.
7	Bhabendu Kumar Mohanta, Debasish Jena,	Internet of Things, December 2019	Blockchain technology: A survey on applications and security	Another paper that focuses on the various applications of blockchain,	A number of applications have been discussed here with respect to the healthcare industry. All of those applications,

	Soumyashree S Panda, Srichandan Sobhanayak		privacy Challenges	listing a number of applications across multiple industries which have already been successfully implemented, all of which have been done in India.	implemented specifically in India, have achieved various aspects of potential benefits of a blockchain application. However, none of them have done so at a scale as complete as ours. "Main focus of the survey is to provide a comprehensive analysis on wide applications of Blockchain technology for the academic research community"[7]. We plan to implement a lot more aspects of a blockchain into the healthcare portal, allowing for a more complete experience for all stakeholders.
8	Kawtar Najmani, Benlahmar El Habib, Nawal Sael, Ahmed Zellou	Big Data and Internet of Things, October 2019	A Comparative Study on Recommender Systems Approaches	The paper explores the various approaches to a recommendation system, analyses the existing popular recommendation systems residing within well-known platforms, and how each has its own set of advantages and disadvantages.	Our web application will involve a recommendation system that allows the patients to get tailored results of the doctors and treatments the patient should look to apply for. Thus, the paper allowed us to analyse and pinpoint the possible approaches for the recommendation system. Two of those systems are "collaborative filtering"[8] and "hybrid filtering"[8], which we will be considering for our project.
9	Elena Laurenza, Michele Quintano, Francesco Schiavone, Demetris Vrontis	Business Process Management Journal, September 2018	The effect of digital technologies adoption in healthcare industry: a case based analysis	This paper follows the method of reviewing and analysing case studies that revolve around digitising the healthcare industry. It showcases each of the cases in a fundamental scale, allowing for easier	A case study titled "BPM improvements in MSD Italy"[9] was analysed within the paper. The result of the analysis was a simple but highly informative "healthcare workflow"[9] diagram, showcasing the flow of processes for any digital platform incorporating a healthcare service. This can be a blueprint for the flow of services we would like to provide through

				understanding and relatability.	our system.
10	Tanja Koch, Charlene Gerber, Mias De Klerk	SA Journal of Human Resource Management, May 2018	The impact of social media on recruitment: Are you LinkedIn?	The methodology of research used in this paper was the exploratory research. This involves the analysis of several social media platforms and it impacted the respective industry of study, which in this case is recruitment.	The main topic of the paper is very much different to what our domain is. "The use of social media is growing daily and its use in the recruitment process seems to have grown exponentially"[10] However, this resulted in the study of the potential impact of social media on healthcare, and how we can support the claim of a successful implementation by looking at a similar project used for recruitment, which covers the customers' need for a catered service, which, as of now, is missing for healthcare.

Review Table 1: A table containing a elementary review of 10 publications related to our field

3. Methodology

For this section, we will be focusing on the approach and methodology we undertook to fulfil the aim of the document, being the bibliometric analysis. This has been broadly divided into two subsections, namely 'Data Collecting Strategy', and 'Bibliometric Maps'.

1. Data Collecting Strategy

"Bibliometric analysis is a study related to the field of library and information sciences which investigates bibliographic content by employing quantitative techniques" [12]. The concept of bibliometric analysis was introduced around 1969 [12]. Due to lack of modern communication and information technology the analysis of these bibliometric studies had to be done manually. The evolution of information and communication technology has made this process of data collection and analysis of this data more efficient.

Bibliometric investigation study is a statistical technique that is used to determine research trends over a period of time, this data can also be used to extract specific information about specific trends. Bibliometric analysis also provides different methodologies to visualize the collected data in an integrated manner. Analysis of previous studies, development of the studies and the time period assists the researchers to evaluate the status of the research. These characteristics have encouraged the use of bibliometric analysis.

We have used Scopus to extract the bibliometric data. Scopus is Elsevier's largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings, with over 36,377 titles from 11,678 publications. "Delivering a comprehensive overview of the world's research output in the fields of science, technology, medicine, social sciences, and arts and humanities, Scopus features smart tools to track, analyze and visualize research" [15]. Scopus allows us to access and export different research documents from different publications. Scopus also has a query search feature through which one could get documents related to the specific query. Our first query was very straight forward, we searched for papers which involve blockchain and healthcare. The query was as follows: TITLE-ABS-KEY (

blockchain AND healthcare)

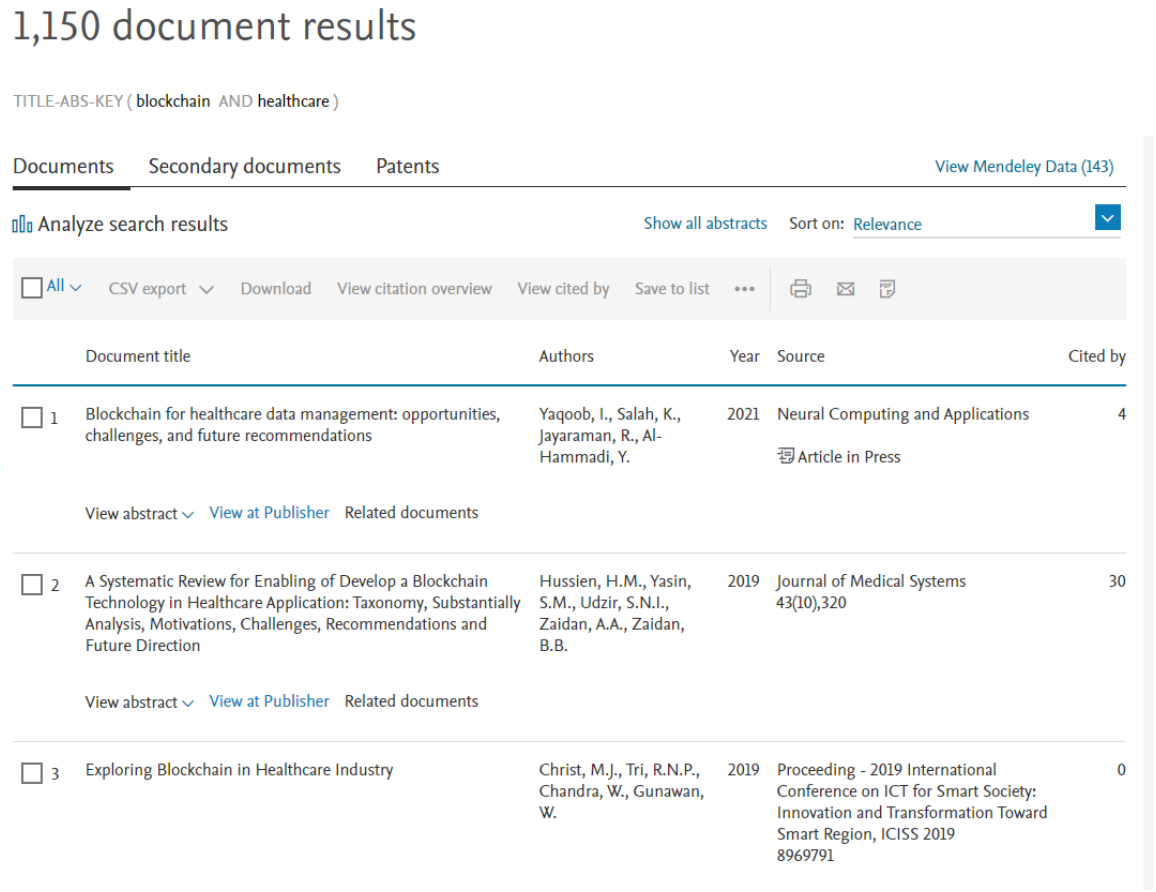

Figure 1 Dataset Result after First Query

The area of interest for our project is blockchain application in healthcare, by filtering the old query with unwanted topics one by one, scopus provides us with the list of all keywords related to the topic we searched, we can exclude these unwanted keywords and subject areas. The final query after finishing the filtering process our query was as follows :

TITLE-ABS-KEY (blockchain AND healthcare) AND (LIMIT-TO (SUBJAREA , "COMP")) AND (LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "MEDI") OR LIMIT-TO (SUBJAREA , "HEAL")) AND (EXCLUDE (EXACTKEYWORD , "Hospital Data Processing") OR EXCLUDE (EXACTKEYWORD , "Human") OR EXCLUDE (EXACTKEYWORD , "Automation") OR EXCLUDE (EXACTKEYWORD , "Decision Making") OR EXCLUDE (EXACTKEYWORD , "Consensus Algorithms") OR EXCLUDE (EXACTKEYWORD , "Fog Computing") OR EXCLUDE (EXACTKEYWORD , "Architecture") OR EXCLUDE (EXACTKEYWORD , "Mobile Telecommunication Systems") OR EXCLUDE (EXACTKEYWORD , "Proposed Architectures") OR EXCLUDE (EXACTKEYWORD , "Smart City") OR EXCLUDE (EXACTKEYWORD , "Green Computing") OR EXCLUDE (EXACTKEYWORD , "Insurance Companies") OR EXCLUDE (EXACTKEYWORD , "Remote Patient Monitoring") OR EXCLUDE (EXACTKEYWORD , "Scalability") OR EXCLUDE (EXACTKEYWORD , "COVID-19") OR EXCLUDE (EXACTKEYWORD , "Wearable Technology") OR EXCLUDE (EXACTKEYWORD , "Computer Architecture") OR EXCLUDE (EXACTKEYWORD , "Energy Utilization") OR EXCLUDE (EXACTKEYWORD , "Industry 4.0") OR EXCLUDE (EXACTKEYWORD , "Insurance") OR EXCLUDE (EXACTKEYWORD , "Supply Chain") OR EXCLUDE (EXACTKEYWORD , "5G Mobile Communication Systems") OR EXCLUDE (EXACTKEYWORD , "Adult") OR EXCLUDE (EXACTKEYWORD , "Agricultural Robots") OR EXCLUDE (EXACTKEYWORD , "Crime") OR EXCLUDE (EXACTKEYWORD , "Different Domains") OR EXCLUDE (EXACTKEYWORD , "Health

Risks") OR EXCLUDE (EXACTKEYWORD , "Hyperledger Fabric") OR EXCLUDE (EXACTKEYWORD , "Information Services") OR EXCLUDE (EXACTKEYWORD , "Integrity") OR EXCLUDE (EXACTKEYWORD , "Medical Imaging")) AND (EXCLUDE (SUBJAREA , "MATE") OR EXCLUDE (SUBJAREA , "SOCI") OR EXCLUDE (SUBJAREA , "PHYS") OR EXCLUDE (SUBJAREA , "ENER") OR EXCLUDE (SUBJAREA , "BUSI") OR EXCLUDE (SUBJAREA , "ENVI") OR EXCLUDE (SUBJAREA , "CENG") OR EXCLUDE (SUBJAREA , "ECON")) AND (EXCLUDE (EXACTKEYWORD , "Developing Countries") OR EXCLUDE (EXACTKEYWORD , "Life Cycle") OR EXCLUDE (EXACTKEYWORD , "Systematic Review") OR EXCLUDE (EXACTKEYWORD , "Telesurgery") OR EXCLUDE (EXACTKEYWORD , "Antennas") OR EXCLUDE (EXACTKEYWORD , "Bioinformatics") OR EXCLUDE (EXACTKEYWORD , "Biomedical Engineering") OR EXCLUDE (EXACTKEYWORD , "Costs") OR EXCLUDE (EXACTKEYWORD , "Cyber-attacks") OR EXCLUDE (EXACTKEYWORD , "Ecosystems") OR EXCLUDE (EXACTKEYWORD , "Electronics Industry") OR EXCLUDE (EXACTKEYWORD , "Engineering Education") OR EXCLUDE (EXACTKEYWORD , "Financial Institution"))

One can copy the above query to access the database we used for further detailed analysis.

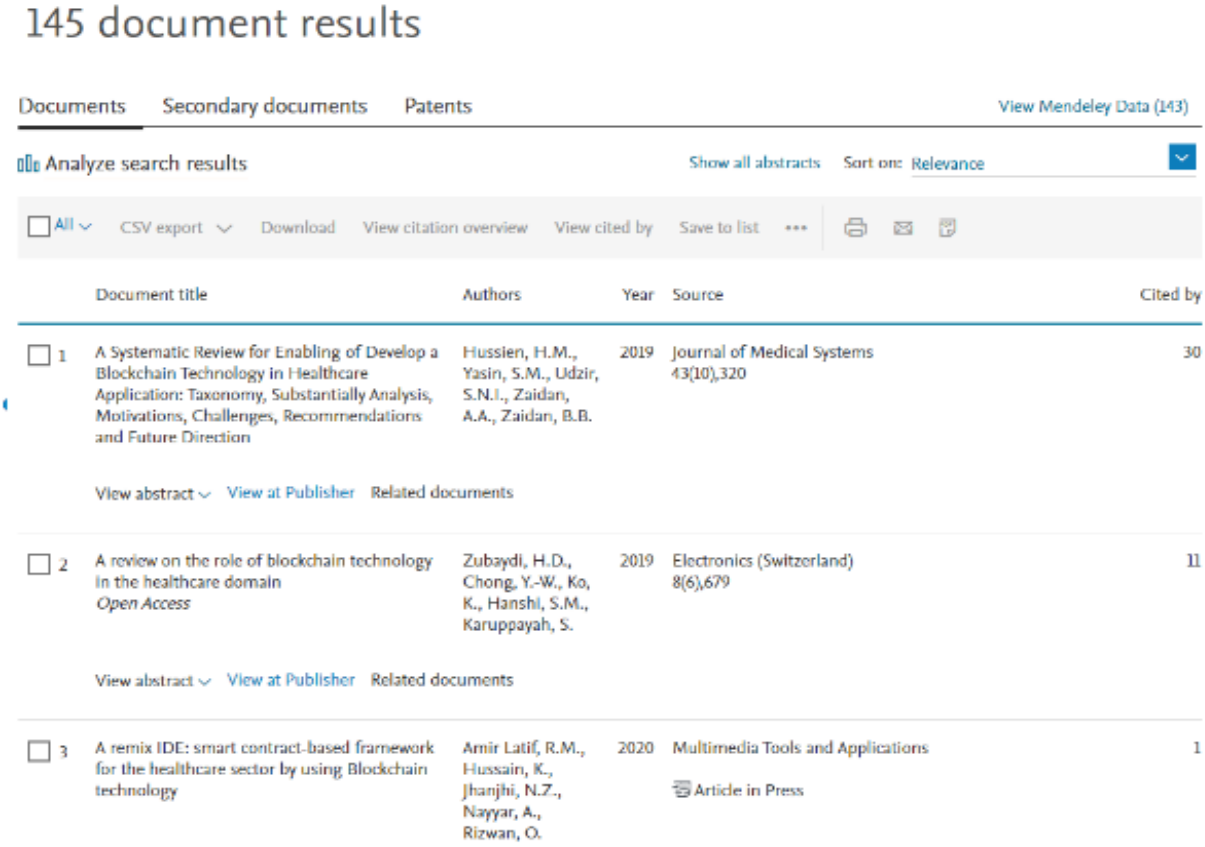

Figure 2 Dataset Result after Second Query

After searching our query, we found exactly 145 documents which matched our result. Exporting all 145 documents in the form of a csv, so that we can feed this bibliometric data to the VOSviewer (will be discussed in the next section). Scopus also allows us to analyze the bibliometric data through various factors and features, and further allow us to perform personalized visualization, which has been exploited and will be used for further explanations in later stages of the document.

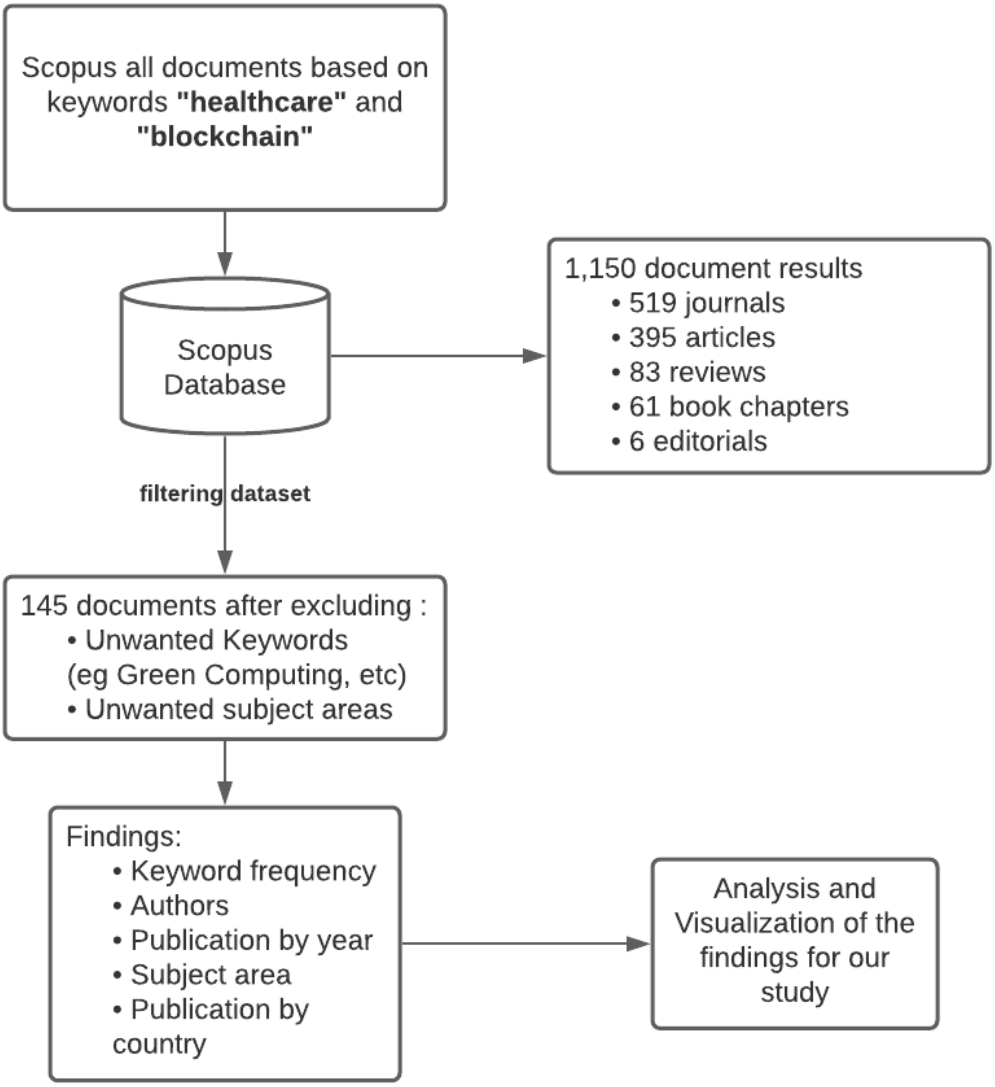

Figure 3 Schematic of Data Collection Process

2. Bibliometric Maps

The maps presented in this section are all generated by using VOSviewer. VOSviewer is a very well-known bibliometric analysis tool. "It is free and contains excellent features that support various types of bibliographic visuals for analysis" [13]. It fetches the bibliometric data presented to it, using this data we can generate graphical maps based on the bibliometric data. These maps can be generated in different styles such as, co-citations, co-authorship, and author keyword co-occurrences.

The .csv file created using scopus is now fed to VOSviewer. We now create a map based on the bibliometric data.

Co-Authorship of Countries :

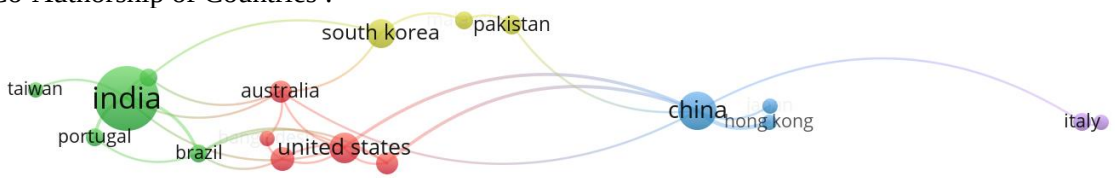

Figure 4 Map of Co-authorship of Countries

The above image is a map based on bibliometric data which shows us the relation between different countries having co-authorship/ mutual publications. This graph illustrates that out of 55 countries 19 countries have a minimum number of documents by country greater than 3. Out of which 18 of the countries are connected to each other. India being the highest contributor, having a total of 45 documents. The rest of the 36 countries have not been displayed on the above map because the number of documents published by them do not satisfy our constraints.

Co-occurrence of Index keywords :
Co-occurrence of index keywords analyzes index keywords that appear in the document. This study analyzes 637 keywords out of which 67 keywords meet our minimum threshold i.e 3. For each 67 keywords, the total strength of the co-occurring links with other keywords will be calculated. The map below shows this analysis.

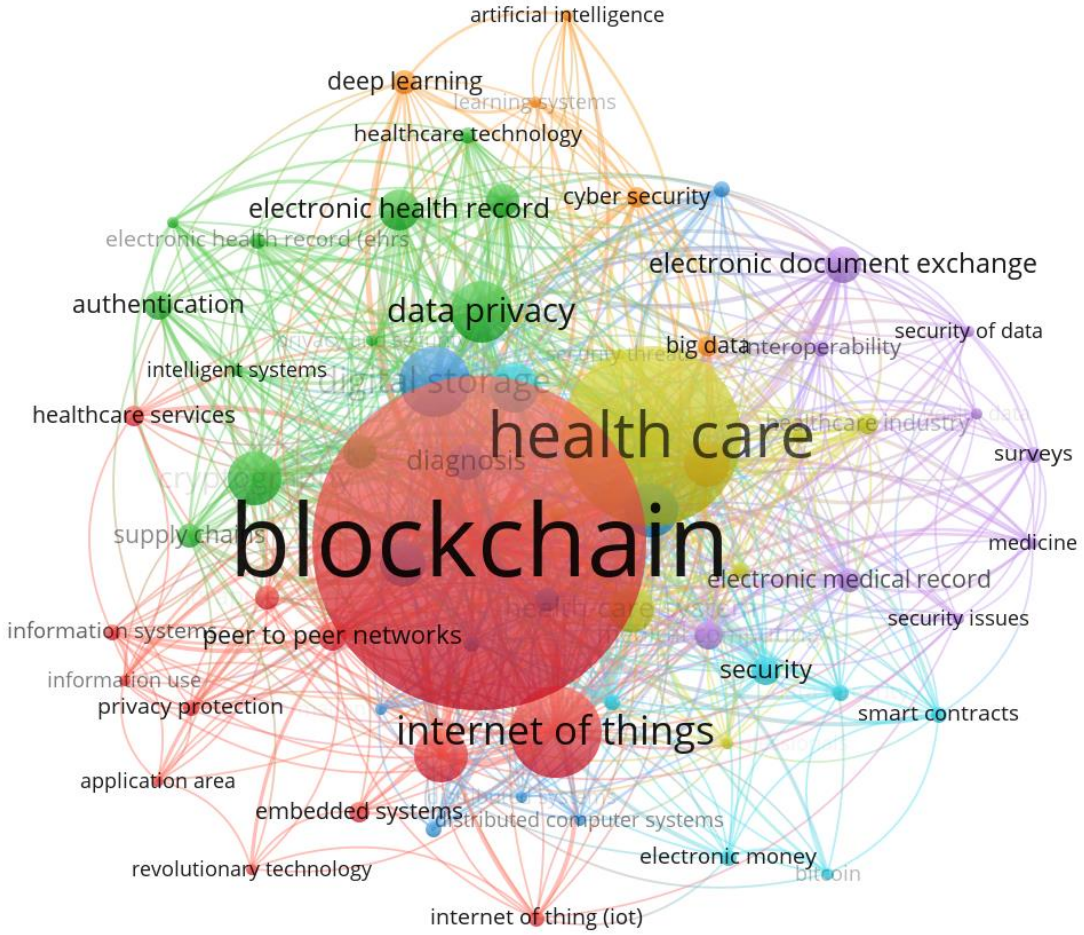

Figure 5 Map of Co-occurrence of Index Keywords

4. Findings and Analysis

The graph in the next page is generated by analyzing the query on scopus. Scopus provides us with different bibliometric data graph visualization, which we analyze in this section. The first graph shows us a representation of the number of documents published on our topic from the year 2016. Blockchain being invented in 2008, did not come into the spotlight until the recent rise of bitcoin around 2016. After 2017, blockchain was considered one of the most secure data protection technologies, and thus began the increase of implementation of blockchain in different applications which emphasize data security. This is why from the year 2017 to 2018 we see this sudden increase in different research papers related to blockchain [16].

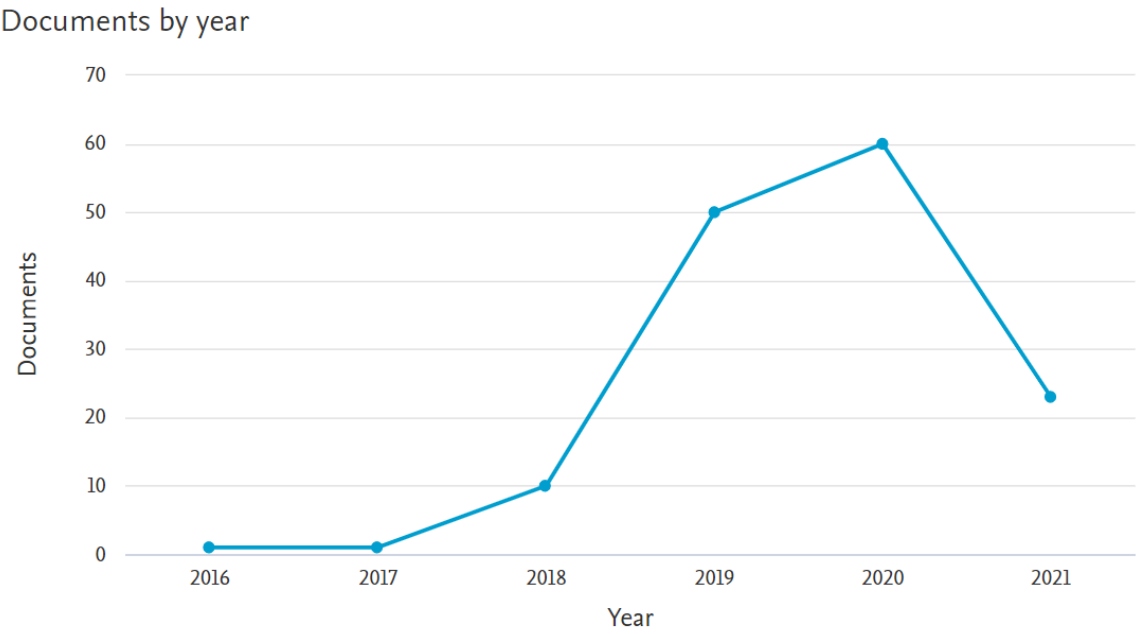

Figure 6 Number of Documents by Year of Publication

Year	Documents	Percentage (%)
2021	23	15.86207
2020	60	41.37931
2019	50	34.48276
2018	10	6.896552
2017	1	0.689655
2016	1	0.689655

Table 1: Number of Documents Vs Year of Publication

The given table on the left will help us understand the above given graph even more.

The graph below shows a statistical analysis based on the number of documents published with Kumar, N publishing the highest number of papers i.e; 5, followed by Tanwar, S, Bhattacharya, P and so on.

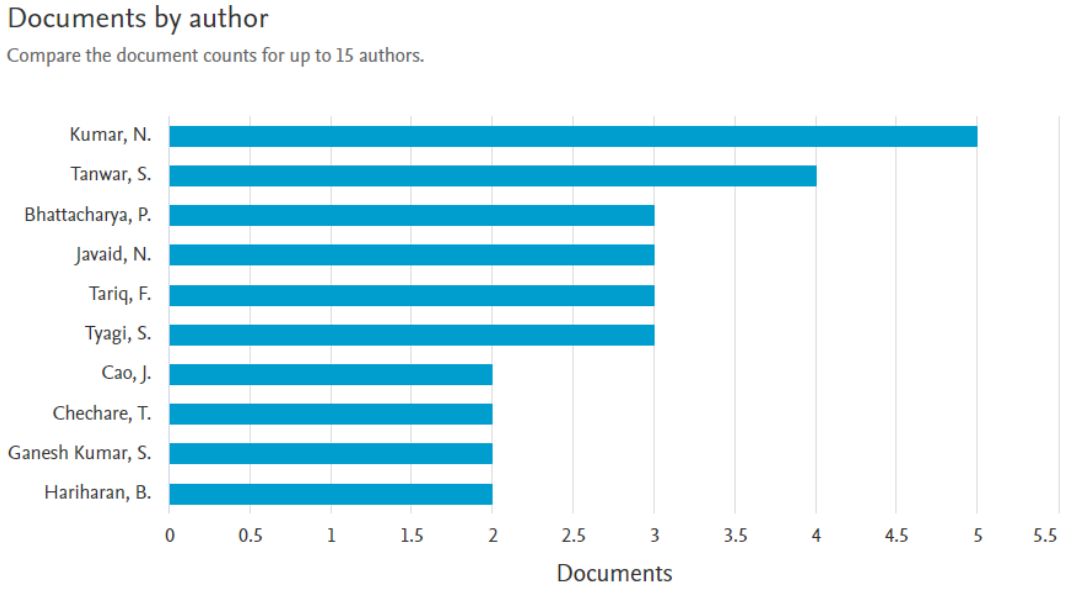

Figure 7 Number of Publications by Author

Author	Publications
Kumar, N.	5
Tanwar, S.4	4
Bhattacharya, P.3	3
Javaid, N.3	3
Tariq, F.3	3
Tyagi, S.3	3
Cao, J.2	2
Chechare, T.2	2
Ganesh Kumar, S.2	2
Hariharan, B.2	2
Jiang, S.2	2
Kaiser, M.S.2	2
Khan, A.U.2	2
Lee, S.Y.2	2
Murugan, A.2	2
Nayyar, A.2	2
Obaidat, M.S.2	2
Prabha, R.2	2
Rodrigues, J.J.P.C.2	2
Sharma, A.2	2
Urmila, M.S.2	2
Wang, L.2	2
Wu, H.2	2
Yang, Y.2	2

Table 2: Number of Documents Vs Author

The table on the left shows a list of various authors who have a publication under the subject of our domain, sorted in descending order. This is essentially the tabular representation of the earlier visualization in the previous page.

The previous page only showed the top 10 authors, whereas this list contains a few others too. Naturally, there are many more authors, however, we decided not to include the entire list and instead mention only the authors who have published more than 1 paper.

The graph below shows the number of documents published by a specific country. India being the top contributor having 45 publications. China ranking second with 17 documents published.

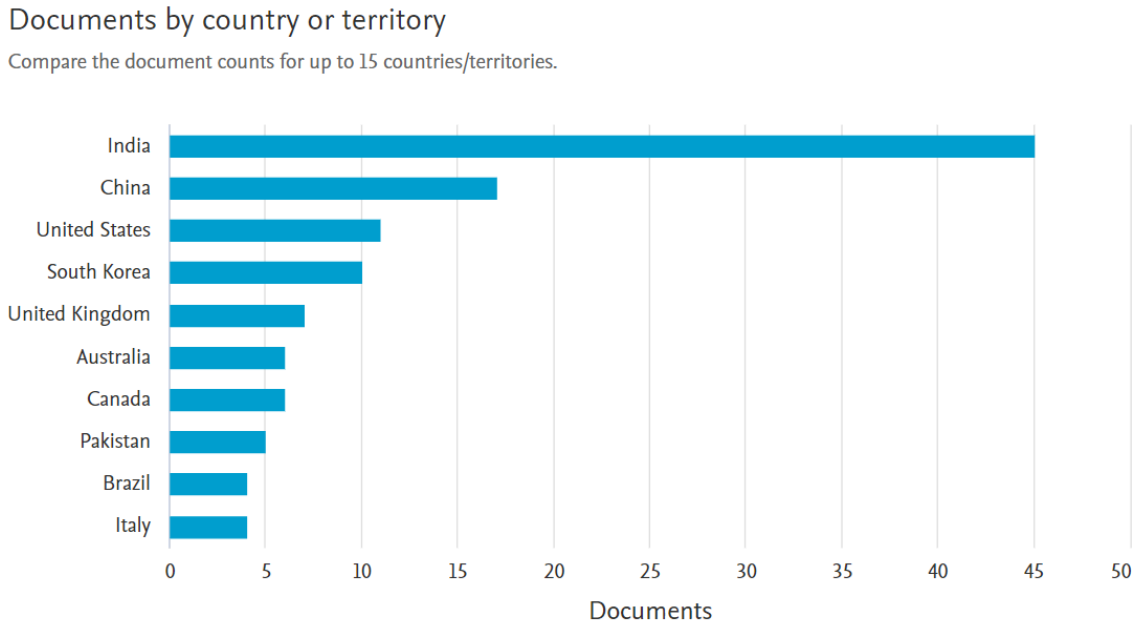

Figure 8 Number of Documents by Country/Territory

The image in the next page is a simple representation of the countries based on the graph above. India being the highest contributor has a much darker shade on the map. Countries such as China, United States of America, and South Korea with lesser number of documents published can be seen in relatively lighter shades followed by some other countries such as United Kingdom, Australia, Canada, etc. Whereas countries which have not contributed have no shade.

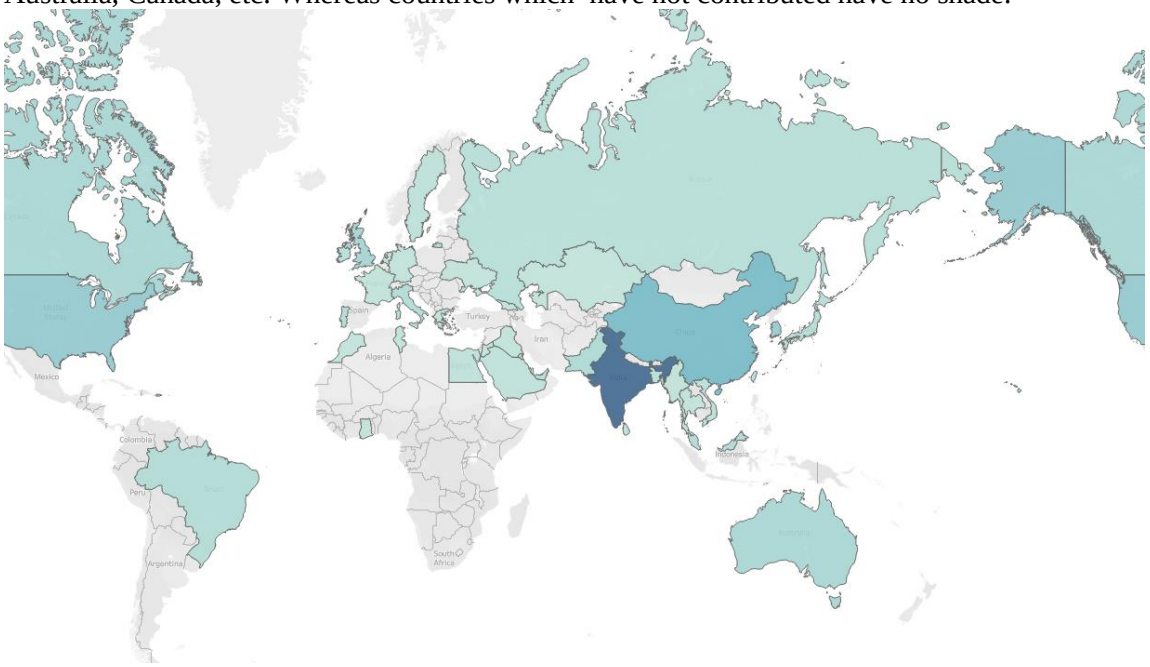

Figure 9 Mapping of Number of Documents by Country/Territory

The graph below represents the subject areas of this study. The highest number publications were published in either the computer science or engineering areas. Subject areas such as medicine and health profession arise because our application is supposed to deliver a healthcare application. The pie chart shows a diverse nature of the subject areas. A very important thing to keep in mind is that it does not represent the number of unique publications, but rather shows the range of subject areas among all other subject areas instead of the papers themselves. Essentially, 100% value of the pie chart does not represent 145 documents, but rather represents the total instances of all subject areas among the papers.

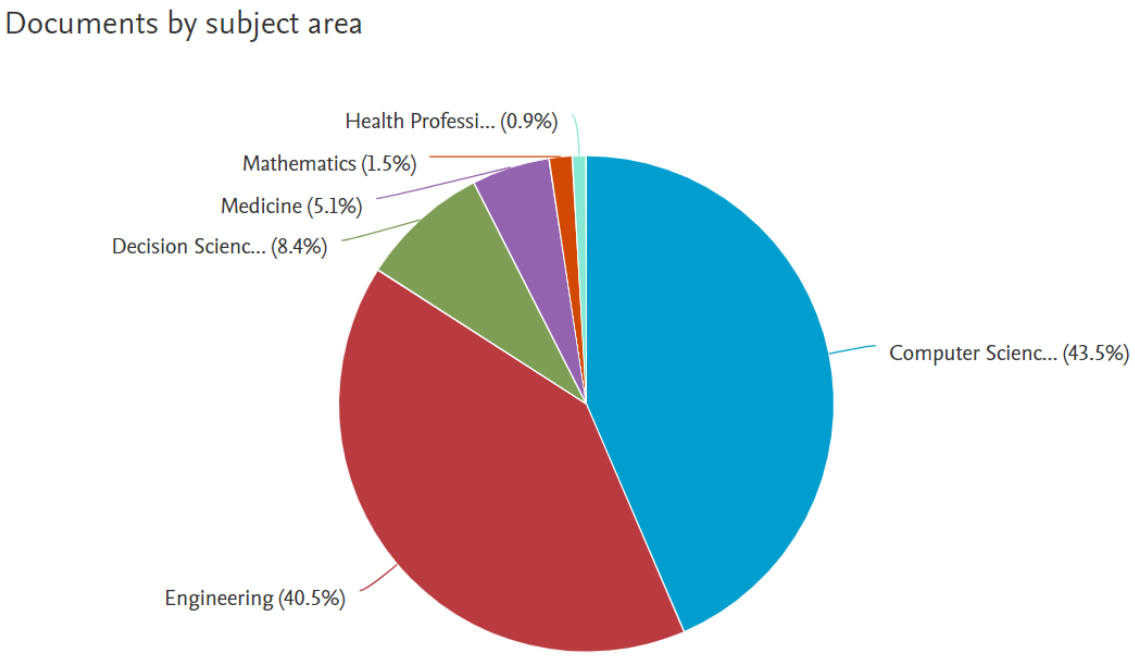

Figure 10 Pie Chart Visualisation of Number of Documents by Subject Area

The table in the next page shows the relation of all the other subject areas with respect to the main subject area, being 'Computer Science'. Other significant subject areas include 'Engineering', 'Decision Sciences', 'Medicine', 'Mathematics', and 'Health Professions'. The table then shows the percentage of documents that include a particular subject area. For example, approximately 93% of the papers that were considered for the study included the subject area of 'Engineering'.

Subject Area	Documents	Percentage (%)
Computer Science	145	100.00000
Engineering	135	93.10345
Decision Sciences	28	19.31034
Medicine	17	11.72414
Mathematics	5	3.44828
Health Professions	3	2.06897

Table 3: Number of Documents by Subject Area

5. Conclusion

The document has explored and investigated the various aspects of publications in the domain of our study, which involves Blockchain implementation in the healthcare industry. Using tools such as Scopus, we managed to fetch the database containing the set of papers related to our study. VOSviewer was used to analyse the keyword occurrences across the collected papers, with special emphasis on our domain, and excluding noise. Later, through basic data visualization techniques and analysis, we could discover various aspects of publications, such as subject areas, geographical source of the publication, co-authorship with respect to countries and territories, and number of publications per year. A clear trend of rapid growth in the numerous publications with respect to time, owing to the increasing popularity of the area of Blockchain, with greater understanding and discovery of applicative purposes of the subject becoming more prominent.

This trend can be noticed across the world, with the added consistency of being true to the field. Thus, we can conclude that the study of Blockchain in healthcare is on the rise across the world, and our work will be very much relevant enough, with the application being potentially disruptive.

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