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**Global Research Productivity on Blockchain Technology: A  
Bibliometric Study**

A DISSERTATION SUBMITTED FOR THE AWARD OF THE DEGREE

OF

**MASTER OF PHILOSOPHY**

IN

**LIBRARY AND INFORMATION SCIENCE**

Submitted by

**Pratibha Prajapati**

Under the Supervision of

**Dr. M.P. Singh**

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DEPARTMENT OF LIBRARY & INFORMATION SCIENCE

(SCHOOL OF INFORMATION SCIENCE & TECHNOLOGY)

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## DECLARATION

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I, hereby declare that the dissertation titled “**Global Research Productivity on Blockchain Technology: A Bibliometric Study**” has carried out by me under the supervision of **Dr. M.P. Singh**, Professor, DLIS, BBAU, Lucknow for the award of the degree of Master of Philosophy in Library and Information Science, is an outcome of my effort and with my knowledge, it is an original work. I declare that the content of this dissertation did not form a basis for the award of any previous degree or diploma to this or any other University. Further, I undertake that the dissertation is essentially free from all kinds of plagiarism and the sources used in this study have been duly acknowledged.

I hereby also undertake that the dissertation submitted by me to Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow satisfies all the requirements as stipulated in the *Master of Philosophy (M.Phil.) Regulations- 2016 as amended in 2019* and it is fit for the submission and evaluation for the award of the degree of Master of Philosophy in Library and Information Science of the university.

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**CERTIFICATE**

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This is to certify that the dissertation titled “**Global Research Productivity on Blockchain Technology: A Bibliometric Study**” submitted by **Pratibha Prajapati** is an original research work and has not been previously submitted in part or full for the award of any other degree or diploma to this or any other university.

The dissertation submitted to Babasaheb Bhimrao Ambedkar University, Lucknow satisfies all the requirements as stipulated in *Master of Philosophy (M.Phil.) regulations-2016 as amended in 2019* and it is fit for submission and evaluation for the award of the degree of Master of Philosophy of the University.

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Date: 05/01/2021

Place: Lucknow

*Pratibha Prajapati*  
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## **PREFACE**

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Bibliometric is the field of study which concerns itself with measuring and analyzing scholarly literature of discipline. It is the most powerful technique for conducting a quantitative study of research production and technological progress of science. Generally, bibliometrics term is used for quantitative analysis of science subjects while bibliometrics is used for other than science subject. It is one of the best ways in getting knowledge of scientific productivity of individual author/scientist, institution and journal. It is helpful to know the pattern of literature growth, nature of research publications, collaborative research, age of literature used and information needs of the authors.

Blockchain Technology is playing a much larger role in our economy and society. It is an emerging technology it will changed the way and acquire and share information with securely. Bibliometrics study on Blockchain Technology can be also used to support the decision-making by government funding agencies and universities, identify the core competency of countries in an area of research, and help in expert selection within a field. India is the second-largest populated country in the world, so that an attempt was made in the present study to measure the trends in various aspects of published literature in the field of Blockchain Technology at the global level. The study of bibliometrics is very popular because it helps to improve scientific documentation, information, and communication activities by quantitative analysis of library collections and services. To better understand the research contribution of world in the field of Blockchain Technology. This dissertation work has been divided into the following five chapters.

### **CHAPTER 1: INTRODUCTION**

This is a brief introductory part of the thesis, which introduces Bibliometrics and Blockchain Technology. It also gives a short description of bibliometrics law and its related formulas. The historical background of bibliometrics, uses and types of blockchain technology have also been elaborated in this chapter.

### **CHAPTER 2: REVIEW OF THE LITERATURE**

In this chapter, the purposes and steps of reviewing literature have been explained. The chapter is divided into two parts: in the first part, the basics papers related to the fundamental

bibliometrics have been reviewed and in the second part, the reputed papers related to bibliometrics study in the context of blockchain technology and its allied has been reviewed.

### **CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY**

This chapter gives a blueprint of the research work, like formulation of the research problem, objectives, scope and limitations, hypothesis formation, methods of data collection, data sorting, data analysis and data interpretations. Applicability of fundamental bibliometrics laws and their related formulas, such as relative growth rate (RGR) and doubling time (DT), Bradford's law of scattering of journals and an overview of VOS viewer, Biblioshiny, etc. have also been elaborated in this chapter.

### **CHAPTER 4: DATA ANALYSIS AND INTERPRETATION**

In this chapter, the data retrieved from Scopus databases on antibiotics research from 2007 to 2021 have been analyzed on the basis of certain formulas with the help of MS-Excel, VOS viewer, and Biblioshiny software. The tables and graphs are created based on data analysis. Bibliometrics law Bradford's law of scattering of journals, has also been applied to measure the research output.

### **CHAPTER 5: FINDINGS, CONCLUSION AND SUGGESTIONS**

This chapter made up findings, conclusion, suggestions, and area of further studies. Findings are a collection of summarized form of data interpretations, which are based on previous chapter-4. After findings, the conclusion, suggestions, and areas for further research have been stated in this chapter.

# **CHAPTER 1**

## **INTRODUCTION**

## CHAPTER-1

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### INTRODUCTION

#### 1.1 Background

Literature plays an important role in conveying knowledge in any area for understanding the concept and meaning. This is very useful to know basic information and knowledge on any subject or topic. Literature means “a collection of basic theory or concept published on a particular topic or subject”. Everybody wants to get exact information and for the sake of knowledge they use the proper medium to reach his knowledge but in ancient era scientists and researchers preserved their information in clay tablets, stones etc. In modern times the number of literature publications is going to increase day by day because many journals, gateways produce scientific literature and represent the collaborative efforts of many scientists and authors of various subjects or areas. The publication of bibliometric analysis plays an important role in research in the field of information science. It could be described to the fact that bibliometric analysis is used to identify the top prominent subject authors and count the authorship pattern and secondary journal coverage. Literature is the body of many thoughts as revealed in published writings. It is an essential indicator for emerging new ideas in any subject.

#### 1.2 BIBLIOMETRICS: AN OVERVIEW

Van Raan states that “Bibliometric analyses performed the macro level (e.g., whole country) yield t best, general assessment of fields as a whole, like how good a country’s performance is in physics, chemistry, psychology or Immunology, without a breakdown to the individual research groups or programs.” Bibliometrics is an application of Mathematical and statistical methods to analyse books and other media of communications. It has recently caught the attention of serious workers in Library and Information science from a theoretical and practical approach. It is considered as a quantitative study of literature on any subject. The term “Bibliometric” was coined in the year 1969 by Alan Pritchard. He was the first person who firstly used this word in his article “Statistical Bibliography” which was published in the “Journal of Documentation”. This word is made of two words ‘Biblio’ and ‘Metrics’. The term “Biblio” word derived from the Latin word ‘Biblion’ which means books and the term ‘Metrics’ derived from the Latin word ‘Metricus’ means Measurement. On other hand

metrics are the “Science of Meter”. The main purpose of Statistical Bibliography is to measure various facts of written communication to understand the nature of a discipline. It is a method in which numerical analysis of data, Book, Book chapter. Patents, software, designs, description of articles. It is also used to develop descriptive statistics as per the need. Generally, bibliometrics means “Book measurement” but it is not only books measurement it also covers journals, articles and other media of communication. This is the era of information explosion and everybody wants nascent information in a few minutes so through this bibliometrics analysis information can be accessed in the easiest way.

### **1.3 HISTORY OF BIBLIOMETRICS**

Alan Pritchard coined the word Bibliometrics in 1969. He was a British Librarian, specially this technique was formed by the more efforts 20<sup>th</sup> century documentation to apply mathematical and statistical analysis to bibliometric units. The ancient review says that F. J. cole and Nellie B. Eates presented the study on bibliometrics in 1917 in Science Progress. E. Hulme introduced the term “Statistical Bibliography” in the year 1923. The main purpose of Statistical bibliography is to shed light on the process of communications and of the nature of development of a subject by means counting and analyzed the various facts of written communication. In 1948, Dr. S. R. Ranganathan introduced the term “Librametry” for studying the various library operations by applying statistics. Scientometric is invented from the Russian word “Naukometria”. In 1966, the term Naukometria became known in English as Scientometric quantitative methods of studying the development of science. Thus, all metrics are still used as a stable term in the field.

### **1.4 DEFINITIONS**

Bibliometrics has been defined by various authors which are given below: -

According to Pritchard, “Bibliometrics is the application of mathematical and Statistical methods to book and other media of communication” and also has been described as “the metrology of information transfer process and its objective analysis and control of the process.”

According to the British standard Glossary of Documentation of Terms, “Patterns of use and publication of bibliometrics documents in which mathematical and statistical methods have been applied.”

According to Hawkins, “Bibliometrics is a quantitative analysis of the bibliography of a body of literature.”

According to Nicholas and Ritchie, “Bibliometrics provides information about the structure of knowledge and how it is communicated.”

According to Broadus,” Bibliometrics is the quantitative study of physical published units or bibliographic units or either.”

According to Sengupta, “Bibliometrics as the organization, classification and qualitative evolution of the publication patterns of all micro and macro communications by their author as well as mathematical and statistical calculus.”

According to Merton and Garfield, “Bibliometrics deals with the field of investigation given for quantitative analysis of science and scientific field.”

### **1.5 APPLICATIONS OF BIBLIOMETRICS**

In recent decades Science and Scientific research have grown day by day. Bibliometrics sub disciplines of Statistics, citations analysis, operation research, circulation theory, information theory and theoretical aspect of information retrieval. The practical approach of bibliometrics are given below: -

- The aim of this study is to improve the bibliographical control by knowing the character of literature in different fields.
- Bibliometric Analysis determines statistics of literature related to the productivity of year, origin of subject, language and author wise distribution of literature. It is beneficial because this analysis suggests the weakness of the coverage area.
- The bibliometric study helps in comparative assessment in the particular literature. It also helps in taking management decision planning of budget, future staff, building needs and library services.
- Citation Analysis also determines the list of highly cited articles, journals or books. It helps in taking the decision to discard the old stack of libraries.

- Bibliometrics Analysis provides basic information about the structure of the knowledge and pattern ship.
- Bibliometric Study derives the subject relationship which suggests efficient general patterns and also covers it. This analysis helps to make a framework for a service in a specific subject area.

## **1.6 BIBLIOMETRIC AS A QUANTITATIVE TOOL**

Bibliometric Analysis is associated as a quantitative tool and techniques, which aims to access the research output. This method also describes quantitative methods which are based on numerical analysis of research publications, including the literature on subject which is useful for major libraries, like most prolific authors, institutions, journals distribution classifying the main areas of literature through citations and most effective language etc. and this communication process is helpful in decision making. Here are several Bibliometrics law and approaches that are used to measure the output of research:

- Bradford's Law
- Lotka's Law
- Zipf's Law

### **1.6.1 Bradford's Law:**

The famous scientist S.C. Bradford, a librarian and chemist in the Science Museum of South Kensington (London). He identified Bradford Law in 1934. It is the frequency distribution of the journals. According to Bradford "If scientific journals are organized in order of decreasing productivity in a given subject, they can be divided into the nucleus of journals that are specifically devoted to the subject and have multiple groups or fields, containing the same number of articles when the number of periodicals. The nucleus and succeeding regions will have 1: n: n<sup>2</sup>."

Bradford Explained journals into three zones and each zone having the same articles but it is different with the number of journals.

**First Zone:** In the first zone the number of journals is very less. In such journals, one third of all published articles are published. This zone is covered as core journals on the subject concerned.

**Second Zone:** In the second zone of a journal the number of published articles will be equal to the first zone but the number of journals will be more in comparison to zone first.

**Third Zone:** In the third zone the number of published articles will be equal to the first and second zone but the number of journals will be much more in the comparison of the first and second zone.

### 1.6.2. Lotka's Law:

The Lotka's Law was enunciated by Alfred J. Lotka in 1926 it is Frequency distribution of Scientific Productivity. In this law, the frequency of publication given by authors of any given field. According to Lotka's Law "the number of authors contributing  $n$  (1) is  $1/n^2$  of those who make; and the publication of all contributors, who make a single contribution, is about 60%."

$X^n * y = C$  formulated is formula to calculate the frequency distribution of Scientific Productivity. The total number of authors  $y$  in a given subject, each producing  $x$  publications, is proportional to some exponential function  $n$  of  $x$ .

Where:

$x$  = number of publications

$y$  = No. of authors credited with  $x$  publications

$n$  = Constant (equal 2 for scientific subjects)

$C$  = Constant

In this law, applicability of this law applies to all authors in a particular specific field. It is also called the inverse square of scientific productivity. In which 60% authors make one contribution and 15% of the authors make two contributions, less than 7% authors make three contributions. Less than 4% authors make four contributions and less

than 2.5 % authors make five contributions. 1.25% of authors will publish six contributions and less than one author will make seven contributions.

### **1.6.3. Zipf's Law**

This law was originally proposed by George Kingsley Zipf in 1933. This law tells about the calculation of the frequency of words in any text or in articles. He enunciated a formula to count the frequency, the formula  $r \times f = C$  was used to calculate this, where  $r$  is the rank of a word,  $f$  is the frequency of occurrence of the word, and  $C$  is a constant that depends on the text analysis. According to Zipf "In a relatively long text, if you list the words that fall within that text in order of decreasing frequency, multiplying the rank of a word in that list by its frequency will be a constant."

Bibliometric law plays a very important role in the research field of Library and Information Science, bibliometrics have an important place. It can be used in any subject area to measure the productivity of a research area. This technique is basically depending on parameters that affect the study and also analysis such as the amount of data to be analysed, scientific development in the particular discipline or number of citations. Bibliometrics is one of the most interesting fields of study for library and information science scientists.

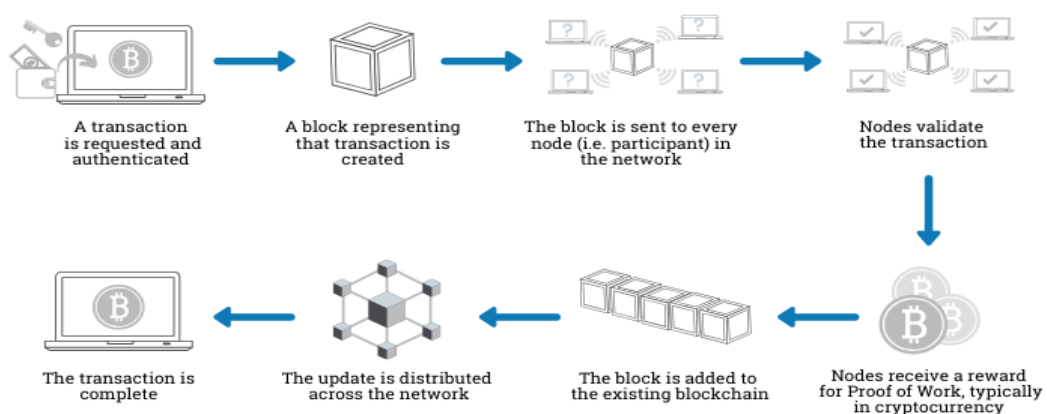
### **1.7 Blockchain Technology: An Overview**

In 2008 Satoshi Nakamoto introduced an electronic (Crypto) currency named Bitcoin. The electronic currency is stored in a system and it works through a technique named e-currency or cryptocurrency. This e-currency mechanism is based on the distributed public ledger system and it is recognized as Blockchain Technology. The term "Block" is defined as a data storage and the term "chain" is defined as connected to each other in a sequence using the hash value and this hash value generated from Cryptography. So, the Blockchain Technology described that it is a data storage block which is arranged in sequential manner and connected with each other. This Blockchain Technology works as transfer data nodes and it is framed with inter connected pattern of information to perform a secure transaction and share through all the nodes involved in the transaction which are connected to the network, it works as decentralised distributed ledger system of recording digital information, all blocks are connected with their hash that makes it difficult or impossible to change any information of blocks no chance of hacking or cheating. Every transaction in the ledger connected with the digital signature of the owner. Mainly, Blockchain is described as a "chain" that means a

block of data. As add fresh data into the network, a new block is created and their key joins with the chain. When a new block is attached in a chain then all nodes update their version of blockchain ledger because all blocks have their key and hash value so when new blocks enter in the chain then the majority of nodes must verify and confirm the originality and attach them in the database. It is based on Digital Ledger Technology that stores any kind of data or information. It is a record of cryptocurrency transactions and information about any organisation. In conventional databases information can be stored for a short time and any one can change, alter and edit the data of the database but Blockchain database is a unique database it totally works in a decentralised way. It is maintained by decentralised administrators for example an excel sheet and bank data have many copies so blockchain helps to spread out all computer networks and data will be secured. In fact, Blockchain 1.0 has been moved to Blockchain 3.0 since 2008. Blockchain 1.0 refers to digital currency, 2.0 to Digital Finance, 3.0 to Digital Society.

Basically, Blockchain is a type of DLT where transactions, information are recorded with an immutable cryptographic signature called a hash. If the data changes in Blocks then the previous hash is already changed with the next one. So, the reasons DLT and Blockchain are working in same way. Blockchain and DLT both are often used interchangeably and understand Blockchain. So firstly, it is important to understand the DLT.

## How does a transaction get into the blockchain?



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Source: <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.euromoney.com>

## **1.8 Distributed Ledger Technology**

Basically, ledger is a record of all log containing the information about the system, node value and configuration datasets. Blockchain technology use distributed ledger for transferring the information. Distributed ledger technology relates with the technological infrastructure and protocol that allowed the access, validation and record updating in an immutable manner across a network that is shared multiple entries. This work can be accessed using keys and cryptographic signature. If once the information stored then information cannot be changed and alter and if change any information the all information change. DLT has good potential and revoluted by governments, institution and corporation works. In DLT each node connected in peer to peer networks. This technology making waves in industries such as finance, music, banks, libraries and more place. Its start-up with many creamy layer companies such as IBM and Microsoft companies using DLT for their works. Ethereum, Hyperledger, fabric, R3canda and quorum are the most popular protocols. It is commonly known as Blockchain Technology was introduced by Bitcoin it covers all industries and sectors. It is the idea of a degendered network against the centuriated (Conventional) mechanism.

### **Definitions of Distributed Ledger Technology**

“A distributed ledger is a consensus of replicated, shared and synchronized digital data geographically spared across multiple sites, countries or institutions.” – Wikipedia.

“Distributed Ledger Technology (DLT) refers to the technological infrastructure and protocols that allows simultaneous access, validation and record updating in an immutable manner across a network that’s spread across multiple entities or locations.” – Investopedia.

In simple clarification, a digital ledger is like a google spreadsheet among a maximum number of networks in which all data is stored in which any one can see the data but they cannot erase or corrupt it. The advantage of this technology is that it has several nodes on a peer to peer network where each replicate and saves an identical copy of the ledger and updates indecently. DLT reduces the cost of transfers and its streams of Distributed ledger help us to mitigate our dependence on many sectors. It also proposed the research helps to clarify a semantic alignment of datasets and contributed parametric equations like the file alignment series and the connecting some attributes.

**1.9 Cryptocurrency:** The first cryptocurrency introduced named Bitcoin was used in Blockchain Technology. In that time, it was more valuable and more popular. In this era most of the cryptocurrency has various functions and specialisation. It is a digital or virtual currency that is secured by cryptography in which double spend or counterfeit is impossible. Most of cryptocurrency are based on Blockchain technology. The word cryptocurrency is taken from the word Encryption Technique which is used to secure the whole network. Most experts said that blockchain technology will disrupt many organizations, like finance and law. It is a system that permissioned for secure payments online which are nominated in terms of virtual token. It is represented by ledger entries of the system.

### **1.10 Types of Blockchain Ledger**

In the beginning of Blockchain technology digital and enterprise environments it is really important to know about private and public blockchain ledger. Basically, both are playing an important role in industries and organizations. Here are two types of Blockchain ledger.

- **Public Blockchain Ledger:** In a public blockchain ledger anyone can participate and can change, alter, edit and audit the data of Blockchain. Basically, in a public ledger no authority can be involved and no one can control the nodes. There are no restrictions for participation; anyone can see the ledger and participate in the consensus process. Everyone can see the ledger any time and also maintain transparency. Example of public blockchain is Ethereum, it is public ledger.

**Best features of Public Blockchain Ledger:** Here are some best features of public Blockchain Ledger.

- High Security
- Open Environment
- Anonymous Nature
- No regulations
- True Decentralization
- Full transparency
- Immutability
- Full user empowerment

- **Private Blockchain Ledger:** If talk about private blockchain ledger it is controlled by an organization or group. Only authority can decide who modify the data and alter the blockchain ledger. The private blockchain is useful for those sectors who are spreading the data or information to staff and other people who are engaged with them. In private ledger some regulations are made up for users of blockchain. It provides high efficiencies because it has access through a single organization. This ledger works with a partially decentralized way and is run with permission licences. Data and information can be entered by the organization committee. So, it means it is not for public people and private ledger is more efficient compared to public ledger. Examples of Private Blockchain are: Hyperledger, R3 corda and Quorum.

#### **Best features for Private Blockchain Ledger:**

- High efficiency
- Full privacy
- Empowering enterprises
- Stability
- Low Fees
- Saves Money
- No illegal agency
- Regulation

#### **1.10.1 Public Vs Private Blockchain Ledger: The Ultimate Comparison**

- **Authority:** In private blockchain ledger organizations people have rights to access the ledger. It is like distributed nature. On the other hand, public ledger works decentralized ledger system. Private blockchain ledger is not fully decentralized but it is still working with the enterprise environment.
- **Access:** In private ledger it works with a single organization and all authorities have to only that organization that means it is not open for public use while in Public blockchain ledger anyone can see the ledger and participates with them no restrictions for new people.

- **Transaction Cost:** In public blockchain ledger maximum number of nodes run on the platform and takes a lot of time to process so prices rise drastically. On the other hand, Private blockchain ledger transaction fee is low because number of requests does not increase transaction fees because only organization transactions accepted that's the reason fees will always be low and accurate.
- **Transaction Speed:** In private ledger only, organization people and selected person can request for transaction so the server work in timely and speed always remains the same on other hand in Public Ledger system everyone can request for transaction when so many requests on the network so the transaction speed already down.
- **Immutability:** Both ledgers are immutable but the public ledger is fully immutable it means if once a block gets on the process no one can change and audit their data. On other hand Private ledger systems are partially immutable because organization authority can change and delete information and certain blocks if they seem fit.
- **Efficiency:** Private blockchain ledger is more efficient compared to public platforms. It deals with scalability issues and always slows down. On other hand private blockchain only handful nodes on the platform that's the reason it always efficient in the compared to public ledger. In both ledgers there are a lot of differences but both are suitable for their work.

### 1.11 Advantage of Blockchain Technology

- **Trust:** This technology creates trust between different participants. Different participants work with each other but they do not have a direct relationship but are already involved in transaction and data sharing through blockchain technology. This technology is based on distributed ledger technology that's why it works with more transparency and security because all data is stored in hash value so it can't be altered and edited.
- **Improved security and privacy:** Blockchain Technology is an emerging technology. It has many security and privacy functions like end to end encryption that catches unauthorised activity. Additionally, all data and transactions are stored in computers through Blockchain technology, making it impossible to hack. Owner of the

transaction has the power; the owner can move anything of value freely and instantly without any intermediaries.

- **Reduced costs:** This emerging technology also can cut costs for organizations. It can create efficiencies in processing data sharing and transactions. It reduces manual tasks such as maintaining data after and before truncations and reporting process which takes more time and manpower. Any organizations can use Blockchain technology because it can clearly and settlement translate directly into process cost saving. It also helps in business to cut the cost of middlemen, vendors and third-party providers.
- **Speed:** This technology totally cut the manual work it eliminates intermediaries and also replaced the remaining manual process in transaction and data sharing. In blockchain technology transactions and data can be sent within seconds or less and it works very quickly. Through blockchain it beats other technologies and processes in terms of speed because a large size of blocks can process in multiple sectors in seconds. Blockchain technology is recognized as the most prominent application for privacy and security purposes. This technology needs intermediaries, speeds up transaction times and increases efficiencies and transparencies.
- **Visibility and traceability:** Blockchain allow to manage inventory of any business and responds to problems. A retailer using blockchain can identify and remove produce cost that comes from that particular way while learning its remaining produce for sale. According to user blockchain technology also can help to track the origins of a variety of items such as to confirm they are organic and they are indeed organic.
- **Immutability:** It simply means that if transaction & data were recorded on the blocks it cannot be changed or deleted because all transactions and data are recorded in time stamped and date stamped so these records are permanent records. As in this technology blockchain can track information over time, enabled a secure and reliable audit of information. In blockchain technology once the transaction is stored, the record is permanent, secured and immutable.
- **Individual control of data:** “In world where data is a very valuable commodity, the technology inherently protects the data they belong to you while allowing you to control it”- Michela Menting (Research director at ABI research). An individual

organization can decide their data and information can be shared with anyone and how much time they use their data with limits enforced by blockchain enabled smart contracts. This technology contains a set of rules under which parties mutually agree-eliminates the need of third parties.

- **Tokenization:** When any asset value converts into a digital token that is called Tokenization. It works and is shared with the help of Blockchain Technology. For example, Token could be used to trade carbon emission allowances under carbon cap programs.
- **Innovation:** Many leaders across industries which have explored and implemented blockchain systems to reduce intractable problems and improve longlisted practises.

### **1.12 Blockchain use in India**

In India, Blockchain Technology is mostly used in banking sector, Health sector, insurance industries and it is mainly used for Bitcoin transactions via Global computer networks. Overall 56% of Indian businesses are moving towards this technology. Hyperlink information system, Infosys, Fueled, Tata consultancy services and Tech Mahindra are top most companies which are using Blockchain Technology. Most of the private companies are using Blockchain technology to improve their efficiencies and ensure their transparency. Already the Indian government invests in the Healthcare sector to provide health coverage to low income families. Any business can run off true information if the information received fast will be more accurate and better. Through this Technology anyone can track orders, payments, accounts, production and much more. If any business man shares a single view of any information but other people can see all details of the transaction end to end it also provides new efficiencies and opportunities.

### **1.13 Blockchain for Libraries**

Librarians play an important role in shaping how blockchain technology is applied to content creation, storage and distribution. In future libraries will be decentralized libraries, where library users can directly access the database without any difficulties. Library users can control their circulation records and manage their issue and return histories. Blockchain is the trending technology which has many potential applications to the library to a smart library. With the help of this technology it can be done in a distributed and timestamped manner. The

emergence of blockchain Technology has inspired libraries to utilize the services at several levels in which some of these are given below: -

**Publishing E-book:** To publish any e-book, third party interference and libraries are forced to pay for full package rather than pay for full package rather than pay what they use. Authors do not get full rights ever after its creation. However, Publica (Where anyone can publish their book) in which through smart contract authors can create an Ethereum (Blockchain) network. Where everyone uses book tokens for purchasing books. New features of publica called Crowdfunding (book ICU) where the author can pre-shell of their token so that everyone is able to raise funds for some initial payment.

**IITs network on Blockchain Technology:** Permissioned blockchain can be used in IITs and all other institutions. This technology is fit for Grey literature, Lab papers and other literature that are playing an important role but is not published in a format. If someone published their new idea, Suggestions and research can be shared through Blockchain and everyone can access that literature. In the process no need to worry about Digital Rights, counterfeiting of the data and the most benefits of this technology no one can edit the data.

**Scholarly Publication and Digital Right Management:** In this technology era, the publisher has all rights. For example, everyone knows about famous journals but the creator has to stay behind and nobody cares about the creators. So, the high tech Blockchain platform can be established like Orvium in which platform scholars can register themselves by using Orvium, GUI and scholars can use their ORCHID ID to register themselves. When any scholars publish their work in Orvium then the scholar receives a token and that token can be used for pay in peer review process and this process can be open or blind.

Libraries can use Blockchain technology for storing information and are also explored in the world of science communication and publications through the tamper resistant settings. This technology creates time stamped verifiable versions of journal articles. Due to its huge potential, Blockchain technology is also enabled in Digital Right Management of libraries as the blockchain can create unique and verifiable records accessible for everyone. This technology could work as a technique to show “Provable Scarcity” of a resource in a digital material.

**User to user or Library to user Loan:** The other most advantage of Blockchain application is lending the book to another library and user without coming to the library. LibChain is a

system which is based on Blockchain Technology and works with modernised procedures to lend books from the libraries. With the help of this Library Management system, users can provide the Library books directly to other library users without returning the book back to the library. LibChain has the only condition that users should be members of the library. LibChain works to extend all library services and creates an ecosystem where the library users get services efficiency, securely and comfortably.

So, the Blockchain is an emerging technology that will change the way we acquire and share information securely because this technology is a combination of cryptography, peer to peer network and smart contract.

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**CHAPTER 2**

**REVIEW OF THE**

**LITERATURE**

## CHAPTER-2

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### Review of Literature

#### 2.1 INTRODUCTION

The main aim of this chapter is to measure the importance of the research work already related to the selected research topic and based on that recognize a title where a new research work can be done. The process of literature review is a summary of previous research on a topic. Through this, researcher review articles, books chapters, books and other scholarly work relevant to the same topic of the selected subjects and in the process compare the previous research work with the proposed research title. Hence, this is also on mind literature review should be relevant to the particular topic subject or area which include which work has been done and which are under process and what works are remaining on the particular field.

#### 2.2 Purpose of the Review of Literature

The main purpose of the literature review is to tell the reader what information and knowledge have been established so far on the selected topic and also about their strengths and weaknesses. “According to the Lawrence and Brenda (2016) both are proposed the purpose of reviewing the literature is as follows:

To provide a reference for the proposed research.

- To identify fundamental works and scholars in the field of the proposed research.
- Accepting existing theories, approaches, hypotheses, etc. in the proposed research area.
- Justify the selected problem.
- To clear misconceptions about previous research.
- Ensuring that the proposed research has not been done before.
- To demonstrate where the proposed research fits into the existing study area of knowledge.
- Enabling the researcher to learn from previous theory on the subject

- Tells which subject has been studied before
- Uncovering flaws in previous research
- Displaying the outline in previous research
- Show that work is adding to the understanding and knowledge of the field
- To contribute to the refinement and development of the proposed subject.

It is clear from the above lines that the literature review has an important part in any research work.

Agbo et al. (2021) carried out Bibliometric study of literature on Smart Learning Environment. Total 1081 data were taken by author and Scopus database was used for data collection. United States found most relevant country in the field of Smart Learning Environments field. Author described both, global and citation of publication and revealed the prolific author and Arthur C. Graesser published 12 documents with 618 citations which was highest citation. Beijing Normal University, China was on top with 37 documents followed by University of Memphis with 24 documents. In this study author revealed that author & Institutions collaboration. “Computer & Education”, “Smart learning Environments” and “Computer in human Behavior” found the most relevant articles for Smart Learning Environment. The most relevant keywords are- Learning Analytics, Adaptive learning, Personalized learning, blockchain and Deep learning. Through this study researcher provides useful contribution in the field of Smart Learning Environment and also provide comprehensive overview and research hotspots, thematic focus and future direction for upcoming researchers who wants to work in the field of Smart Learning environment.

Ante et al. (2021) presented Bibliometric analysis of Blockchain & Energy and the study author used exploratory factor analysis in six research streams. The use of blockchain Technology and its application in the energy sector is a diverse field. UCINET software was used for analyze one mode and two mode matrix data. Data were retrieved from the Web of Science database and used Exploratory Factor Analyses and only six research streams were taken for this study. Author identified by exploratory factor analyses in which Energy market innovation and transformation’s factor loading 28.6% and factor score 2037 followed by Blockchain for data sharing and security factor loading 26.0% and factor score 2.56%.

Author found a high degree of homogeneity in all six-research streams and explained more than 71 % of variance in the study period.

Barbosa (2021) did a bibliometric analysis in the Ari food supply chain (AFSC) research field during the study period of 2008-2019. Data retrieved from the Web of Science database. Total 1236 literature found during the study period. USA was ranked in first position with 226 publications and 3943 citations followed by England with 195 publications and 3838 citations ranked in second position. In journal wise production International Journal of production Economics was on top with 1275 citations, 399 articles and 5.134 impact factor whereas Journal of Cleaner Production was on second with 1275 citations, 66 publications and 7.246 Impact Factor. Thomas Reardon was on top with 35413 citations and h-index 86 which is followed by Jack G.A.J. Van Der Vast with 9212 citations and h-index 48. This study also found that USA researchers' contributions have been more cited than other countries' researchers and observed new research themes include contract, Blockchain, Internet of things, resilience and short food supply chain. This study shows some new frequently used keywords are food supply chain management, food industry and food security.

Bayramova et al.(2021) described the main role of blockchain technology in Augmenting Supply chain resilience in Cybercrime. Total 867 papers were retrieved from the Scopus database during the study period from 2016-2020. VoS viewer and NVivo used for this study. He identified six clusters in research analysis from Subsequent Grounded theory. United States, India, United Kingdom and China were the found most prominent countries. Author described the top ten most prolific authors, countries and sources of publications. Li, Z was found on top with 10 papers followed by Choi, T and Wang, Y. with 9 papers in this paper. Author found a top prolific source in which IEEE Access was on top with 35 publications followed by ACM International Conference Proceeding Series with 22 publications. 28 SCR found positive responses which were- Visibility, Collaboration, Integration, risk management and information sharing.

Daniel et al. (2021) did a bibliometric analysis on Big Data and Microservice and the author used five queries in this study which were “Big Data” “Microservice” “Microservices” “Micro Service” “Micro services”. Data were selected which were co-relate with both and after cleaning only 243 entries were selected in which most of the publication was published in conference paper with 171(70.37%) which was followed by Article 34 (13.99%) and

Conference Review with 33 literature. During the study period the author found 21 most cited authors were engaged in both fields in which Gao, L. was on top with 148 citations. Year 2019 has the highest publication with 56 literature followed by 2020 with 50 literature and the least publication in 2015 with 6 publications. Author examined that in subject wise distribution Computer Science with 179(87.75%) followed by Engineering subject with 62 (30.39%).

Dhiaf et al.(2021) analyzed the only Journal “Operations Management Research (OMR) and data were taken from Scopus database during the study period from 2008-2020. R studio, VoS viewer and Micro Excel used for analysis and visualization. The average citation per document was 18.27. During the study single author with 19 documents whereas multi authored with 373 documents and documents per author was calculated with 0.423. Olhager J. was on top with 7 publications and 2 H-index whereas Shafer S. with 5 publications and 1H-index. Total 368 single authors observed and proportion of authors 88.46%. Author shows only top ten universities in which Wake Forest University published highest with 12 publications followed by Lund University with 7 publications. United States was on top with 68 documents and 859 citations followed by Italy with 20 documents and 294 citations. Total 166 documents, in which 140 documents received one citation.

Wamba & Queiroz (2021) examined a bibliometric study as well as insight and research direction of artificial intelligence in the field of Digital Health. Author examined four different periods of year such as 1977 to 1990, 1991 to 2006, 2007 to 2014 and 2015 to 2011 in which publication’s unpredicted growth during the year 2015 to 2020 periods. IEEE Access was on top first with 300 papers. In country wise distribution USA, China and UK has more than 10000 citations. Author told about AI related technologies which applied AI in Digital Health and some benefits are Personalize medicine, Efficiency, Reliability, and cost & performance improvement for the hospitals.

Gajmal et al. (2021) examined a bibliometric analysis on Cloud using the author's master keywords were cloud computing, Access control and Blockchain. Author analyzed that Xidian University, China was at the top with 106 publications followed by the Chinese Academy of Science, China with 55 publications. Author indicated that 2314 articles were published in an English language, which was on top first followed by Chinese with 77 articles. In access type distribution which found that most of the publications come under all open access and minimum number of articles in Hybrid Gold. Majority of the paper was

published in conference paper and few of the publications were also made part of the book chapter and Review. Computer Science subject has the highest publication with 2021 documents followed by Engineering with 876 documents. China was on top of most countries. National Natural Science Foundation of China encourages and sponsors many publications.

Garg et al. (2021) measured the benefits of Blockchain technology implementation in the banking sectors. In this study researchers collected data from 291 respondents who were Blockchain consultants, blockchain marketing experts or implementer and adviser in Blockchain Technology. Author told that customer services are key to the success of any business. Author used five items that offer Blockchain technology increased with transparency, increase in trust, data accuracy, risk reduction and automation. Author described that if Blockchain technology is implemented in the Banking Sector it will enhance the quality of services which are provided to customers because in the banking sector efficiency and security is must for satisfying customers.

Goyal et al. (2021) concluded a bibliometric analysis of Blockchain Technology in the Health care sector. Data were retrieved from Scopus database and VoS viewer software used for data visualization. Data collected from 2016- 2021 in which 2020 found the highest publication with 60 (41.37%) publications in the field of Blockchain technology in the Health Care sector followed by 2021 with 23 (15.86%) publications. They found Kumar, N. published the highest number of papers that was 5 followed by Tanwar, S. with 4 papers. India was on the top highest country in the publication. Highest percentage of the documents in Computer Science subject with 43.5%. They observed that Blockchain Technology was considered one of the top most secure technologies and it increased after the year 2017. Author visualized co-occurrences of Index keywords in which 637 keywords analyzed and 67 keywords links with other keywords. Blockchain found the most highly occurrences keyword followed by Health care and Internet of Things.

Guo et al.(2021) explored the bibliometric analysis on Blockchain Technology during the study year 2013-2020 and collected 3826 articles from the Web of Science database. Cite space and VoS viewer used as an analysis tool. They observed that from 2013 to 2015 there were 100 documents and after the year 2016 blockchain technology increased. Author divided year wise distribution in two parts first period was start from 2013 to 2015 and second period was 2016 to 2020 and both study period author found that first period found 50

documents and second period 2016-2020 found 3789 documents. Computer Science was on top during the first study period. China was the observed largest output country with 971(25.38%) articles followed by the USA with 790 (20.65%) articles.

Huang et al. (2021) examined the literature Quality function deployment improvement. Author conducted a comprehensive bibliometric analysis of the articles during the year between 1990 to 2020 and data were retrieved from the Web of Science and the retrieval result was 1031 articles. In publication wise distribution 2019 was on top with 45 documents followed by 2018 with 33 publications and least publication in year 2000 with 01 publication. Author found most significant journals on QFD improvement in International journal of production Research with 38 publications and 4.577 impact factor while Expert Systems with applications with 28 publications and 5.452 impact factor. Author found that a total 126 different journals contributed their publication in QFD. Chen, YZ observed the most productive author with 20 papers and there were five authors who published more than 10 papers and in citation wise distribution Karsak, E.E, Kwong C.K, and Buyukozkan, G. ranked the top most. City University of Hong Kong was the most productive institution with 17 publications followed by Galatasary University with 14 publications.

Li et al. (2021) considered only Financial Technology for bibliometric analysis and the author retrieved data from Scopus database during the study period from 1995 to 2021. Total 27 years were taken and the author used three stages; the first stage was observed like the low level stage 1995 to 2003. The second stages observed a stable level which was from the year 2004 to 2012 and the last stage has maximum publication start with 2013 to 2021. People R. China was on top with 805 publications whereas the USA with 700 publications. In journal wise distribution Sustainability source on top with 32 publications followed by Electronic Commerce Research and Applications with 14 publications. Fintech observed highly occurring keywords which were used in maximum times. Expert Systems with Applications was highly Source literature with 220 citations followed by Journal of management with 206 citations.

Sharma & Khurana (2021) concluded a bibliometric analysis on Blockchain during the study period from 2014-2020. Data was retrieved from the Web of Science database and only “Blockchain” were used for query. Author examined that a total 1786 authors published their documents in the field of blockchain, in which 1478 authors found at least one publication, observed the ratio of single author count 38.7%, 28.9 % observed double author, Three author

with 16.5% and more than five authors with 3.5%. Author concluded only 5 lead country wise lead authors in which China was on top with 21.6% followed by the USA with 11.9%. India's author ranked third with 5.9% which was followed by South Korea with 5.2%.

Only 17 languages were observed in Blockchain in which most of the literature published in the English language. In 2019 37.47% publications were published which was on top followed by year 2020 with 36.90% and the lead publication in the year 2014 with 0.04 %.

Moosavi et al., (2021) presented a bibliometric analysis on Supply Chain Management and data were collected from 2010-2019. In this study bibliometric indicators such as year wise distribution, Top prolific authors, Top most dominant Universities. Author observed that the year 2019 was on top followed by the year 2017. Three authors were on top first with 5 articles and 5 citations. Hong Kong Polytechnic University was the most dominant university with 7 publications followed by Worcester Polytechnic Institute with 6 publications. Author shows the top 10 ten funding agencies in which the National Natural Science Foundation of China was on top first rank with 15 publications whereas the Ministry of Science and Technology, Taiwan with 4 publications. In the author keyword Occurrences "Blockchain" occurred 207 times followed by "Supply Chain" with 100 times occurrences. Europe, Australia and the USA were found to be the top most productive countries.

Niknejad et al.(2021) examined Blockchain Technology in the particular field, Food & Agriculture during the year 2016-2019.Total 171 papers were found author used VoS software and R package in this Bibliometric study. Author revealed that the interest of users increased annually because 2016 published the least number of articles and 2019 counted the highest number of publications. Author examined that India was on top followed by China and USA and "An agri-food supply chain traceability system for China based on RFID & Blockchain Technology" was found in a highly cited article with Global citation was 210 and 20 local citations during this study period. Traceability, supply chain, IoT and smart contract were top keywords. In this study the author also found correspondence analysis, bibliographic coupling analysis, co-citation analysis and network view map analysis. In this study the author counts the local citations and 171 nodes connected with the global citations. In journal-wise production IEEE Access is on top with 62 publications in the field of Food and agriculture followed by Food Control with 64 publications.

Pede & Lal Saini (2021) concluded a bibliometric study on Blockchain Technology in the HealthCare domain. Data were retrieved from two database Scopus and Web of science database total 598 articles were retrieved from Scopus database and 594 articles were taken from WoS database during the study year from 2016-2021. English language found most productive language and the term Blockchain has highest occurrences of keyword National Natural science foundation of China has funded 43 projects according to Scopus database. Most of the paper comes under the subject Computer Science with 32.4% followed by engineering subject with 20.3%. Conference found the top most document type of publication with 45.3% followed by Journal article with 38.8%. In country wise publications India was on second and United States found on top first country according to Scopus database but in WoS database USA was on top first followed by People R. China.

Rejeb et al. (2021) considered only the data of Health Care for Bibliographic Analysis. Data were retrieved from the Web of Science database and this study was limited to journal articles and conference papers. Cite space was used for analysis and visualization. Author presented top 12 journals that have published at least seven literature. IEEE Access top in list with 100 publications followed by Journal of Medical Internet Research & sensors which published 34 documents. University of Electronic Science and Technology of China ranked in first place with 14 publications. In country wise representation China & USA was on top with 145 publications each followed by India with 74 publications and England with 68 publications. Author extracted 52 keywords and each with an occurrence of nine and more times. Only eight authors were contributed in 2016 which was the least number of publications and the number grew to 1437 in 2020.

Shete et al.(2021) evaluated a bibliometric analysis on Internet of Things based Messaging Protocols for Aquaculture applications. Total 372 documents found during the study year from 1995 to 2021. Author described the maximum number of papers published in Conference papers which were 227 articles followed by articles with 115 articles. Pusan National University of South Korea found the top most with 8 documents. The highest contribution was by the first author who had seven Scopus documents. Author observed that India has coupling with 20 countries out of 21 countries with 71 documents followed by China with 39 documents.

Tandon et al. (2021) concluded a bibliometric study on Blockchain Application in only the Management field. Total 586 articles retrieved from the Scopus database during the study

period from 2015 to 2019. Author observed the noteworthy contribution of authors based in developing countries such as the USA, UK and Germany. USA was led by 135 articles followed by the UK with 82 articles. L, Xuan who was at Hunan University observed the top ranked author. Author and index keywords in both Blockchain were on top with author keyword 311 and index keyword 138 co-occurrences. Author observed that a total of 1284 authors were analyzed, 72 countries contributed in the field of Blockchain technology in management fields and 1016 organisations produced their literature. Total 273 journals participate in the field of BT in the Management sector.

Yildiz (2021) a Bibliometric study of the literature Internet of Things and smart cities. Total 2288 literature found during the study year from 2011-2021. Author has been observed that from the year of 2016 literature has been increased and presented top 15 countries and Italy country found the most cited country and China has highest number of publications in the field of IoT and Smart cities. Top three ranking countries were Italy, China and the USA. Italy was the most highly cited country with 5188 citations and 402 articles. In university-based contribution top 20 universities examined during the study period. University of Bologna followed by Kyunpook National University (Korea). Cloud computing verified the highest frequency with 165 occurrences followed by Big Data with 164 occurrences. Year 2020 found highest publications with 782 literature followed by 2019 with 543 literature found during the study period from 2011-2021.

Bharati & Singh (2020) explained a bibliometric analysis of the literature Coronavirus during the study period from 2011 to February 2020. Total 7758 documents were found during this study and the Scopus database was used for data collection. Author measured maximum AGR in the year 2013. Maximum publication found in 2015 which was the most productive year with 1012 literature followed by 2014 with 946 publications. Author presented the top ten most productive countries in which the United States was ranked on top with 2373 literature followed by China with 1378 literature. In journal wise distribution Journal of Virology was on top first with 330 publications. Author described 158 authors have written their papers on Coronavirus during the study. Medicine subject published 3631 documents which was on top first rank. Maximum number of literatures published in Journal Articles with 7310 literature followed by books with 102 publications. Author taken that the total of 59 countries for visualization in which the USA was found to be the most collaborative country. “Mers-cov” and “Corona virus” keywords used in maximum times. Dusten, C. was

the most productive corresponding author with 108 articles followed by Memish, Z. A. with 107 documents.

Bharati et al..(2020) carried out a bibliometric analysis on Big data for 2015-2019 at Indian level. The purpose of the study was to identify the most prolific literature which were retrieved from the Scopus database. A total of 1059 articles were taken in five years. Maximum AGR was counted in 2016 with 92.50 followed by year 2017 with 89.61, Minimum doubling time count in 2017. Computer science was found prominent subject followed by Engineering and Mathematics. Most of the literature published in Conference Proceedings followed by Journal. Johri, R. observed a top prolific author with 12 literature followed by Chakraborty, T with 9 literature.

Kumar & Gochhait (2020) concluded a bibliometric analysis on Digital Currency. Total 4216 records were taken from the Web of Science database during the study period from 1996-2020. VoS viewer and Tableau software were taken for data cleaning, sorting and visualization. In this study the author calculated (ACPP) average citation per paper which was maximum in 2015 to 2018 year and 2016 has the highest ACPP. Author clarified that China was on top with 973 articles followed by the USA with 874. Measured the publication efficiency index PEI in a country which includes, USA, England, South Korea and so on. Author highlighted India's publication which was 196 articles and 726 citations and PEI measured 0.50545 and H- Index found 14 so that India stands at 7<sup>th</sup> position.

Kamran et al. (2020) described that bibliometric study on Blockchain technology & Internet of Things. The Web of Science database was used for data collection. Author indicated that the Computer science information system was the top leading category with 63 publications. In time trend of BIOT publications in IOT and Blockchain domain was counted during the study year from 2016-2019. Total 12109 publications found in IOT publication and 975 in total blockchain publication. In published venues IEEE Access, Sensor and future generation computer systems were the found highest number of venues. In subject wise distribution Computer Science was on top followed by Telecommunication subject, China country was on top with 42 publications followed by USA with 33 publications. Author observed top keywords found such as security, computing, privacy, smart city and smart contract. In this study most of funds provided by National Natural Science Foundation of China. Blockchain and smart contracts for the Internet of Things found the highest with 248 citations.

Mohapatra et al. (2020) investigated a bibliometric analysis and policy imperatives on Blockchain Technology in the specific field Agri-Food system during the study year from 1981 to 2020. Author described that some major policy implications of blockchain technology represented that the largest node indicates its network is larger than others. In this study the author shows only 15 countries in which China had the most publications with 27.8% followed by the USA with 11.8%. Researcher shows top 20 research themes in which Computer Science subject found on top with 72 articles followed by Engineering with 56 articles and found the number of citations in 2020 was 811, which increased 45% as compared to the year 2019.

Singh & Bharati (2020) conducted a bibliometric analysis on Plagiarism literature. Total 1882 literature collected from Scopus database during the study period from 2010-2019. Microsoft Excel was used for data analysis and VoS Viewer software used for visualization in this study. Author examined that in 2013 the maximum number of papers were published in Journal Article followed by Conference Proceeding. Social Science subject was on top first followed by Computer Science. Author found that most of the Author keywords occurred in Plagiarism which was followed by Plagiarism Detection. The USA was found to be the most collaborative country during the % study year 2010 to 2019.

Singh & Bharati (2020) did a bibliometric analysis of Antibiotic Resistance during the study year between 2010- 2019. Total 445 papers were retrieved from Scopus database VoS Viewer used for visualization. In this study, 2017 was observed to be the most productive year with 67 publications followed by year 2019 with 61 publications and maximum AGR were recorded in 2012 with 61.95 %. Total 159 journals published papers in the field of antibiotics in which Journal of Clinical and Diagnostic research journal ranked in first position followed by Journal of Pure and applied Microbiology. Tamhanker, A was found most productive author with 1 publication followed by Lundborg, C. S. with 9 publications. Author observed that 25 subjects contributed in the field of Antibiotic and Medicine subjects found most productive with 113 publications followed by Bio- Chemistry, Genetics & Micro biological with 73 publications. USA was the most collaborative country followed by Sweden, Saudi Arabia and Emergence of a new Antibiotic Resistance Mechanism in India, Pakistan and the UK: A molecular biological and epidemiological study was most highly cited articles with 1818 citations.

Bharati & Singh (2019) examined the literature of Cloud Computing during the study period from 2010 to 2019. Total 11776 articles were retrieved from the Web of Science database. R. Buyya was ranked on top with 138 articles followed by J. Lee with 114 publications. China was ranked on top with 3556 publications and India was in third position with 997 research articles. English was found the prominent language with 11681 publications followed by Spanish Languages covered 54 publications. Author examined 92.89% of research articles published in articles whereas 3.11% published in review form. The most productive journal found that Future Generation Computer published the highest number of literatures published in this journal which was 445 publications followed by IEEE Access with 332 publications. Author presented top 10 highly cited papers in which A view of Cloud Computing was on top with 3225 citations followed by Internet of Things (IOT): A vision, architectural elements and future direction with 2469 citations. Computer Science, Engineering, Library and information science, Management, Science, Social Science were the found major subjects contributed in Cloud Computing research.

Bhaskar et al. (2020) provides a systematic review on Blockchain Technology in the field of education management and describes its benefits, barriers and some issues which were facing during the use of this technology and give a short bibliometrics analysis. In this paper author summarized that blockchain technology have been beneficial and easier and in education sector and it used in various works such as Admission process, Libraries works, extracurricular activities and alumni partnership because this platform mainly used for transparency and security but lack of cost, data unavailability, scalability, immaturity were found the most common reason to use blockchain technology without resolved the barriers this technology cannot be used. Most of the papers were published in Conference papers with 108 publications followed by Articles with 53 publications. In the year wise distribution year 2019 published the highest documents with 16 and 7 citations followed by 2018 with 10 publications and 8 citations.

Darabseh & Martins (2020) explained a bibliometric analysis of Blockchain literature during the study period from 2013 to 2018 and data were retrieved from the Web of Science database. Author analyzed five research questions in this study. Total 995 papers were taken for study and the author observed that 2017 was the highest publication with 444 papers and 2015 found the least number of citations. National Natural Foundation of China (NSFC) has supported the greatest number of publications with 100 papers. Computer Science subject

covered the greatest number of papers in Blockchain Technology. Blockchain and smart contracts for the Internet of Things was found highly cited article with 40.67 followed by Decentralizing Privacy: Using Blockchain to protect personal data with 21 citations. Lecture notes in Computer science examined the most popular venue based on the total number of publications.

Darabseh & Martins (2020) examined a Bibliometric study for that available literature on Blockchain Technology implementation in AECO (Architecture, Engineering, Construction and Operation) sector. Data retrieved from Web of knowledge and Scopus database. Total 40 records were taken during this study. In Annual Scientific Production 2019 has the highest publication with 30 documents and least publication in 2017 with 02 publications. Co-occurrences analysis categorized into three clusters. Blockchain found the most common keyword with 26 times occurrence, BIM 12 times and Smart contracts seven times. Nawari & Ravindran were the most productive authors with 3 articles and China was on top most productive country with 4 articles. The author observed that use of Blockchain in construction has been increasing day by day. Turk and Klinc was found to have the most cited article with 28 citations and total citation per year was 14 followed by Wang, J. with 17 citations and 8.5 total citation per year.

Firdaus et al. (2019) focused on the utilization of blockchain technology and gave a bibliometric analysis on literature. Total 1000 articles were retrieved from the Scopus database between the study period from 2013-2018. Through this study the author examined that the USA was a country that collaborated most published blockchain articles followed by China and in citation wise distribution the United States found on top with 326 citations which was followed by Germany with 160 citations. Top twenty author keywords ranked in this study in which blockchain ranking on top followed by bitcoin. Author observed that the most used communication channel in the field of blockchain technology was conference paper with 564 followed by Article with 315 publications. Least of the papers published in Short Survey, Letter and Erratum. In source wise distribution Lecture notes in computer science including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics with 152 publications followed by ACM international conference proceeding series with 36 publications.

Merediz-Solà & Bariviera (2019) concluded a bibliometric study on Bitcoin Scientific production. Total 1162 documents found during the study period from 2012-2019. Only the

Web of Science database is considered for data collection. Researchers observed that 1.97 average number of authors per document found and maximum number of documents were multi authored, being only 322 literature single authored. Economics letters and finance research letters were found top most journals. In this study the number of articles published on Bitcoin Scientific Production has been increased and the yearly growth rates were observed 124%. Author found that 35% of the articles published were made by authors of multiple countries.

Orastean et al. (2019) concluded bibliometric studies on bitcoin in the scientific literature total 887 documents were taken during the study period from 2012-2019 and data were retrieved from Web of Science core collection. Author noticed that the number of papers has increased in 2018 and 2019. Most documents used articles during this study period. Author concluded three main research fields: Computer Science with 54.1% Economics Business and finance 33.5% and Engineering Field with 12.7%. Bouri, E and Roubaud, D. found the top most authors with 12 publications. USA found the highest contribution in the field of bitcoin and the author shows only top 33 highly cited papers in which Bitcoin and beyond: A technical survey on decentralized digital currencies was on top with 192 citations.

Miau & Yang (2018) investigated the literature growth and author productivity of Blockchain Technology research and data were retrieved from Scopus database and total 801 articles found during the study year from 2008 to march 2017. Author used three stages to discover the production. The first stage from 2008 to 2013 which was related to Bitcoin and cryptocurrencies and second stage from 2014 to 2015 in this stage Bitcoin literature grew rapidly and after 2016 most fields were paying attention to the technique of blockchain and smart contract. Author used Lotka's law and indicated 605 authors make a single publication. USA archived the most important position during the study and observed top 5 sources which were found during the study period such as journals, conference proceedings, book series, books and trade publications.

Hoy, M. (2017) defined the term blockchain technology and how it will be used in libraries. In this study the author told that Librarians can have their Library work through Time stamped records in which all information was collected and preserved for a long time and sharing the information easily and with transparency and security. Digital Right Management is the best tool, librarians using this technology and it will make the work easier and save the time of librarians as well as users. As well as libraries and in the Health care sector affected

with this technology to store patient records, Medicine Information and it help to track their drug data and manufacturing status.

Kartik, H (2017) described that Blockchain Technology makes it affordable as the cost of registration and voting process is less. Blockchain Technology saved the money and also stopped the wastages of money, manpower and space. He told through this study Africans Nations and other developing countries choose this technology because it is more convenient, transparent and expensive. It is an almost automated process and also less manpower involved.

Patra (2005) examined a bibliometric study on bibliometric literature of bibliometric during the study 1968 to 2004. Collected data from LISA total 3781 records were retrieved for this bibliometric analysis. English Language produced 3110 literature followed by Russian with 172 literatures. Author found that 280 journals contribute in the field of bibliometric in which Scientometric journal was on top with 1571 articles followed by Journal of the American Society of information Science & Technology. In authorship pattern 3106 single authors have only one publication and 470 authors have two publications. Egghe was found most productive author with 62 publications followed by Glanzee, W. with 60 publications during the study.

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**CHAPTER 3**

**RESEARCH DESIGN AND**

**METHODOLOGY**

## CHAPTER-3

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### RESEARCH DESIGN AND METHODOLOGY

Data collection and research methodology is the backbone of any research work. It is the important part of any research process through which researchers conduct their research work. With the help of literature Review, researchers determine their research problems and then calculate. This chapter discusses the problem of research, hypothesis, data collection and method of data analysis. The growth and development of any discipline depends on the quality of research output. Generally, it is a recognized and significant part of any scientific research. This chapter represents that methodology is adopted for the present study.

#### 3.1 STATEMENT OF THE PROBLEM

The problem selected for the study entitled “**Global Research Productivity on Blockchain Technology: A Bibliometric Study**”. Scientific productivity is evaluated by the method of measuring the metric analysis and this is called bibliometric. This study identifies the emerging areas of scientific research, measures the development over time and geographical and organizational distribution of research. This study analyses the research productivity, authorship pattern, Citation count and literature growth Blockchain Technology by applying bibliometric parameters.

#### 3.2 OBJECTIVES OF THE STUDY

1. To find out the growth pattern of publication in Blockchain technology literature.
2. To examine the authorship pattern in blockchain technology.
3. To examine the collaborative patterns in blockchain technology.
4. To identify the most prolific authors, journals, productive countries, and communication channels.
5. To examine the applicability of bibliometrics laws in Blockchain technology.
6. To compare India’s research output along with the world’s output in Blockchain technology.
7. To find out the highly cited authors(s), articles and journals.

### **3.3 HYPOTHESES OF THE STUDY**

1. Annual growth rate of research publication is increasing.
2. Multi-authored publications are greater than a single author.
3. India is the most collaborative country in Blockchain technology.
4. USA is the most productive country in Blockchain technology.
5. Bradford's laws for journals are fit to Blockchain technology.
6. India's ranks among the top ten producing countries in world production.
7. USA is the most cited country in Blockchain technology research.

### **3.4 METHODOLOGY**

The study carried out using the Scopus database, an international database that searches for all records of articles contributed from various organizations and countries of the world. In order to fulfil the objectives, the related database was visited and the search term (TITLE-ABS\_KEY (blockchain AND technology) AND PUBYEAR < 2022) has been used. Total 14238 literature retrieved from database and MS Excel-19 version used for data analysis and for graphical presentation of data and also used VOSviewer and Biblioshiny software for data visualization and for measure of citations. Below the snapshot of the Scopus data retrieved result.

### **3.6 SCOPE AND LIMITATIONS OF THE STUDY**

There is another parallel database available for Blockchain related literature output but only the Scopus database has been used for this study. "Blockchain Technology" is the only keyword used for the data collection at Global level. The Bibliometric analysis is focused on the productivity of Blockchain Technology research for 15 years i.e. 2007-2021.

### **3.7. SIGNIFICANCE OF THE STUDY**

Bibliometric Analysis has emerged as one of the core parameters in research assessment and research output since a lot of techniques and tools were identified. The advent of new technologies and the generation maintained of bibliographic database research is gaining momentum. This study identifies prevailing trends of research, research prolific literature, geographical dominance in a particular subject enable the information generators and providers to design their own work and techniques, so it is enabled to serve the end user

based on the detailed metric analysis of the research output. This study revealed that there has been a growing development in the field of Blockchain Technology day by day. This study collected all bibliographic information in one place which is more useful for future researchers who will be engaged with this technology and also helpful to those persons who want to use this technology at their workplace such as library, Hospital, Banks and other companies.

### 3.8 STATISTICAL TOOLS AND METRIC ANALYSIS

- Annual Growth Rate
- Relative Growth Rate
- Doubling Time
- Bradford's Law

#### 3.8.1 CALCULATION OF ANNUAL GROWTH RATE (AGR)

The formula used for AGR calculation was given by Kumar and Kaliyaperumal in 2015. The below formula is used for AGR calculation:

$$\text{Annual Growth Rate (AGR)} = \frac{W_2 - W_1}{W_1} \times 100$$

IN this formula AGR represent Annual Growth Rate, W2 present the end value of the publication and W1 present first/initial value of the publication.

#### 3.8.2 CALCULATION OF RELATIVE GROWTH RATE (RGR)

The Relative Growth Rate is increased in the number of publications or pages per unit of time. A specified period of interval can be calculated from the following equations. The following model was developed by Mahapatra.

$$\text{Relative Growth Rate (RGR)} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1}$$

Where

RGR = Growth rate over the particular period of time

Log<sub>e</sub> W1 = Log of initial number of publication/ pages

$\log_e W_2 = \log$  of the final number of publication/ pages after a particular period of the interval

$T_2 - T_1 =$  The unit difference between the initial time and final time.

Here, the year can be assumed as unit of time. The RGR for the both pages and publication have been calculated separately.

### 3.8.3. DOUBLING TIME (DT)

From the calculation, this shows the direct equivalence existing between the RGR and DT. If the number of publications or pages of a subject doubles during the given period then the difference between the logarithms of the number at the beginning and at the end of the period must be the logarithms of the number two. If one uses the natural logarithms, this difference has a value of 0.693. The doubling time of the publication on a research is calculated by the following formula:

$$\text{Doubling Time (Dt)} = \frac{0.693}{R}$$

Whereas 0.693 is the constant value in the formula and R represents the Relative Growth Rate (RGR) in the concerned year.

### 3.8.4 BRADFORD'S LAW:

According to Bradford "If scientific journals are organized in order of decreasing productivity in a given subject, they can be divided into the nucleus of journals that are specifically devoted to the subject and have multiple groups or fields, containing the same number of articles when the number of periodicals. The nucleus and succeeding regions will have 1: n: n<sup>2</sup>."

Bradford Explained that journals into three zones each zone having the same articles but it is different with the number of journals.

**First Zone:** In the first zone the number of journals is very less, in such journals, one third of all published articles are published. This zone covered core journals on the subject concerned.

**Second Zone:** In the second zone of a journal the number of published articles will be equal to the first zone but the number of journals will be more in comparison to zone first.

**Third Zone:** In the third zone the number of published articles will be equal to the first and second zone but the number of journals will be much more in the comparison of the first and second zone.

### **3.9 VOS viewer**

VOSviewer is a software used to visualize data. It was developed in the year 2007 by Nees Jan Van Eck and Ludo Waltman at Leiden University's Centre for Science & Technology Studies (CWTS). Its first version was released in 2007 after that it has been continuously updated. Currently, the latest updated version 1.6.15 has been used for this study. In this study VOSviewer software has been used to construct and visualize co-occurrences, co-citations and network collaboration of literature. It represents network visualization through maps that use different colors, circle, size and font size and connecting lines to present it. The thickness of the connecting lines represents their mutual relations such as higher relative strength suggested a stronger association and circle size or font size indicated high productivity or citations.

### **3.10 BIBLIOSHINY**

Biblioshiny is a metric software that provides web based Bibliometrix GUI. It is a kind of a program built in mathematical computation and graphics R programming language to follow a logical bibliometric workflow. It is an open source tool for bibliometrics and Scientometric quantitative testing that incorporates to big bibliometric methods of study. It is open- source software and it is simple in use for the users, it is made by a well-known statistician. Bibliometrix has become very easy to use, basically for those who have no coding idea. This package includes routines for importing bibliographic data from databases such as Scopus, Web of Science, PubMed, Digital Science, Dimensions and Cochrane conducting analysis and creating data metrics for co-citation, coupling and co- word analysis.

Research Design and methodology both are the backbone of any research study and plays an important role in any research study. Data collection and interpretation of data is also a most important task of a research. The quality of research depends to a large extent on how the data has been collected to complete the research and also explain the methods which are used for study. In this way proposed objectives keeping in mind all methods and tools for collecting and interpreting data has been described in this chapter which will be more beneficial in understanding and providing the quality of research.

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**CHAPTER 4**

**DATA ANALYSIS AND**

**INTERPRETATION**

## Chapter- 4

### Data Analysis and Interpretation

This chapter discussed the whole research output on Blockchain Technology and the secondary data has been analysis and interpretation with the MS.-Excel 19 version and also statistical tools used such as VOSviewer and Biblioshiny software. All the data on Blockchain Technology retrieved from Scopus database for 2007 to 2021 using keyword (TITLE-ABS-KEY (blockchain AND technology) AND PUBYEAR < 2022) and total 14238 documents published in the field of Blockchain Technology during 2007-2021 were used in the analysis. This analysis has been categorised into many ways such as year wise distribution, world growth ratio, language wise distribution, communication channels, collaborative pattern, highly cited journal, authors, title, keyword occurrences, Bradford law and country wise distribution.

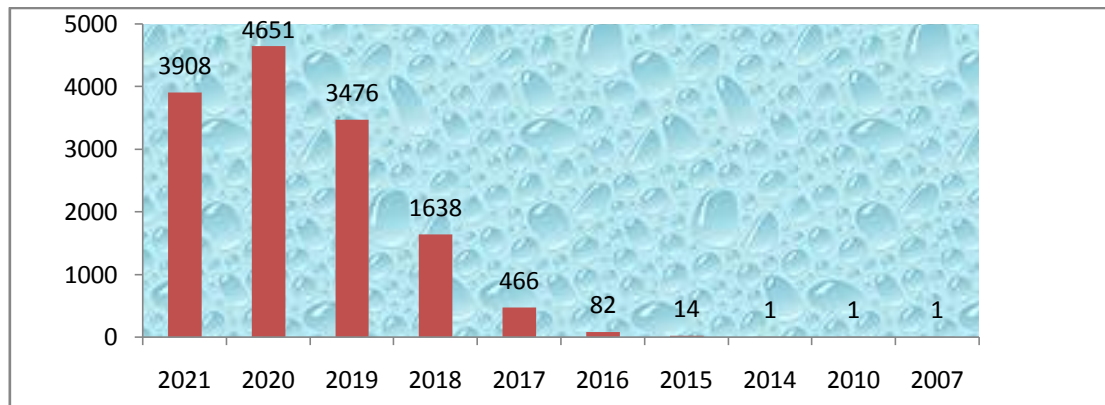
#### 4.1 Year-Wise Distribution of Publications

Year wise distribution of publication has been presented in table-4.1.1 and figure-4.1.1 A total 14238 number of publications is found during the study period. This table shows the highest number of publications in 2020 with 4651(32.66%) and least number of publications in the years 2007, 2010 and 2014 with 01 publication. In this study, it is found that there was no publication in the year of 2008,2009,2011,2012 and 2013.

**Table-4.1.1 Year wise distribution**

S.N.	Year	Number of Publications	% (14238)
1	2021	3908	27.44%
2	2020	4651	32.66%
3	2019	3476	24.41%
4	2018	1638	11.50%
5	2017	466	3.27%
6	2016	82	0.57%
7	2015	14	0.09%
8	2014	1	0.007%
9	2010	1	0.007%
10	2007	1	0.007%
		14238	100%

**Figure-4.1.1 Year wise distribution**



#### 4.2 Annual Growth Rate of Blockchain Technology Publication

Table and figure shows the Annual Growth Rate of Blockchain Technology literature during the study period from 2007-2021. In this study researcher count maximum AGR in 2015 with 1300 Annual growth rate followed by year 2016 with 485.71 and minimum AGR count in 2021 with -15.97% followed by year 2020 with 33.80. Detailed calculation of Annual Growth Rate of Blockchain Technology publication is based on the following formula which is given by Kumar and Kaliyaperumal in 2015.

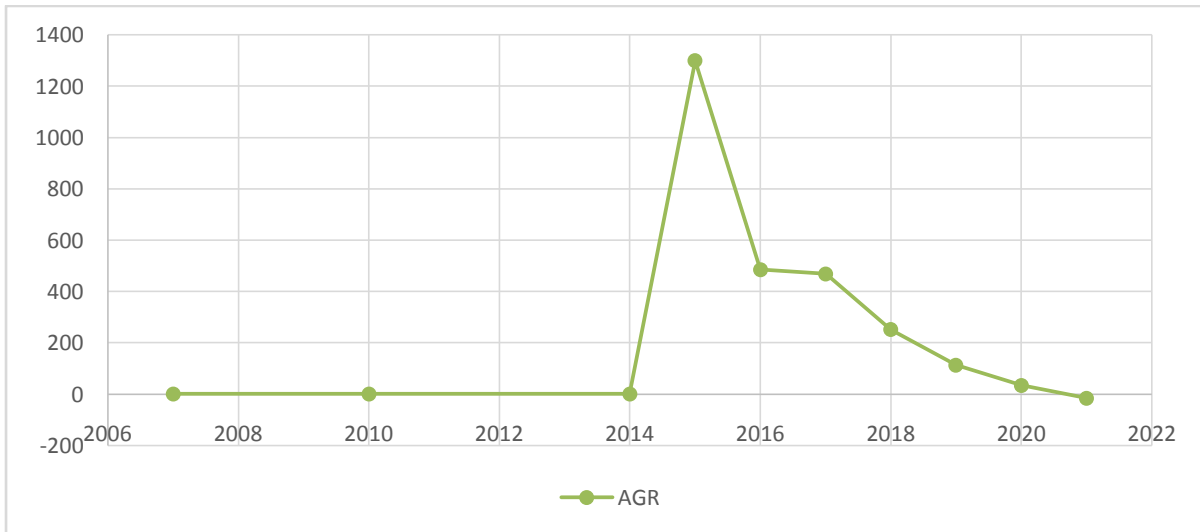
$$\text{Annual Growth Rate (AGR)} = \frac{W2 - W1}{W1} \times 100$$

In this formula AGR represents Annual Growth Rate, W2 presents the end value of the publication and W1 presents the initial value of the publication.

**Table-4.2.1 Annual Growth Rate**

S.N.	Year	Initial Value(W1)	End Value(W2)		AGR
1.	2007	0	1	1	Not define
2.	2010	1	1	0	0
3.	2014	1	1	0	0
4.	2015	1	14	13	1300
5.	2016	14	82	68	485.71
6.	2017	82	466	384	468.29
7.	2018	466	1638	1172	251.50
8.	2019	1638	3476	1838	112.21
9.	2020	3476	4651	1175	33.80
10.	2021	4651	3908	-743	-15.97

**Figure-4.2.1 Annual Growth Rate**



### 4.3. Relative Growth Rate of Blockchain Technology Publications

Relative Growth rate on the Blockchain Technology literature are calculated by a formula. The RGR formula are given below:

$$\text{Relative Growth Rate (RGR)} = \frac{W2 - W1}{T2 - T1}$$

In this formula RGR represents the Relative Growth Rate, W1 is found out by  $\text{Log}^e$  value of the initial number of publications, W2 is found out by  $\text{Log}^e$  value of the end number of publications. T1 represents the initial year and T2 represents the end year.

#### The Doubling time of the publication:

The doubling time of the publication on Blockchain Technology is calculated by the following formula:

$$\text{Doubling Time (Dt)} = \frac{0.693}{R}$$

Whereas 0.693 is the constant value in the formula and R represents the Relative Growth Rate (RGR) in the concerned year.

**Table-4.3.1 Relative Growth Rate and Doubling time**

Year	Initial Value	New added Publication	End Value of Publication	W1	W2	RGR	Dt
2007	0	1	1	Undefined	0	Undefined	Undefined
2010	1	1	2	0	0	0	0
2014	1	1	2	0	0	0	0
2015	1	14	15	0	2.63	2.63	0.26
2016	14	82	96	2.63	4.4	1.77	0.39
2017	82	466	548	4.4	6.14	1.74	0.40
2018	466	1638	2104	6.14	7.4	1.26	0.55
2019	1638	3476	5114	7.4	8.15	0.75	0.92
2020	3476	4651	8127	8.15	8.44	0.29	2.39
2021	4651	3908	8559	8.44	8.27	-0.17	-4.08

**Figure-4.3.1 Relative Growth Rate of Blockchain Technology Publication**

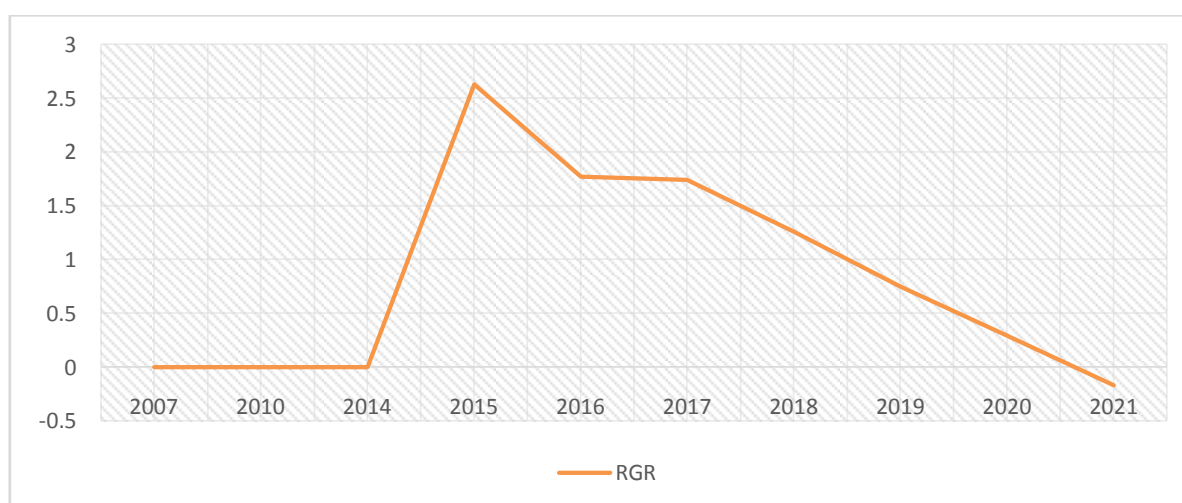


Table and figure-4.3.1 presented the RGR on Blockchain Technology publications during the study period from 2007-2021 in which Maximum RGR count in 2015 which was 2.63 whereas in the year 2016 RGR calculated 1.77 and minimum RGR count in the year 2021 - 0.17 which is followed by 0.29 in the year 2020. Further, the calculation has been made for doubling time for the publication of Blockchain Technology research and maximum Doubling Time recorded in 2020 which was 2.39.

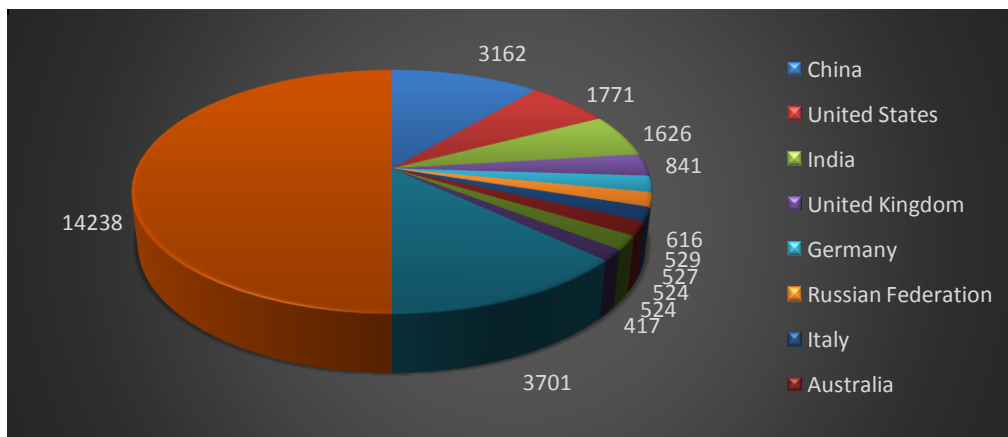
#### 4.4. India's Research output along with the World's output in Blockchain Technology

India's contribution to world contributions during the year 2007-2021 in Blockchain Technology research is shown on table and figure-4.4.1. Maximum 160 countries' authors contributed papers on Blockchain Technology during the study period. It is analysed that total 14238 number of publications published in which 1626 publications by Indians contributors which is around 11.42 % of total world output of 14238. China has the highest publications 3162 which is around 22.21 % of the world output followed by the United States with 1771 (11.42%). During the analysis it has been found that India's Sharing percentage in the world secured at the third position.

**Table-4.4.1. India's Research Output along with the World's Output**

S.N.	COUNTRY	PUBLICATIONS	PERCENTAGE
1.	China	3162	22.21
2.	United States	1771	12.44
3.	India	1626	11.42
4.	United Kingdom	841	5.91
5.	Germany	616	4.33
6.	Russian Federation	529	3.72
7.	Italy	527	3.70
8.	Australia	524	3.68
9.	South Korea	524	3.68
10.	Canada	417	2.93
11.	Other Countries	3701	25.99
	Total	14238	100.00

**Figure-4.4.1 India's Research output along with the world's output**



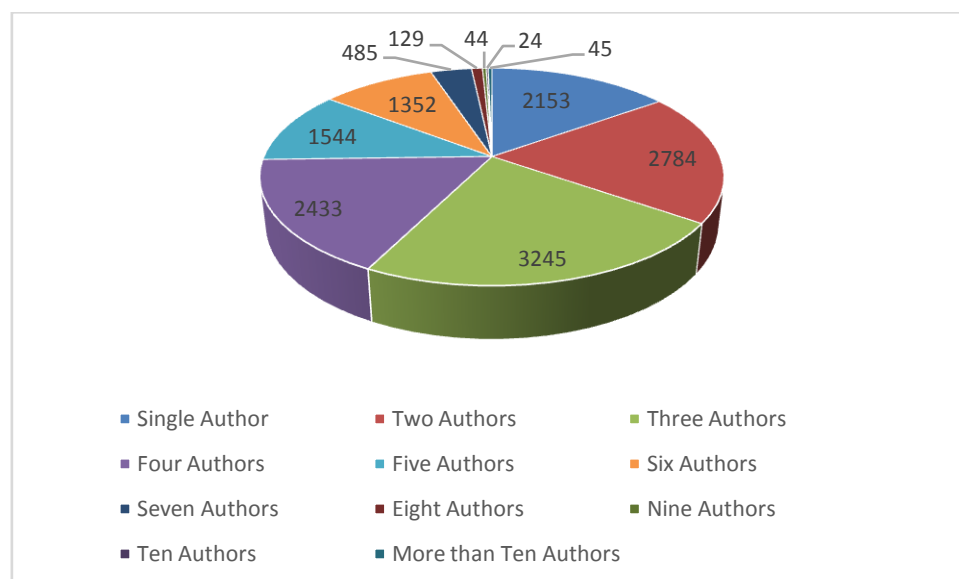
#### 4.5 Authorship Pattern

It is found that Table and figure-4.5.1 presents the authorship pattern of Blockchain Technology during the study period. Total number of 14238 literature published on Blockchain Technology in which 2153 single authors published literature on blockchain Technology in Various forms during the study period. Total 2784 literature published by Double author, 3245 literature published by three authors. Further it is observed that 45 documents were published by more than ten authors. Maximum number of literature (22.79%) is 3245 that is published by three authors.

**Table-4.5.1 Authorship pattern**

S.N.	Author	Number of Documents	Percentage
1.	Single Author	2153	15.12
2.	Two Authors	2784	19.55
3.	Three Authors	3245	22.79
4.	Four Authors	2433	17.09
5.	Five Authors	1544	10.84
6.	Six Authors	1352	9.50
7.	Seven Authors	485	3.41
8.	Eight Authors	129	0.91
9.	Nine Authors	44	0.31
10.	Ten Authors	24	0.17
11.	More than Ten Authors	45	0.32
	Total	14238	100.00

**Figure-4.5.1 Authorship Pattern**



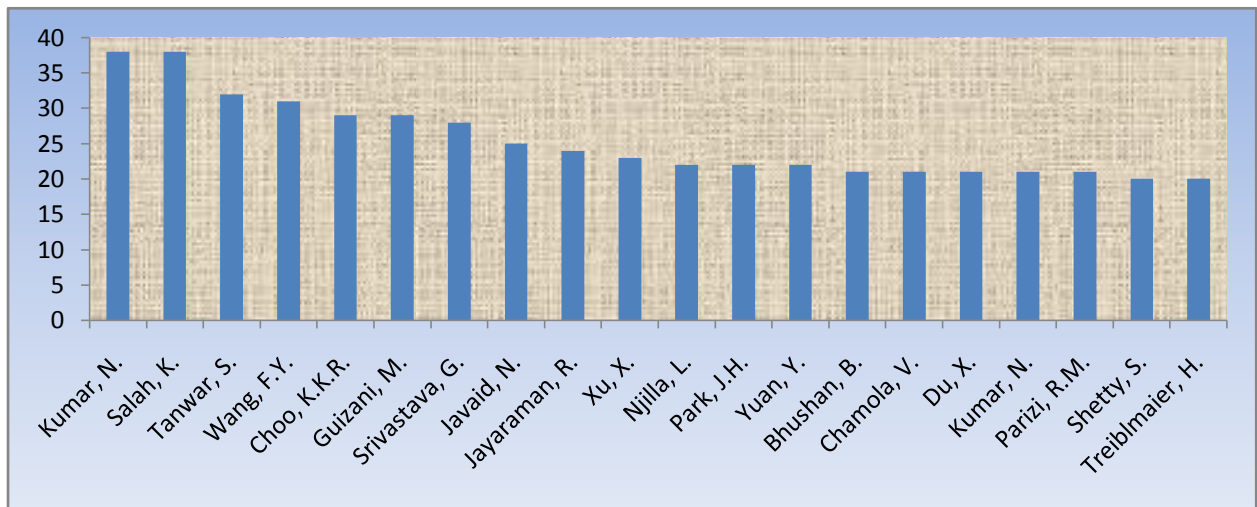
#### 4.6 Most Prolific Authors

Table-4.6.1 and figure-4.6.1 shows the top twenty most prolific authors based on their number of publications during the period 2007-2021. Authors contribute in the field of Blockchain Technology in which top twenty are presented here in which Kumar, N. and Salah, H have been found highest prolific authors with 38 publications followed by Tanwar, S. which was on third number with 32 publications. Wang, F.Y. observed on fourth number with 31 publications followed by Choo, K.K.R. with 29. More than twenty authors published under 10 publications in the field of Blockchain Technology during the 2007-2021.

**Table-4.6.1 Top Twenty Prolific Authors**

<b>S.N.</b>	<b>AUTHOR NAME</b>	<b>NUMBER OF PUBLICATIONS</b>
1.	Kumar, N.	38
2.	Salah, K.	38
3.	Tanwar, S.	32
4.	Wang, F.Y.	31
5.	Choo, K.K.R.	29
6.	Guizani, M.	29
7.	Srivastava, G.	28
8.	Javaid, N.	25
9.	Jayaraman, R.	24
10.	Xu, X.	23
11.	Njilla, L.	22
12.	Park, J.H.	22
13.	Yuan, Y.	22
14.	Bhushan, B.	21
15.	Chamola, V.	21
16.	Du, X.	21
17.	Kumar, N.	21
18.	Parizi, R.M.	21
19.	Shetty, S.	20
20.	Treiblmaier, H.	20

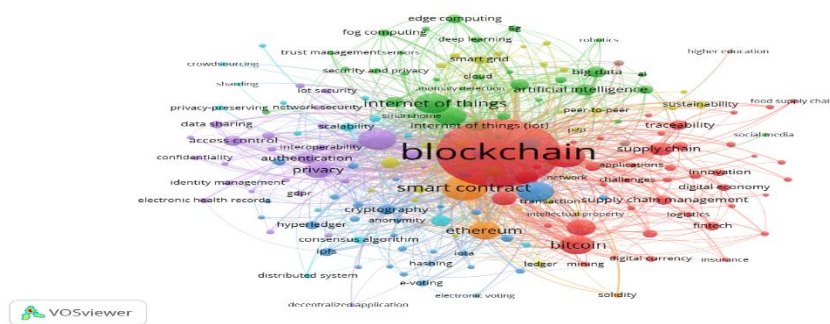
**Figure-4.6.1 Top Twenty Prolific Authors**



**4.7 Author Keyword Occurrences**

The VOSviewer software has been used for the co-occurrences bibliometric map. Author keywords are retrieved from the Scopus database. A total 14941 keywords have been found in 14238 articles of Blockchain Technology. In which 935 keywords have been found when minimum occurrences were selected at 5. Further it is observed that the “Blockchain” keyword occurs in maximum times followed by Smart Contract and Internet of Things.

**Figure-4.7.1. Author keyword Occurrences**



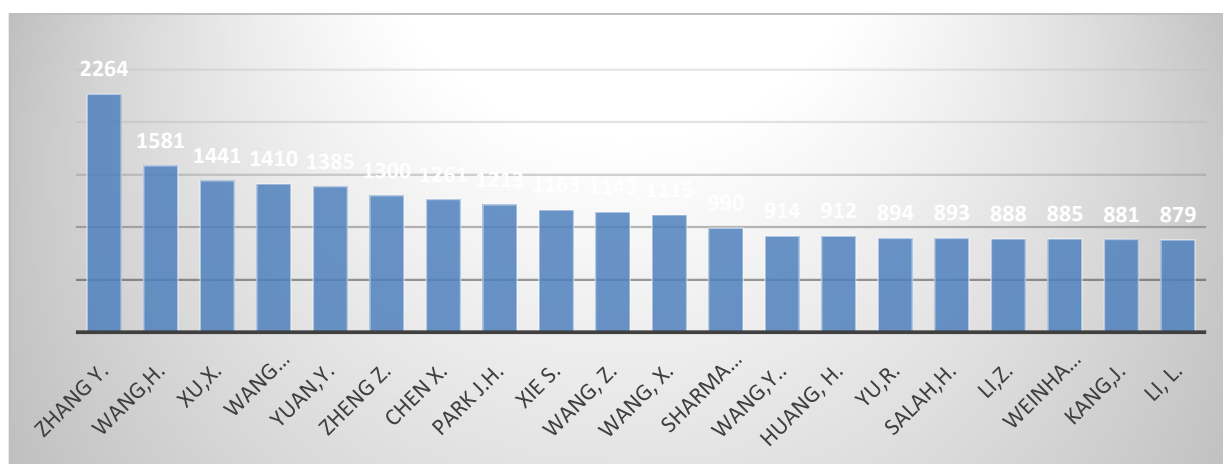
**4.8 Highly Cited Authors**

Table and figure-4.8.1 presented top twenty highly cited authors in the field of Blockchain Technology during 2007-2021. Zhang Y. was at first position with 2264 citations followed by Wang, H. with 1581 citations. Xu, X. was at third position with their 1441 citations whereas Wang f, Y. with 1410 citations. A detail of Top twenty author along with their citations.

**Table-4.8.1 Top Twenty Highly Cited Authors**

S.N.	AUTHORS	CITATIONS
1.	Zhang y.	2264
2.	Wang,h.	1581
3.	Xu,x.	1441
4.	Wang f, Y.	1410
5.	Yuan,Y.	1385
6.	Zheng Z.	1300
7.	Chen X.	1261
8.	Park j.h.	1213
9.	Xie S.	1163
10.	Wang, Z.	1143
11.	Wang, x.	1115
12.	Sharma P.K	990
13.	Wang,Y..	914
14.	Huang, H.	912
15.	Yu,R.	894
16.	Salah,H.	893
17.	Li,Z.	888
18.	Weinhardt, C.	885
19.	Kang,J.	881
20.	Li, L.	879

**Figure-4.8.2 Top Twenty Highly Cited Authors**



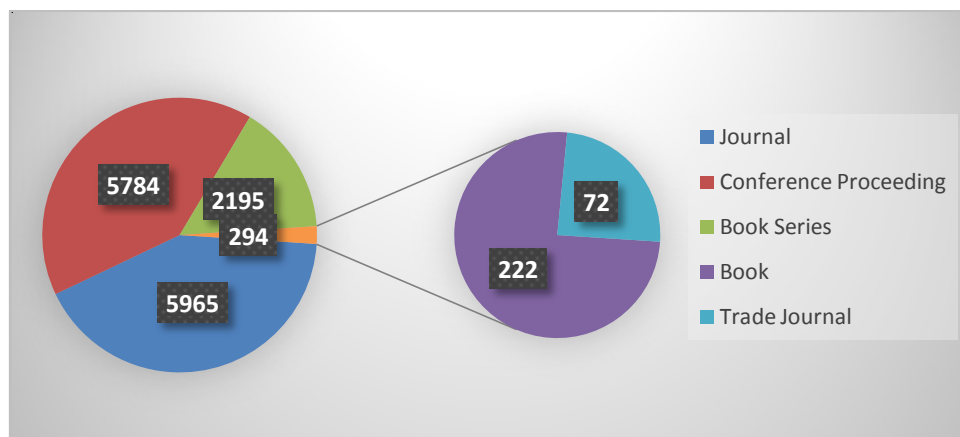
#### 4.9 Most Prolific Communication Channels

Table and figure-4.9.1. shows that the most prolific communication channels in the field of blockchain Technology during the 2007- 2021. Here most prolific communication channels are presented in which Journal is top with 5965 (41.89%) publications followed by Conference Proceeding with 5784 (40.62%) publications. 2195 (15.42%) Blockchain Technology literature published in Book series whereas in Book, 222 publications published. The least number of communication channels is found in Trade journals with 72(0.51%) publications.

**Table-4.9.1 Most Prolific Communication Channels**

S.N.	Communication Channels	Number of Publication	% (14238)
1.	Journal	5965	41.89
2.	Conference Proceeding	5784	40.62
3.	Book Series	2195	15.42
4.	Book	222	1.56
5.	Trade Journal	72	0.51

**Figure-4.9.1 Most Prolific Communication Channels**



#### 4.10 Most Prolific Journals

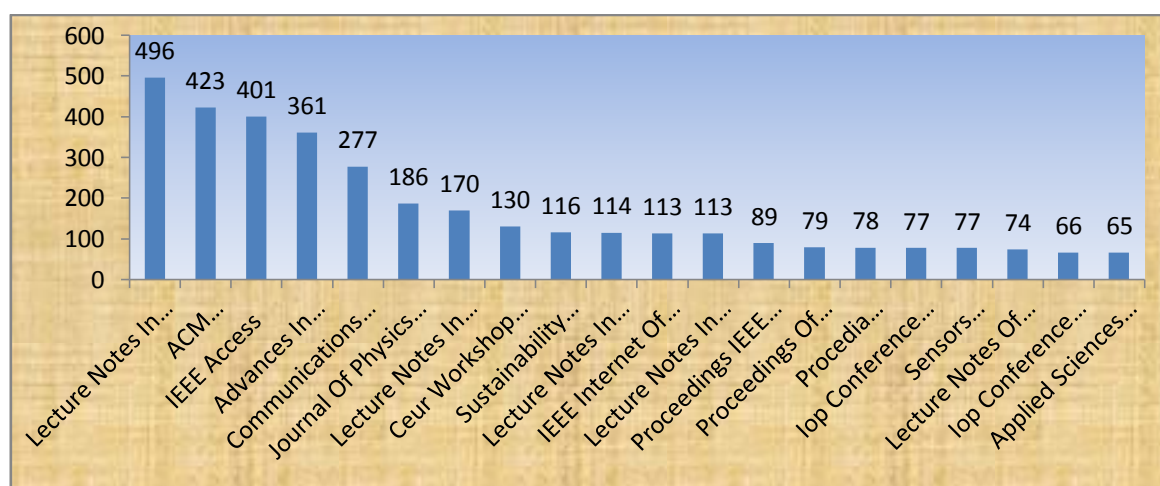
Table-4.10.1 and figure-4.10.1 shows the top twenty most prolific journals in the field of Blockchain Technology during the study period from 2007-2021. Total 5965 articles published in journal in which author is found that “Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In

Bioinformatics” with 496 (8.32%) followed by “ACM International Conference Proceeding Series” with 423 (7.09%).

**Table-4.10.1 Most Prolific Journals**

<b>S.N.</b>	<b>SOURCE TITLE</b>	<b>NUMBER OF PUBLICATIONS</b>	<b>%</b>
1.	Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	496	8.32
2.	ACM International Conference Proceeding Series	423	7.09
3.	IEEE Access	401	6.72
4.	Advances In Intelligent Systems And Computing	361	6.05
5.	Communications In Computer And Information Science	277	4.64
6.	Journal Of Physics Conference Series	186	3.12
7.	Lecture Notes In Networks And Systems	170	2.85
8.	Ceur Workshop Proceedings	130	2.18
9.	Sustainability Switzerland	116	1.94
10.	Lecture Notes In Electrical Engineering	114	1.91
11.	IEEE Internet Of Things Journal	113	1.89
12.	Lecture Notes In Business Information Processing	113	1.89
13.	Proceedings IEEE 2018 International Congress On Cybermatics 2018 IEEE Conferences On Internet Of Things Green Computing And Communications Cyber Physical And Social Computing Smart Data Blockchain Computer And Information Technology Ithings Greencom Cpscom Smartdata Blockchain CIT 2018	89	1.49
14.	Proceedings Of The Annual Hawaii International Conference On System Sciences	79	1.32
15.	Procedia Computer Science	78	1.31
16.	Iop Conference Series Earth And Environmental Science	77	1.29
17.	Sensors Switzerland	77	1.29
18.	Lecture Notes Of The Institute For Computer Sciences Social Informatics And Telecommunications Engineering Lnicst	74	1.24
19.	Iop Conference Series Materials Science And Engineering	66	1.11
20.	Applied Sciences Switzerland	65	1.09

**Figure-4.10.1 Most Prolific Journals**



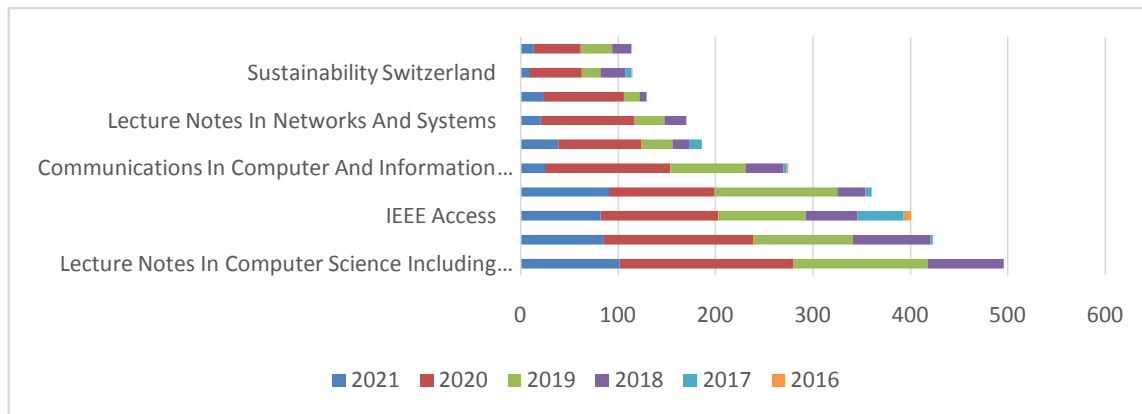
#### 4.11 Year wise Journal Growth

The year wise growth of Blockchain Technology from 2016-2021 is shown in the below table and figure. It is observed that Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics published 178 articles in the year 2020 but during 2016 to 2017, it has not been published even single articles. ACM International Conference Proceeding Series is at second position which publishes 67 articles in 2021 and no publication in the year of 2016. It is found that the number of publications in the top ten journals has been increased in the year of 2020 and 2021.

**Table-4.11.1 Year-Wise Journal Growth**

S.N.	NAME OF JOURNAL	2021	2020	2019	2018	2017	2016
1.	Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	102	178	138	78	0	0
2.	ACM International Conference Proceeding Series	85	154	102	80	2	0
3.	IEEE Access	82	121	90	53	47	8
4.	Advances In Intelligent Systems And Computing	91	108	126	29	6	1
5.	Communications In Computer And Information Science	25	129	77	39	3	2
6.	Journal Of Physics Conference Series	39	85	32	17	13	0
7.	Lecture Notes In Networks And Systems	21	96	31	22	0	0
8.	Ceur Workshop Proceedings	24	82	16	7	1	0
9.	Sustainability Switzerland	9	54	19	26	6	1
10.	Lecture Notes In Electrical Engineering	13	49	32	20	0	0

**Figure-4.11.1 Year-Wise Journal Growth**



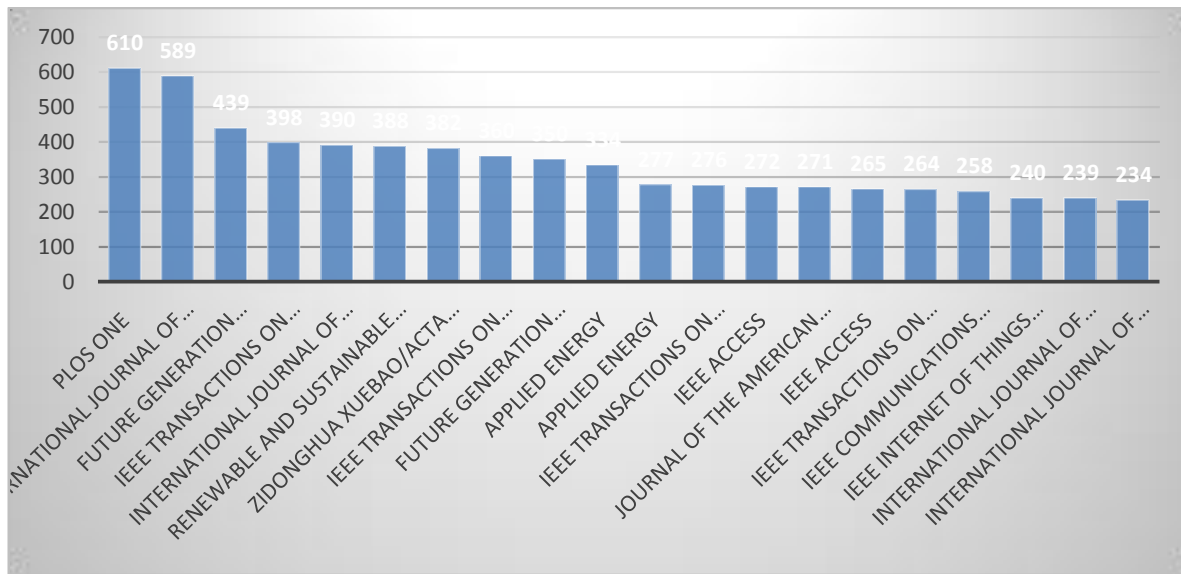
### 4.12 Highly Cited Journals

Table and figure-4.12.1 presents the top twenty highly cited Journal during 2007-2021. Total 5965 journals are published literature on Blockchain Technology in which “PloS One” is found at top with 610 citations followed by “International Journal of Web and Grid Services” with 589 citations. Future “Generation Computer Systems” at third position with 439 citations whereas “IEEE Transactions on Industrial Informatics” with 398 citations.

**Table-4.12.1 Highly Cited Journals**

S.N.	JOURNAL NAME	CITATIONS
1.	PloS ONE	610
2.	International Journal of Web and Grid Services	589
3.	Future Generation Computer Systems	439
4.	IEEE Transactions on Industrial Informatics	398
5.	International Journal of Production Research	390
6.	Renewable and Sustainable Energy Reviews	388
7.	Zidonghua Xuebao/Acta Automatica Sinica	382
8.	IEEE Transactions on Industrial Informatics	360
9.	Future Generation Computer Systems	350
10.	Applied Energy	334
11.	Applied Energy	277
12.	IEEE Transactions on Dependable and Secure Computing	276
13.	IEEE Access	272
14.	Journal of the American Medical Informatics Association	271
15.	IEEE Access	265
16.	IEEE Transactions on Knowledge and Data Engineering	264
17.	IEEE Communications Magazine	258
18.	IEEE Internet of Things Journal	240
19.	International Journal of Network Security	239
20.	International Journal of Production Research	234

**Figure-4.12.1 Highly Cited Journals**



**4.13 Bradford’s Law and distribution of Articles on Journals**

Total 14238 literature found during 2007-2021 on Blockchain Technology in which 5965 literature found under the journal categories so only these publications were considered for calculation. Table4.13.1 shows that a total 1582 journals have published 5965 publications in Blockchain Technology research. It is also seen that in total 918 journals have published only one paper, on the other hand there is one journal in which 402 literature have been published. It is also observed that 235 journals have published only two articles.

**Table-4.13.1 Distribution of Articles in Journals**

No. of Journals	No. of Articles	Total Articles	Cumulative Journal(s)	Cumulative Total Articles	% of Articles	Zone
1	402	402	1	402	6.74	Zone 1
1	130	130	2	532	2.18	Zone 1
1	108	108	3	640	1.81	Zone 1
1	77	77	4	717	1.29	Zone 1
1	76	76	5	793	1.27	Zone 1
1	64	64	6	857	1.07	Zone 1
1	60	60	7	917	1.01	Zone 1
1	52	52	8	969	0.87	Zone 1
1	45	45	9	1014	0.75	Zone 1
1	44	44	10	1058	0.74	Zone 1
4	41	164	14	1222	2.75	Zone 1
4	39	156	18	1378	2.62	Zone 1

1	37	37	19	1415	0.62	Zone 1
1	36	36	20	1451	0.60	Zone 1
1	34	34	21	1485	0.57	Zone 1
1	30	30	22	1515	0.50	Zone 1
1	29	29	23	1544	0.49	Zone 1
5	27	135	28	1679	2.26	Zone 1
1	26	26	29	1705	0.44	Zone 1
1	22	22	30	1727	0.37	Zone 1
1	24	24	31	1751	0.40	Zone 1
1	23	23	32	1774	0.39	Zone 1
8	11	88	40	1862	1.48	Zone 1
6	21	126	46	1988	2.11	Zone 1
16	20	320	62	2308	5.36	Zone 2
4	19	76	66	2384	1.27	Zone 2
4	18	72	70	2456	1.21	Zone 2
3	17	51	73	2507	0.85	Zone 2
8	16	128	81	2635	2.15	Zone 2
3	15	45	84	2680	0.75	Zone 2
8	14	112	92	2792	1.88	Zone 2
8	13	104	100	2896	1.74	Zone 2
9	12	108	109	3004	1.81	Zone 2
16	10	160	125	3164	2.68	Zone 2
11	9	99	136	3263	1.66	Zone 2
24	8	192	160	3455	3.22	Zone 2
23	7	161	183	3616	2.70	Zone 2
26	6	156	209	3772	2.62	Zone 2
41	5	205	250	3977	3.44	Zone 2
63	4	252	313	4229	4.22	Zone 3
116	3	348	429	4577	5.83	Zone 3
235	2	470	664	5047	7.88	Zone 3
918	1	918	1582	5965	15.39	Zone 3
1582	1657	5965	5216	95122	100.00	Zone 3

Table-4.13.1 described the Bradford zones of Scattering for Blockchain technology literature. It is found that total 1582 journals have published 5965 literature during the study year 2007-2021. Total 1582 journals are divided in to three zones each are publishing approximately 33% (1988) of the total Blockchain Technology literature (5965). Further it is also seen that 46 journals (2.91%) of the journals that published articles on Blockchain technology have been scattered in Zone 1 whereas 204 journals (12.90%) have been scattered in Zone 2 and 1332 journals (84.20%) journals have been scattered in Zone 3. After the data analysis, Zone 3 observed lower influence than Zone 1 or Zone 2. All zones for the journals and articles have been analyses as follows:

The total articles are scattered into three Zones. Approximately 33% of articles have been taken in each part as follows

= 1988:1989:1988 (1<sup>st</sup> 33%: then next 33%: then next 33%)

The number of journals published to the 1<sup>st</sup> 1988 articles have been placed in Zone 1 and the number of journals 1989 have been placed in Zone 2. Furthermore, the number of journals published the next 1989 journals have been placed in Zone 3.

For the calculation of the expected value of three zones and the Bradford formula is used as follows:

= 1: n: n<sup>2</sup> (where multiplier 'n' = 5.48 (average) is calculated from the division of observed journals with each other)

= 46 X 5.48<sup>0</sup>: 46 X 5.48<sup>1</sup>: 46 X 5.48<sup>2</sup>

= 46: 252: 1381

Accordingly, the expected value of journals for all zones have been calculated. It has been found that from Table-4.13 shows that the calculated value of Zone II is 252 while the observed value is 204. Next Zone III, the calculated value was observed to be 1381 while the observed value 1332. It is found that there is a difference between expected value and observed values so that Bradford Law of Scattering of articles in journals is not applicable in Blockchain Technology research.

**Table-4.13.2 Bradford's Law of Scattering of Articles in Journals**

<b>Zone</b>	<b>Observed Journals</b>	<b>% of Journals</b>	<b>No. of Articles</b>	<b>% of Articles</b>	<b>Cumulative of articles</b>	<b>Bradford' Multiplier</b>	<b>Expected Journals</b>
<b>Zone 1</b>	46	2.91	1988	33.32%	1988	-	46
<b>Zone 2</b>	204	12.90	1989	33.34%	3977	4.43	252
<b>Zone 3</b>	1332	84.20	1988	33.32%	5965	6.53	1381
<b>Total</b>	<b>1582</b>	<b>100</b>	<b>5965</b>	<b>100%</b>	<b>11930</b>	<b>5.48</b>	<b>1679</b>

#### 4.14 Collaboration of Countries

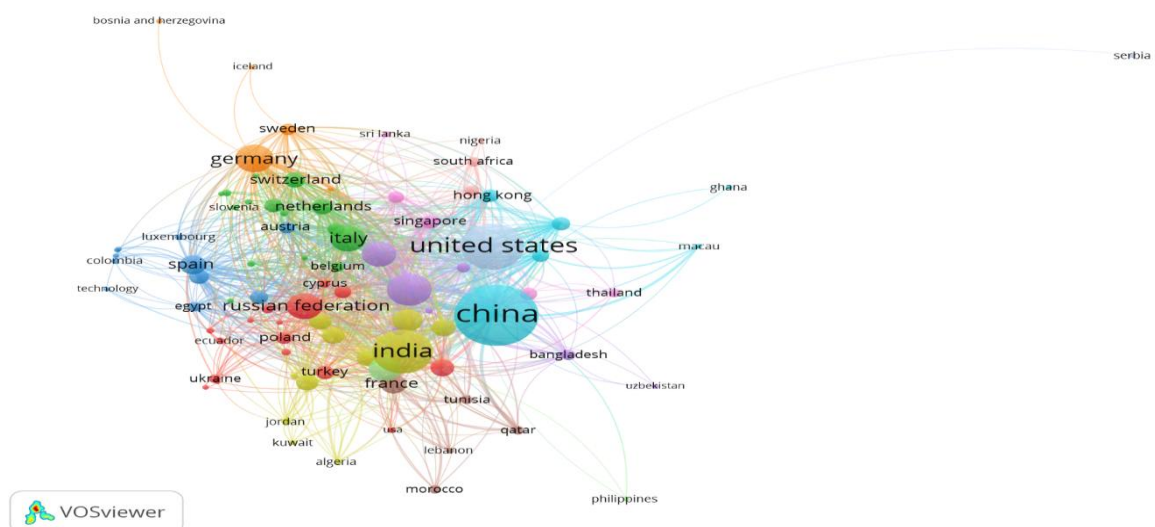
Table and figure-4.14.1 shows collaboration of countries on the publication of Blockchain Technology during the study year. In this study the author has observed that the United States

is found to be the most collaborative country and collaborated with 67 countries followed by the United Kingdom with 8176 citations and collaborated with 63 countries. Further it is observed that China has the highest citations and it collaborates with 60 countries. India is in fourth number and it collaborates with 57 countries.

**Table-4.14.1 Collaboration of Countries in the field of Blockchain Technology**

S.N.	COUNTRY	CITATIONS	LINKS
1.	UNITED STATES	18954	67
2.	UNITED KINGDOM	8176	63
3.	CHINA	20234	60
4.	INDIA	4963	57
5.	AUSTRALIA	5841	52
6.	CANADA	3414	43
7.	GERMANY	4995	48
8.	ITALY	5236	42
9.	SPAIN	2347	39
10.	SOUTH KOREA	5139	37

**Figure-4.14.1 Collaboration of Countries in the field of Blockchain Technology**



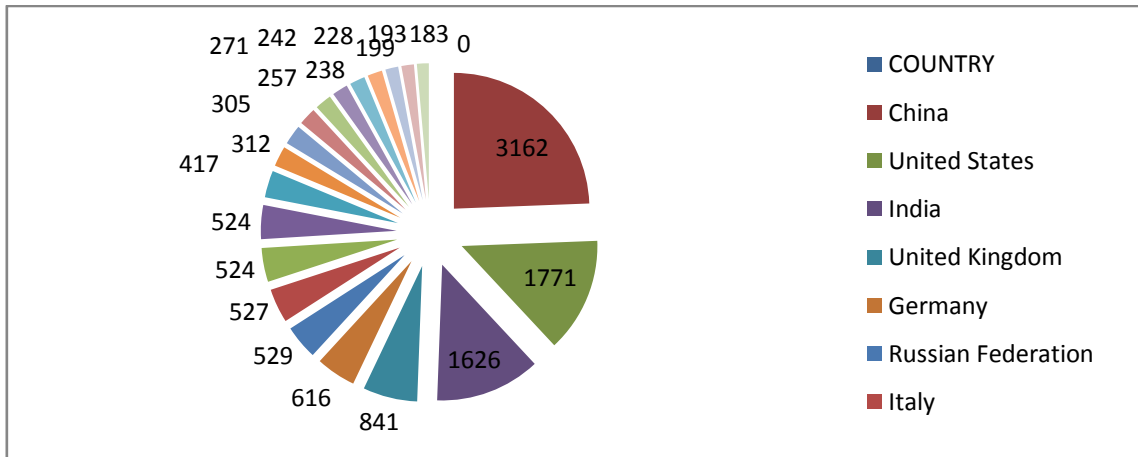
#### 4.15 Most Productive Countries

Table and figure-4.15.1 represented the top 20 most productive countries in the publication of Blockchain Technology. Maximum 145 countries have published literature on Blockchain Technology in which China observed the highest number of publications with 3162 (17.65%) publications followed by the United States with 1771(9.88%) documents. India is in third position with 1626 (9.07%) documents, United Kingdom is in fourth position with 841(4.69%) publications, Germany is in fifth position with 616(3.43%) publications. There are twenty countries, where less than 10 publications have been published in which countries are Oman, Peru, Argentina and Belarus.

**Table-4.15.1 Top 20 Most Productive Countries**

S.N.	COUNTRY	NUMBER OF PUBLICATION	PERCENTAGE
1.	China	3162	17.65%
2.	United States	1771	9.88%
3.	India	1626	9.07%
4.	United Kingdom	841	4.69%
5.	Germany	616	3.43%
6.	Russian Federation	529	2.95%
7.	Italy	527	2.94%
8.	Australia	524	2.92%
9.	South Korea	524	2.92%
10.	Canada	417	2.32%
11.	France	312	1.74%
12.	Spain	305	1.70%
13.	Saudi Arabia	271	1.51%
14.	Taiwan	257	1.43%
15.	Malaysia	242	1.35%
16.	Japan	238	1.32%
17.	United Arab Emirates	228	1.27%
18.	Pakistan	199	1.11%
19.	Netherlands	193	1.07%
20.	Switzerland	183	1.02%

**Figure-4.15.1 Top 20 Most Prolific Countries**



**4.16 Highly Cited Articles**

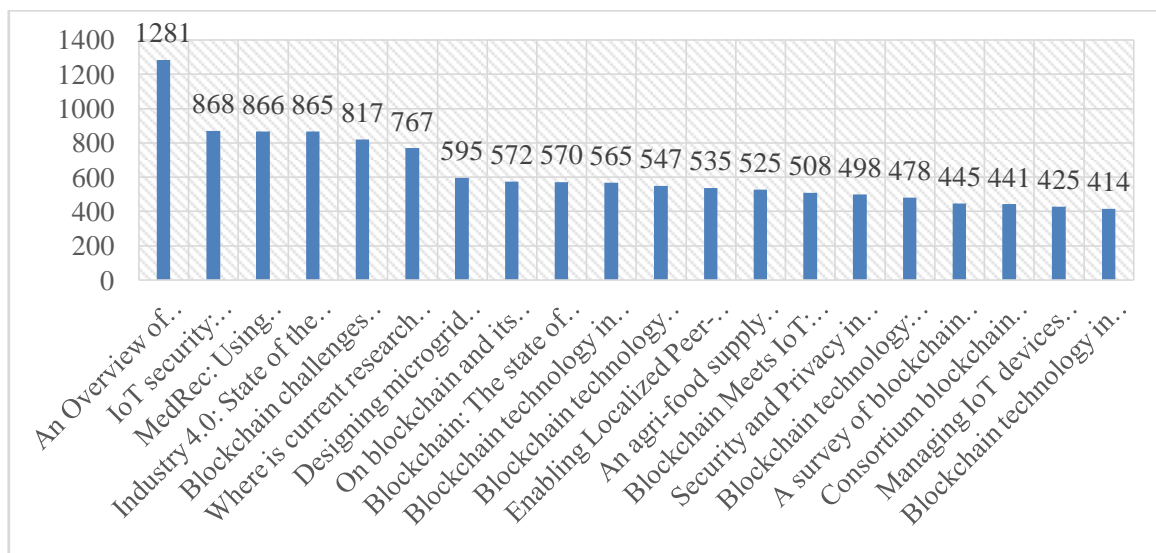
Table and figure-4.16.1 shows highly cited articles in the field of Blockchain Technology during the study period from 2007-2021. It is found that “An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends” received the highest citations with 1281 followed by “IoT security: Review, blockchain solutions, and open challenges” with 868 citations. Further it is seen that the title “MedRec: Using blockchain for medical data access and permission management” is on third position with 866 citations followed by “Industry 4.0: State of the art and future a trend” is on fourth position with 865 citations while “Blockchain technology in healthcare: The revolution starts here” is on 20<sup>th</sup> position with 414.

**Table-4.16.1 Highly Cited Articles**

S.N.	Title	Citations
1.	An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends	1281
2.	IoT security: Review, blockchain solutions, and open challenges	868
3.	MedRec: Using blockchain for medical data access and permission management	866
4.	Industry 4.0: State of the art and future trends	865
5.	Blockchain challenges and opportunities: A survey	817
6.	Where is current research on Blockchain technology? - A systematic review	767
7.	Designing microgrid energy markets: A case study: The Brooklyn Microgrid	595
8.	On blockchain and its integration with IoT. Challenges and opportunities	572

9.	Blockchain: The state of the art and future trends	570
10.	Blockchain technology in the energy sector: A systematic review of challenges and opportunities	565
11.	Blockchain technology and its relationships to sustainable supply chain management	547
12.	Enabling Localized Peer-to-Peer Electricity Trading among Plug-in Hybrid Electric Vehicles Using Consortium Blockchains	535
13.	An agri-food supply chain traceability system for China based on RFID & blockchain technology	525
14.	Blockchain Meets IoT: An Architecture for Scalable Access Management in IoT	508
15.	Security and Privacy in Decentralized Energy Trading Through Multi-Signatures, Blockchain and Anonymous Messaging Streams	498
16.	Blockchain technology: Principles and applications	478
17.	A survey of blockchain security issues and challenges	445
18.	Consortium blockchain for secure energy trading in industrial internet of things	441
19.	Managing IoT devices using blockchain platform	425
20.	Blockchain technology in healthcare: The revolution starts here	414

**Figure-4.16.1 Highly Cited Articles**



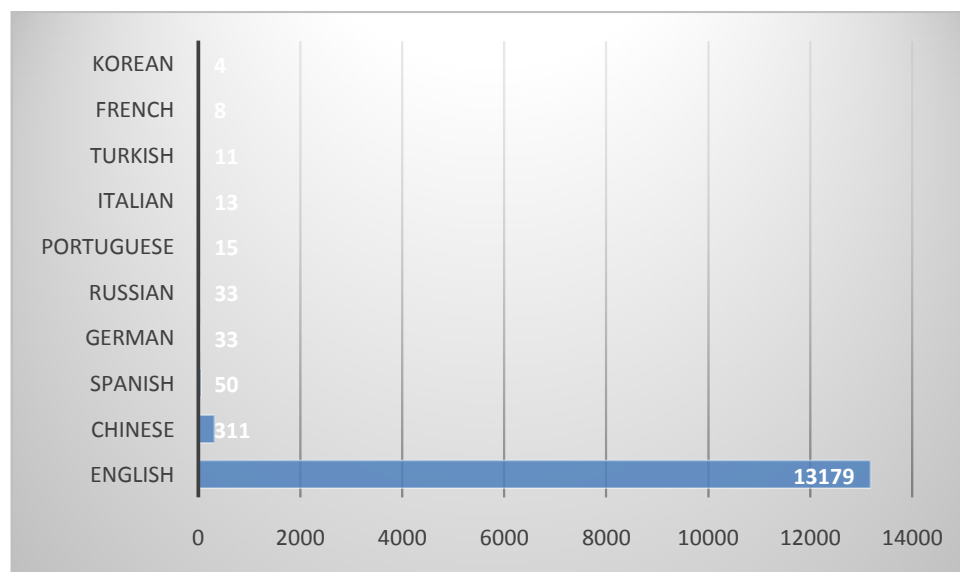
#### 4.17 Language-Wise Distribution

Language wise distribution of literature on Blockchain Technology has been shown in below table and figure. This study reveals that the maximum number of publications on Blockchain Technology is published in English language with 13179 (96.42%) followed by Chinese language with 311(2.28%) publications, Spanish language with 50 (0.37%) publications and the remaining languages such as Turkish, French and Other languages.

**Table-4.17.1 Language-Wise Distribution**

S.N.	LANGUAGE	NUMBER OF PUBLICATIONS	PERCENTAGE
1.	English	13179	96.42%
2.	Chinese	311	2.28%
3.	Spanish	50	0.37%
4.	German	33	0.24%
5.	Russian	33	0.24%
6.	Portuguese	15	0.11%
7.	Italian	13	0.10%
8.	Turkish	11	0.08%
9.	French	8	0.06%
10.	Korean	4	0.03%

**Figure-4.17.1 Language-Wise distribution**



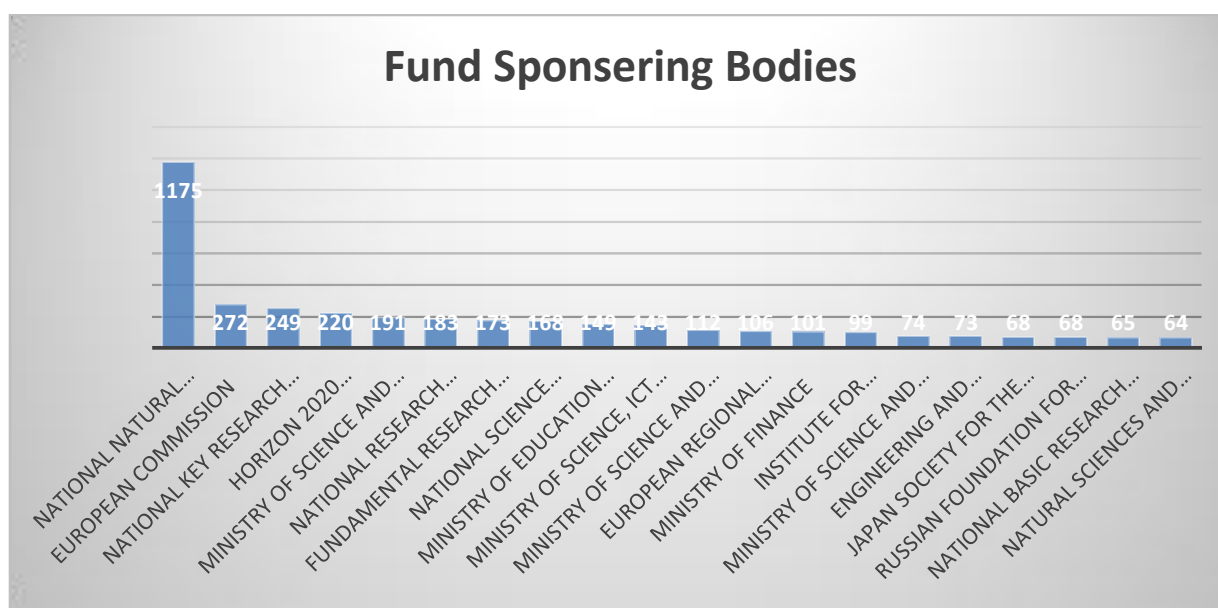
#### 4.18 Fund Sponsoring Bodies

Table and figure-4.18.1 shows the top twenty fund sponsored bodies for Blockchain Technology. Total 160 bodies have released funds to various institutions for conducting research in this field. It has been observed that the National Natural Science Foundation of China has sponsored 1175 times to various institutions, followed by the European Commission with 272 and National Key Research and Development Program of China with 249 times. Horizon 2020 Framework Programme has also given grants to 220 different institutes to promote research on this.

**Table-4.18.1 Fund Sponsoring Bodies**

<b>S.N.</b>	<b>SPONSORING BODIES</b>	<b>FUNDS</b>
1.	National Natural Science Foundation of China	1175
2.	European Commission	272
3.	National Key Research and Development Program of China	249
4.	Horizon 2020 Framework Programme	220
5.	Ministry of Science and Technology of the People's Republic of China	191
6.	National Research Foundation of Korea	183
7.	Fundamental Research Funds for the Central Universities	173
8.	National Science Foundation	168
9.	Ministry of Education of the People's Republic of China	149
10.	Ministry of Science, ICT and Future Planning	143
11.	Ministry of Science and ICT, South Korea	112
12.	European Regional Development Fund	106
13.	Ministry of Finance	101
14.	Institute for Information and Communications Technology Promotion	99
15.	Ministry of Science and Technology, Taiwan	74
16.	Engineering and Physical Sciences Research Council	73
17.	Japan Society for the Promotion of Science	68
18.	Russian Foundation for Basic Research	68
19.	National Basic Research Program of China (973 Program)	65
20.	Natural Sciences and Engineering Research Council of Canada	64

**Figure-4.18.1 Fund Sponsoring Bodies**



#### 4.19 Subject Wise Distribution

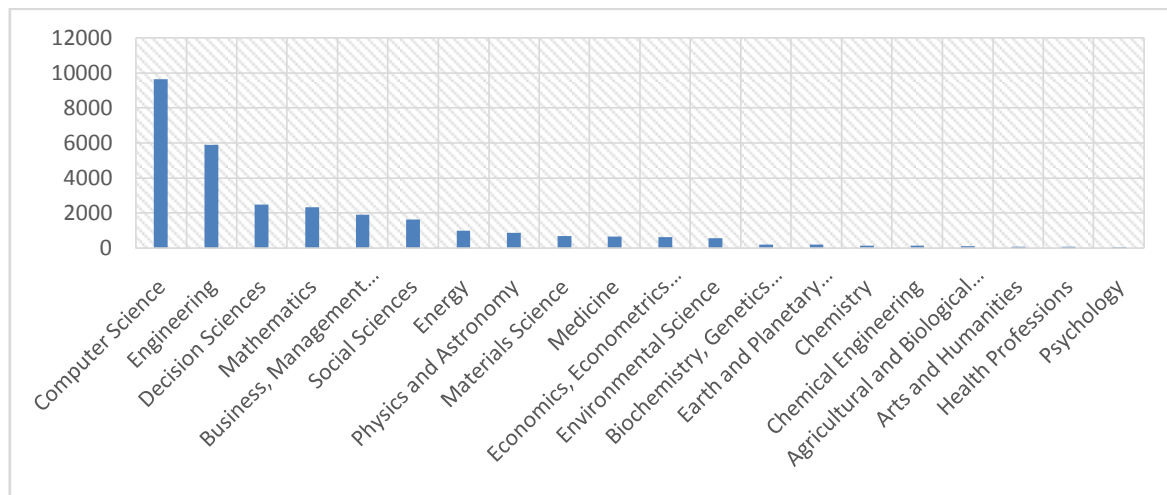
Table and figure-4.19.1 shows that subject wise distribution in the field of Blockchain Technology. It is observed that the Computer Science subject is found to be the most prominent subject during the study year. Total 32.49% literature published in that subject whereas Engineering subject is in second position with 19.87 %. At third position, only 8.44 % literature published under the subject Decision Science followed by Mathematics with 7.84 % literature in the field of Blockchain technology.

**Table-4.19.1 Subject Wise Distribution**

S.N.	SUBJECT AREA	NUMBER OF PUBLICATIONS	% (29712)
1.	Computer Science	9653	32.49
2.	Engineering	5904	19.87
3.	Decision Sciences	2509	8.44
4.	Mathematics	2330	7.84
5.	Business, Management and Accounting	1909	6.43
6.	Social Sciences	1648	5.55
7.	Energy	1000	3.37
8.	Physics and Astronomy	893	3.01
9.	Materials Science	700	2.36

10.	Medicine	676	2.28
11.	Economics, Econometrics and Finance	628	2.11
12.	Environmental Science	582	1.96
13.	Biochemistry, Genetics and Molecular Biology	228	0.77
14.	Earth and Planetary Sciences	220	0.74
15.	Chemistry	167	0.56
16.	Chemical Engineering	157	0.53
17.	Agricultural and Biological Sciences	121	0.41
18.	Arts and Humanities	93	0.31
19.	Health Professions	78	0.26
20.	Psychology	70	0.24

**Figure-4.19.1 Subject wise Distribution**



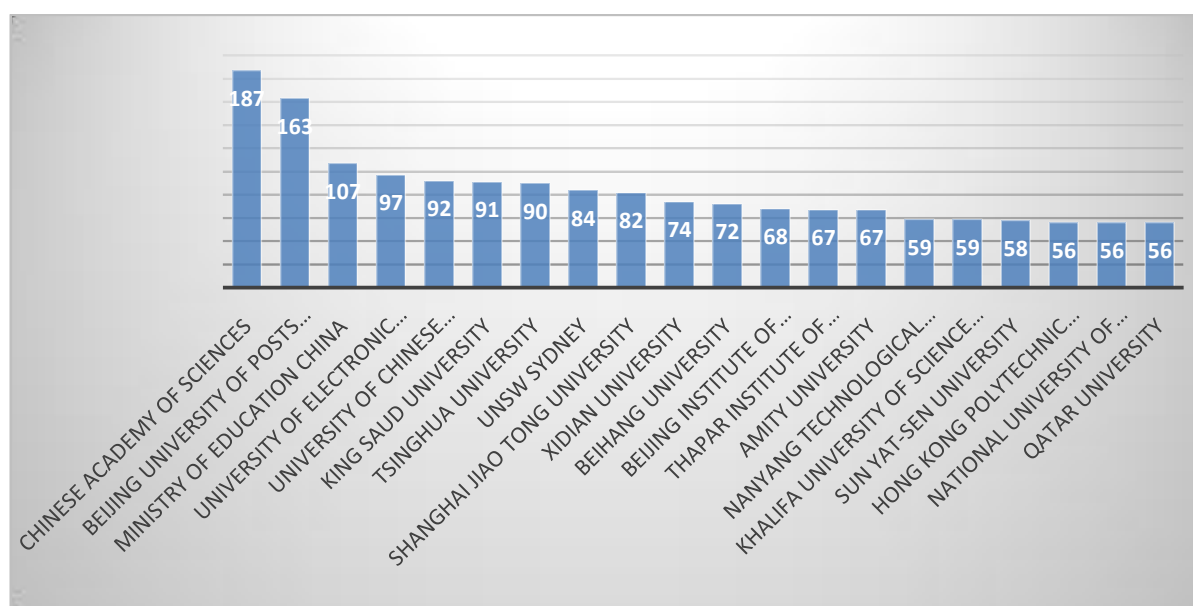
#### 4.20 Highly Productive Institutions

Table and figure-4.20.1 presents the top twenty highly productive institutions in Blockchain Technology. This study reveals that the “Chinese Academy of Sciences” with 187 publications have been observed as highly productive institutions in the field of Blockchain technology Research followed by “Beijing University of Posts and Telecommunications” with 163 publications whereas “Ministry of publications Education China” found third position with 107 publications.

**Table-4.20.1 Highly Productive Institutions**

S.N.	INSTITUTES	NUMBER OF PUBLICATIONS
1.	Chinese Academy of Sciences	187
2.	Beijing University of Posts and Telecommunications	163
3.	Ministry of Education China	107
4.	University of Electronic Science and Technology of China	97
5.	University of Chinese Academy of Sciences	92
6.	King Saud University	91
7.	Tsinghua University	90
8.	UNSW Sydney	84
9.	Shanghai Jiao Tong University	82
10.	Xidian University	74
11.	Beihang University	72
12.	Beijing Institute of Technology	68
13.	Thapar Institute of Engineering & Technology	67
14.	Amity University	67
15.	Nanyang Technological University	59
16.	Khalifa University of Science and Technology	59
17.	Sun Yat-Sen University	58
18.	Hong Kong Polytechnic University	56
19.	National University of Defense Technology	56
20.	Qatar University	56

**Figure-4.20.1 Highly Productive Institutions**



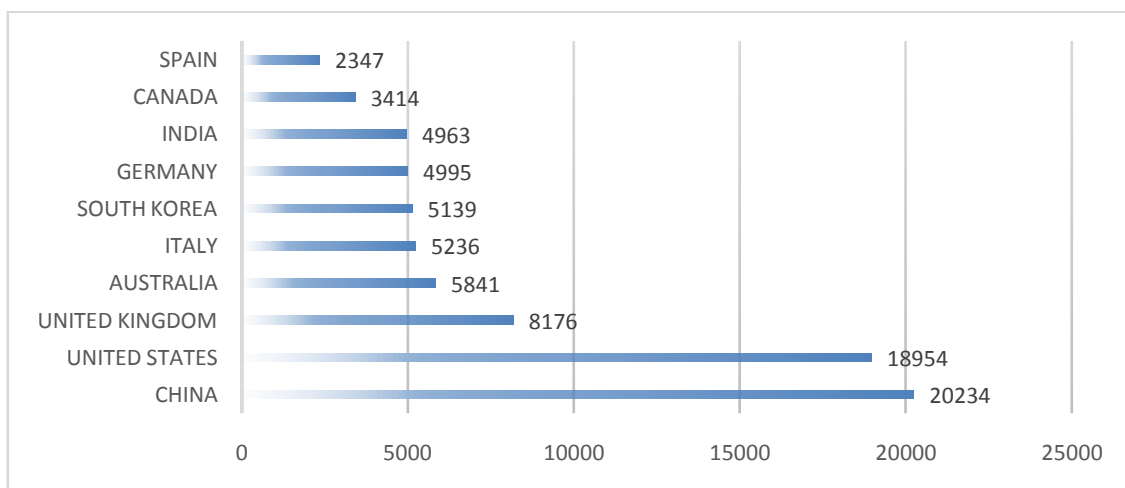
#### 4.21. Highly Cited Countries

Table and figure-4.21.1 revealed that maximum 160 countries published literature in the field of Blockchain Technology. In which top ten highly cited countries are presented and in which China has maximum citations followed by United States, United Kingdom. India is on 8<sup>th</sup> position with 4963 citations.

**Table-4.21.1 Highly Cited Countries**

S.N.	COUNTRY	CITATIONS
1.	CHINA	20234
2.	UNITED STATES	18954
3.	UNITED KINGDOM	8176
4.	AUSTRALIA	5841
5.	ITALY	5236
6.	SOUTH KOREA	5139
7.	GERMANY	4995
8.	INDIA	4963
9.	CANADA	3414
10.	SPAIN	2347

**Figure-4.21.1 Highly Cited Countries**



**CHAPTER 5**

**FINDINGS, CONCLUSION**

**AND SUGGESTIONS**

## CHAPTER-5

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### FINDINGS, SUGGESTIONS AND CONCLUSION

This chapter reveals significant Findings, suggestions and conclusions which depend upon the result of Data analysis.

#### 5.1 FINDINGS AND SUGGESTIONS

##### 5.1.1 Year wise distribution

A total number of 14238 literature were taken from the Scopus database on Blockchain Technology during the period of 2007-2021. The maximum literature published in 2020 with 4651 (32.66%) followed by 2021 with 3908 (27.44%) literature. The years 2008, 2009, 2011, 2012, and 2013 have found no publication. After 2016 the growth of publications is increasing in a continuous manner. The annual average growth rate of publications in the entire world is 1423.8 per year. (Excluding- 2008 to 2013).

##### 5.1.2 Annual Growth Rate

The Annual Growth rate (AGR) of the publication has decreased after 2015. After the analysis, it is found that the maximum AGR was counted in 2015.

##### 5.1.3 Relative Growth Rate and Doubling Times

The Relative Growth Rate has decreased year by year. Maximum RGR was recorded in the year 2015 and after the year 2015, the growth rate of RGR continuously decreased. The value of doubling time regularly increases year by year only excluding the year 2021.

##### 5.1.4. India's Research Output

India found the third position with 1626 (11.42%) literature whereas China was on top with sharing the highest literature which was 3162 (22.21%).

##### 5.1.5 Authorship Pattern

A total of 14238 literature was published by various authors of which 15.12 % of articles were published by a single author, 19.55 % of articles published by a double author. After the analysis, it is found that maximum literature was published by Three authors.

### **5.1.6 Most Prolific Authors**

After the analysis Kumar, N. and Salah, N found the most prolific authors with 38 articles. It is found that most of the author's publications are 10.

### **5.1.7 Author Keyword Occurrences**

During 2007-2021, a total of 14941 authors' keywords were found in 14238 literature published. Total 935 have been selected for visualization in which "Blockchain" was the most recurring author keyword followed by "Smart Contract".

### **5.1.8 Highly Cited Authors**

After the analysis, researchers found that Zhang, Y. highly cited authors with 2264 citations followed by Wang, H. 1581 citations, and Xu, X with 1441 citations.

### **5.1.9 Communication Channels**

Most of the literature is published in Journal and Conference Proceeding forms. Around 41.89% have been published in under journals and 40.62% literature published in Conference Proceeding form. Other communication channels such as Book Series, Book and Trade Journal.

### **5.1.10 Most Prolific journals**

A total of 5965 Journals have been founded in the contribution of Blockchain Technology. "Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics" was the most prolific journal at rank first position with 496 publications. It has published the highest number of papers during the year 2007-2021.

### **5.1.11 Year Wise Journal Growth**

Researchers also record the yearly growth of the top 10 Highly productive journals in the year 2016-2021. "Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics" published maximum literature in 2020. All top ten journals Year 2020 found the most productive year in which a maximum number of publications were published under the journal.

### **5.1.12 Highly Cited Journal**

After the analysis, the researcher found that a total of 5965 journals published literature in the field of Blockchain Technology during the study period. In which “PloS One” journal is cited by maximum times whereas “Top 20 International journal of Web and Grid” with 589 citations.

### **5.1.13 Bradford’s Law of Scattering of Articles in Journals**

The 2.91% (46 Journals) of the total journals that published articles are scattered in zone-1 while 12.90% (204 Journals) in Zone-II and 84.20% (1332 journals) in Zone-III.

Expected values are calculated by formula  $1: n: n^2$  that is 46: 252: 1381 journals scattered in Zone-I, Zone-II, and Zone-III respectively.

The finding is that there is a difference between expected values and observed values so that Bradford’s law of scattering of articles in journals is not applicable in Blockchain Technology.

### **5.1.14 Collaboration of Countries**

In the analysis, the researcher observed that many countries collaborated with each other. United State collaborates with the maximum number of countries followed by the United Kingdom collaborates with 63 countries. India also collaborates with 57 countries with the fourth position.

### **5.1.15 Highly Productive Countries**

On the basis of analysis, the researcher observed that China (17.65%) contributes maximum literature in the field of Blockchain Technology. The United States published 9.88 % of the literature while India published 9.07% of literature which is in Third position.

### **5.1.16 Highly Cited Articles**

“An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends” has received a maximum of 1281 citations Followed by “IoT security: Review, blockchain solutions and open Challenges” with 868 citations.

### **5.1.17 Language Wise Distribution**

After analysis of data, the researcher finds that a total of 96.42% of literature has been published in the English language and remains in other languages such as Chinese, Spanish, German and Russian.

### **5.1.18 Fund Sponsoring Bodies**

National Natural Science Foundation of China is sponsoring to maximum no of institutes and provided grants followed by the European Commission, National Key Research and development program of China.

### **5.1.19 Subject Wise Distribution**

Total 29 subjects contribute in the field of Blockchain Technology in which highest 9653 (32.49%) articles were published under Computer Science subject followed by Engineering with 19.87 % and Decision Sciences with 8.44%. This study reveals that it has a multi-disciplinary scope, it has not been published only in Computer Science but also on other subjects as Mathematics, Engineering, and Management.

### **5.1.20 Highly Productive Institutions**

Chinese Academy of Sciences with 187 articles has been observed as a highly productive institution followed by Beijing University of Posts and Telecommunications with 163 articles and the Ministry of Education China with 107 articles.

### **5.1.21 Highly Cited Countries**

China has maximum citations with 20234 followed by the United States with 18954, United Kingdom. India is in 8th position with 4963 citations.

This study is a helpful tool in the assessment of research publications of researchers and scientists in the subject field of Blockchain technology. In the period of 2007-2021, it is observed that the Indian contribution has been low in Blockchain Technology hence the Indian should be encouraged to publish the research result in Blockchain technology. It will lead to enhancing the reputation of India. Indian authors should be initiated to produce the number of articles in this field. Indian Institutions should produce qualitative literature because no institution of India is in the tenth position.

## 5.2. Testing of Hypotheses

### 1. Annual Growth Rate of Research Publication is increasing.

S.N.	Year	Initial Value(W1)	End Value(W2)		AGR
1.	2007	0	1	-1	Not define
2.	2010	1	1	0	0
3.	2014	1	1	0	0
4.	2015	1	14	13	1300
5.	2016	14	82	68	485.71
6.	2017	82	466	384	468.29
7.	2018	466	1638	1172	251.50
8.	2019	1638	3476	1838	112.21
9.	2020	3476	4651	1175	33.80
10.	2021	4651	3908	-743	-15.97

The above table shows the Annual Growth Rate in the field of Blockchain technology. It is clear from the table that Annual Growth Rate is decreasing. Thus, the hypothesis-1 has been rejected.

### 2. Multi-Authored Publications are greater than a Single Author.

S.N.	Author	Number of Documents	Percentage
1.	Single Author	2153	15.12
2.	Two Authors	2784	19.55
3.	Three Authors	3245	22.79
4.	Four Authors	2433	17.09
5.	Five Authors	1544	10.84
6.	Six Authors	1352	9.50
7.	Seven Authors	485	3.41
8.	Eight Authors	129	0.91
9.	Nine Authors	44	0.31
10.	Ten Authors	24	0.17
11.	More than Ten Authors	45	0.32
	Multi-Author	12085	84.89

The above table shows the authorship pattern. After the analysis of secondary data, results revealed that Multi-authored publications are greater than a single author. Therefore, hypothesis-2 has been proved.

### **3.India is the Most Collaborative Country in Blockchain Technology.**

<b>S.N.</b>	<b>COUNTRY</b>	<b>CITATIONS</b>	<b>LINKS</b>
1.	UNITED STATES	18954	67
2.	UNITED KINGDOM	8176	63
3.	CHINA	20234	60
4.	INDIA	4963	57
5.	AUSTRALIA	5841	52
6.	CANADA	3414	43
7.	GERMANY	4995	48
8.	ITALY	5236	42
9.	SPAIN	2347	39
10.	SOUTH KOREA	5139	37

The above table presents that collaboration of countries in the field of Blockchain Technology. The analysis revealed that India is not on the top most among collaborative country. However, hypothesis-3 has been rejected.

### **4. USA is the most Productive Country in Blockchain Technology.**

<b>S.N.</b>	<b>COUNTRY</b>	<b>NUMBER OF PUBLICATION</b>	<b>PERCENTAGE</b>
1.	China	3162	17.65%
2.	United States	1771	9.88%
3.	India	1626	9.07%
4.	United Kingdom	841	4.69%
5.	Germany	616	3.43%
6.	Russian Federation	529	2.95%
7.	Italy	527	2.94%
8.	Australia	524	2.92%
9.	South Korea	524	2.92%

10.	Canada	417	2.32%
11.	France	312	1.74%
12.	Spain	305	1.70%
13.	Saudi Arabia	271	1.51%
14.	Taiwan	257	1.43%
15.	Malaysia	242	1.35%
16.	Japan	238	1.32%
17.	United Arab Emirates	228	1.27%
18.	Pakistan	199	1.11%
19.	Netherlands	193	1.07%
20.	Switzerland	183	1.02%

The above table shows that top twenty most productive countries. The table revealed that USA is not top most productive country. Thus, the hypothesis-4 has been rejected.

#### **5. Bradford's Law for journals are fit to Blockchain Technology.**

<b>Zone</b>	<b>Observed Journals</b>	<b>% of Journals</b>	<b>No. of Articles</b>	<b>% of Articles</b>	<b>Cumulative of articles</b>	<b>Bradford' Multiplier</b>	<b>Expected Journals</b>
<b>Zone 1</b>	46	2.91	1988	33.32%	1988	-	46
<b>Zone 2</b>	204	12.90	1989	33.34%	3977	4.43	252
<b>Zone 3</b>	1332	84.20	1988	33.32%	5965	6.53	1381
<b>Total</b>	<b>1582</b>	<b>100</b>	<b>5965</b>	<b>100%</b>	<b>11930</b>	<b>5.48</b>	<b>1679</b>

The above table shows that Bradford's Law of Scattering of articles in journals. The outcome of data analysis shows that Bradford's law for journals is not fit to Blockchain technology. Therefore, hypothesis-5 has been rejected.

**6. India's ranks among the top ten producing Countries in World Production.**

<b>S.N.</b>	<b>COUNTRY</b>	<b>NUMBER OF PUBLICATION</b>	<b>PERCENTAGE</b>
1.	China	3162	17.65%
2.	United States	1771	9.88%
3.	India	1626	9.07%
4.	United Kingdom	841	4.69%
5.	Germany	616	3.43%
6.	Russian Federation	529	2.95%
7.	Italy	527	2.94%
8.	Australia	524	2.92%
9.	South Korea	524	2.92%
10.	Canada	417	2.32%
11.	France	312	1.74%
12.	Spain	305	1.70%
13.	Saudi Arabia	271	1.51%
14.	Taiwan	257	1.43%
15.	Malaysia	242	1.35%
16.	Japan	238	1.32%
17.	United Arab Emirates	228	1.27%
18.	Pakistan	199	1.11%
19.	Netherlands	193	1.07%
20.	Switzerland	183	1.02%

The above table shows that Top twenty productive countries in the field Blockchain Technology. The table revealed that India's ranks among the top ten producing countries in world production. Therefore, hypothesis-6 has been proved.

**7. USA is the most Cited Country in Blockchain Technology Research.**

<b>S.N.</b>	<b>COUNTRY</b>	<b>CITATIONS</b>
1.	CHINA	20234
2.	UNITED STATES	18954
3.	UNITED KINGDOM	8176
4.	AUSTRALIA	5841
5.	ITALY	5236
6.	SOUTH KOREA	5139
7.	GERMANY	4995
8.	INDIA	4963
9.	CANADA	3414
10.	SPAIN	2347

The above table presented the top ten highly cited countries in the field of Blockchain Technology. The result revealed that USA is not highly cited country. Thus, hypothesis-7 has been rejected.

### **5.3. CONCLUSION**

Basically, the bibliometric technique is one of the best techniques for conducting a quantitative analysis of research production and progress of any subject and institution. Blockchain Technology is an emerging technology so its bibliometric study will provide the best guidance for those who will use this technology. This technology came in 2007 but it grew up in the year 2015. Nowadays, almost every work has been carried out using emerging technologies and blockchain technology mostly used in the financial sector for privacy and security purposes. This study is based on 14238 literature indexed in the Scopus database and the literature taken from the year 2007-2021 in the field of Blockchain Technology. This bibliometrics study provides some factual and factorial data. All Research papers have been analyzed for annual growth trends, authorship pattern, Relative growth rate, doubling time, Collaboration with countries, the applicability of Bradford's law, and examined the prolific authors, journals and also count the citations on a different base. In this study a total of 14238 literature was retrieved from the Scopus database during the period of 2007-2021. The maximum number of literature published in the year 2020 and maximum AGR is counted in 2015 and after 2016 there is a steady growth of publication for India and the world (Except-2021). Average of 1423.8 publications published per year at the global level. India is in the third position and China is in the first position. During the study Kumar, N. and Salah, H have been found to be highly prolific authors. Most of the literature was published in the English language and published by three authors. Literature published in journals on Blockchain Technology does not follow Bradford's law. "An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends" is a highly cited article published by "IEEE" journal in 2017. "PloS One " is a highly cited journal in the field of Blockchain Technology. Maximum works of literature are published in Journals and Conference Proceeding form. "National Natural Science Foundation of China" has sponsored various institutions. Maximum Literature published in Computer Science Subject. This study is the collection of all bibliographic information in one place which is more useful for future researchers who are engaged with this technology and also helpful to those persons who want to use this technology at their workplaces such as libraries, hospitals, banks, and other companies.

#### **5.4 SUGGESTIONS**

- This study is a helpful tool in the assessment of research publications of researchers and scientists in the subject field of Blockchain technology. During the study process, it is observed that the Indian contributions have been considerably low in Blockchain Technology hence the Indian authors should be encouraged to publish research output in Blockchain technology.
- It leads to enhancing the reputation of India and Indian authors should be initiated to produce the number of articles in this field.
- Indian Institutions should be producing qualitative literature because no institution of India is in under the tenth position.

#### **5.5 AREA FOR FURTHER RESEARCH**

- The present study is based on only the Scopus database. There is a need for a comprehensive and comparative bibliometric study on Blockchain technology with different databases like Web of Science, Up to Date, and PubMed.
- This study is based on literature from all over the world. The bibliometric study can also be done in India and also can be compared India to in the rest of the world.
- Only Bradford's law has been applied in this study but there are also remaining two laws like- Lotka's Law and Zipf's law also can be applied.

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## BIBLIOGRAPHY

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