

**MEASURING THE OPEN ACCESS UPTAKE OF SELECTED  
CENTRAL UNIVERSITIES OF INDIA: A STUDY BASED ON  
DATA CARPENTRY APPROACH**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE DEGREE OF DOCTOR OF  
PHILOSOPHY**

**SWAGOTA SAIKIA**

**MZU REGISTRATION NO.: 2200193**

**Ph.D. REGISTRATION NO.: MZU/Ph.D./2046 of 19.08.2022**



**DEPARTMENT OF LIBRARY AND INFORMATION SCIENCE  
SCHOOL OF ECONOMICS, MANAGEMENT AND  
INFORMATION SCIENCE  
OCTOBER 2025**

**MEASURING THE OPEN ACCESS UPTAKE OF SELECTED CENTRAL  
UNIVERSITIES OF INDIA: A STUDY BASED ON DATA CARPENTRY  
APPROACH**

**BY**

**SWAGOTA SAIKIA**

**Department of Library and Information Science**

**Supervisor**

**Prof. MANOJ KUMAR VERMA**

**Submitted**

**In partial fulfillment of the requirement of the degree of Doctor of Philosophy in  
Library and Information Science of Mizoram University, Aizawl**



**MIZORAM UNIVERSITY**

**(A Central University)**

**Department of Library & Information Science**

**Tanhril, Aizawl – 796004, Mizoram**

---

**☎ 0389-2331607(O); +91-9774003201(M)**

---

**CERTIFICATE**

This is to certify that **Swagota Saikia**, Ph.D. Research Scholar of the Department of Library and Information Science, Mizoram University has written her thesis titled **“Measuring the Open Access Uptake of Selected Central Universities of India: A Study based on Data Carpentry Approach”** under my supervision. To the best of my knowledge and belief, the work embodies her original investigation and findings and has not been published anywhere. I consider it worthy of the Degree of Doctor of Philosophy (Ph.D.) in Library and Information Science at Mizoram University.

**(PROF. MANOJ KUMAR VERMA)**

Supervisor

Aizawl, Mizoram

**DECLARATION**  
**MIZORAM UNIVERSITY**  
**OCTOBER 2025**

I **Swagota Saikia**, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to do the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute.

This is being submitted to the Mizoram University for the **Degree of Doctor of Philosophy in Library and Information Science**.

**(SWAGOTA SAIKIA)**

Candidate

**HEAD**

**Dent. of Librarv and Information**

**(Prof. MANOJ KUMAR VERMA)**

**Supervisor**

## ACKNOWLEDGEMENT

At the very outset, I would like to offer my heartiest and deepest gratitude to my supervisor **Prof. Manoj Kumar Verma**, from the Department of Library and Information Science, Mizoram University, Aizawl, for his valuable guidance, support and inspiration throughout the research work. It has been a privilege working under the supervision of a hardworking, knowledgeable, and experienced person like him, who has always been a source of support and confidence. I sincerely thank him for giving me the freedom to express my thoughts and making the research work an enjoyable one.

I gratefully acknowledge **Prof. Pravakar Rath, Prof. R.K. Ngurtinkhuma, Prof. S.N. Singh (Retd.), Dr. Langaizuali, Dr. F. Chanchinmawia, and Dr. Manendra Kumar Singh** of the Department of Library and Information Science, Mizoram University, Aizawl for their moral support and helpful advice during my research work.

It is my privileged and proud moment to thank all the teachers I was taught by for shaping my life.

I would like to extend my sincere thanks to all my fellow research scholars (**Dr. Maya Deori, Dr. Triveni Pathak, Dr. Bwsrang Basumatary, Dr. Dhrubajyoti Buragohain, Subhayan Chakravorty and Nijwm Basumatary** for their insightful suggestions and help. Thanks, should go to all my cooperative and supportive friends and well-wishers.

The bibliography given in the thesis is to be considered as an acknowledgement to the respective proprietor of the document. It is my core duty to thank all the research scholars whose thesis were the major area of my study.

Especially, thanks to **Madam Amita Verma** for her care, love, blessing and support as a family member during my research work.

Finally, I would like to express my heartfelt gratitude to my greatest motivators my mother, **Mrs. Morami Saikia**, and my father, **Mr. Hara Kanta Saikia** for their

unwavering love, support, and guidance. Whatever I have achieved today is solely because of them. I am deeply indebted to them for their sacrifices and for shaping the person I have become.

A special thanks to my brother, **Mr. Subhasis Saikia**, for his constant support and for shouldering my parents' responsibilities during my absence from home. I would also like to extend my heartfelt gratitude to my best friend, **Mr. Rajpratim Sarma**, for always being there for me through ups and downs. His unwavering support and encouraging words have consistently given me the strength to persevere throughout my Ph.D. journey.

I offer my prayers to the Almighty and express my heartfelt gratitude to the universe for all that I have. I am deeply thankful for the guidance, strength, and opportunities that have come my way, and for the countless blessings both seen and unseen that have supported me throughout this journey.

**Aizawl, Mizoram**

**(SWAGOTA SAIKIA)**

Dated:

## TABLE OF CONTENTS

| Description           | Page No.                     |
|-----------------------|------------------------------|
| Certificate           | i                            |
| Declaration           | ii                           |
| Acknowledgment        | iii-iv                       |
| Table of Contents     | v-x                          |
| List of Tables        | xi                           |
| List of Figures       | xii-xiv                      |
| List of Abbreviations | xv-xvii                      |
| <br><b>CHAPTER 1</b>  | <br><b>INTRODUCTION</b>      |
| 1.1                   | 1-20                         |
| 1.1.1                 | 1                            |
| 1.1.2                 | 2                            |
| 1.1.3                 | 4                            |
| 1.1.4                 | 5                            |
| 1.2                   | 5                            |
| 1.3                   | 6                            |
| 1.4                   | 7                            |
| 1.4.1                 | 8                            |
| 1.4.2                 | 8-9                          |
| 1.4.3                 | 9                            |
| 1.5                   | 9-10                         |
| 1.5.1                 | 10-11                        |
| 1.5.2                 | 11                           |
| 1.5.3                 | 11-13                        |
| 1.5.4                 | 13-14                        |
| 1.5.4.1               | 15                           |
| 1.5.4.2               | 15                           |
| 1.6                   | 15-16                        |
| 1.7                   | 16                           |
|                       | 16-18                        |
|                       | 19-20                        |
| <br><b>CHAPTER 2</b>  | <br><b>LITERATURE REVIEW</b> |
| 2.1                   | 21-66                        |
| 2.1.1                 | 21                           |
| 2.2                   | 21                           |
| 2.2.1                 | 22                           |
| 2.2.2                 | 23                           |
|                       | 25                           |

|                  |         |                                                                                                                                                      |               |
|------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|                  | 2.2.3   | Global and National Open Access Initiatives                                                                                                          | 29            |
|                  | 2.2.4   | Assessment of Open Access Publications                                                                                                               | 32            |
|                  | 2.2.5   | Gender Disparities in Scholarly publishing                                                                                                           | 43            |
|                  | 2.2.6   | Comparative Evaluation of Open Access and Non-Open Access Publications                                                                               | 47            |
|                  | 2.2.7   | Research on Data Carpentry Practices                                                                                                                 | 48            |
|                  | 2.2.8   | Impact of Social Media Attention and Citation Advantage of Open Access                                                                               | 53            |
| 2.3              |         | Research Gap                                                                                                                                         | 58            |
|                  |         | Reference                                                                                                                                            | 59            |
| <b>CHAPTER 3</b> |         | <b>OPEN ACCESS: AN OVERVIEW</b>                                                                                                                      | <b>67-109</b> |
| 3.1              |         | Scholarly Communication                                                                                                                              | 67            |
|                  | 3.1.1   | Evolution of Scholarly Communication                                                                                                                 | 68            |
|                  | 3.1.1.1 | Era of Traditional Print Publishing                                                                                                                  | 68            |
|                  | 3.1.1.2 | The Rise of Academic Journals                                                                                                                        | 68            |
|                  | 3.1.1.3 | Era of Electronic Publishing                                                                                                                         | 69            |
| 3.2              |         | Open Access Movement                                                                                                                                 | 70            |
| 3.3              |         | What is Open Access?                                                                                                                                 | 71            |
|                  | 3.3.1   | Definitions of Open Access                                                                                                                           | 72            |
| 3.4              |         | Why Open Access?                                                                                                                                     | 73            |
|                  | 3.4.1   | Open Access Publications                                                                                                                             | 74            |
| 3.5              |         | Open Access Routes                                                                                                                                   | 75            |
| 3.6              |         | Brief History of Open Access                                                                                                                         | 78            |
|                  | 3.6.1   | Budapest Open Access Initiative (BOAI)                                                                                                               | 78            |
|                  | 3.6.2   | Bethesda Statement on Open Access Publishing (2003)                                                                                                  | 79            |
|                  | 3.6.3   | Berline Declaration on Open Access to Knowledge in the Sciences and Humanities                                                                       | 82            |
|                  | 3.6.4   | International Federation of Library Associations and Institutions (IFLA) Statement on Open Access to Scholarly Literature and Research Documentation | 83            |
|                  | 3.6.5   | Australian Research Information Infrastructure Committee Statement (ARIIC)                                                                           | 84            |
|                  | 3.6.6   | Organization for Economic Cooperation and Development (OECD)'s Declaration on Access to Research Data from Public Funding                            | 84            |
|                  | 3.6.7   | Delhi Declaration on Open Access                                                                                                                     | 84            |
| 3.7              |         | Open Access Initiatives                                                                                                                              | 87            |
| 3.8              |         | Open Access Initiative in India                                                                                                                      | 91            |
| 3.9              |         | Open Access Policies and Mandates                                                                                                                    | 98            |
| 3.10             |         | Licensing Approach in Open Access                                                                                                                    | 101           |
|                  | 3.10.1  | Creative Commons Licenses                                                                                                                            | 102           |

|                    |                                                          |                |
|--------------------|----------------------------------------------------------|----------------|
|                    | References                                               | 105            |
| <b>CHAPTER - 4</b> | <b>DATA CARPENTRY: CONCEPTUAL APPROACH</b>               | <b>110-118</b> |
| 4.1                | Introduction                                             | 110            |
| 4.2                | The Carpentries                                          | 111            |
| 4.2.1              | Software Carpentry                                       | 112            |
| 4.2.2              | Library Carpentry                                        | 112            |
| 4.2.3              | Data Carpentry                                           | 112            |
| 4.3                | Origin of Data Carpentry                                 | 114            |
| 4.4                | Number of Workshops Held Across Countries                | 115            |
|                    | References                                               | 117            |
| <b>CHAPTER - 5</b> | <b>PROFILE OF SELECTED CENTRAL UNIVERSITIES OF INDIA</b> | <b>119-152</b> |
| 5.1.               | Introduction                                             | 119            |
| 5.2                | Evolution of Higher Education in India                   | 119            |
| 5.2.1              | Importance of Higher Education Institutions              | 120            |
| 5.3                | Indian Higher Education Governing Bodies                 | 120            |
| 5.3.1              | Ministry of Education, Government of India               | 120            |
| 5.3.2              | Department of School Education & Literacy (SE&L)         | 121            |
| 5.3.3              | Department of Higher Education (DHE)                     | 122            |
| 5.3.4              | University Grant Commission (UGC)                        | 123            |
| 5.3.4.1            | Importance of Central Universities                       | 125            |
| 5.4                | Ranking and Evaluation of Higher Education Institutions  | 128            |
| 5.5                | Profile of selected Central Universities of India        | 131            |
| 5.5.1              | Jawaharlal Nehru University                              | 131            |
| 5.5.2              | Jamia Millia Islamia                                     | 132            |
| 5.5.3              | Banaras Hindu University                                 | 133            |
| 5.5.4              | University of Hyderabad                                  | 134            |
| 5.5.5              | Aligarh Muslim University                                | 135            |
| 5.5.6              | University of Delhi                                      | 136            |
| 5.5.7              | Central University of Kashmir                            | 137            |
| 5.5.8              | Central University of Jammu                              | 138            |
| 5.5.9              | Tezpur University                                        | 139            |
| 5.5.10             | North Eastern Hill University                            | 140            |
| 5.5.11             | Pondicherry University                                   | 141            |
| 5.5.12             | Mizoram University                                       | 142            |
| 5.5.13             | Central University of Punjab                             | 143            |
| 5.5.14             | Central University of Tamil Nadu                         | 144            |

|                  |        |                                                            |                |
|------------------|--------|------------------------------------------------------------|----------------|
|                  | 5.5.15 | Visva Bharati University                                   | 145            |
|                  | 5.5.16 | Assam University                                           | 146            |
|                  | 5.5.17 | Central University of Kerala                               | 147            |
|                  | 5.5.18 | English & Foreign Languages University                     | 148            |
|                  | 5.5.19 | Manipur University                                         | 149            |
|                  |        | Reference                                                  | 151            |
| <b>CHAPTER-6</b> |        | <b>DATA ANALYSIS AND INTERPRETATION</b>                    | <b>153-211</b> |
| 6.1              |        | Introduction                                               | 153            |
| 6.2              |        | Data Analysis and Interpretation                           | 153            |
| 6.3              |        | Research Growth and Science Mapping                        | 155            |
|                  | 6.3.1  | Overall Year-wise Growth of OA Publications                | 156            |
|                  | 6.3.2  | Year-wise Growth of Jawaharlal Nehru University            | 158            |
|                  | 6.3.3  | Year-wise growth of Jamia Milia Islamia                    | 159            |
|                  | 6.3.4  | Year-wise Growth of Banaras Hindu University               | 160            |
|                  | 6.3.5  | Year-wise Growth of University of Hyderabad                | 161            |
|                  | 6.3.6  | Year-wise Growth of Aligarh Muslim University              | 162            |
|                  | 6.3.7  | Year-wise Growth of University of Delhi                    | 163            |
|                  | 6.3.8  | Year-wise Growth of Central University of Kashmir          | 164            |
|                  | 6.3.9  | Year-wise Growth of Central University of Jammu            | 165            |
|                  | 6.3.10 | Year-wise Growth of Tezpur University                      | 166            |
|                  | 6.3.11 | Year-wise Growth of North Eastern Hill University          | 167            |
|                  | 6.3.12 | Year-wise Growth of Pondicherry University                 | 168            |
|                  | 6.3.13 | Year-wise Growth of Mizoram University                     | 169            |
|                  | 6.3.14 | Year-wise Growth of Central University of Punjab           | 170            |
|                  | 6.3.15 | Year-wise Growth of Central University of Tamil Nadu       | 171            |
|                  | 6.3.16 | Year-wise Growth of Visva-Bharati University               | 172            |
|                  | 6.3.17 | Year-wise Growth of Assam University                       | 173            |
|                  | 6.3.18 | Year-wise Growth of Central University of Kerala           | 174            |
|                  | 6.3.19 | Year-wise Growth of English & Foreign Languages University | 175            |
|                  | 6.3.20 | Year-wise Growth of Manipur University                     | 176            |

|       |                                                                                           |     |
|-------|-------------------------------------------------------------------------------------------|-----|
| 6.4   | Subject Trends, Impact, and Publishing Influence in OA Research                           | 177 |
| 6.4.1 | Subject wise Distribution of OA Publications                                              | 178 |
| 6.4.2 | OA publications Trend in the Domain of Sciences, Social Sciences, and Arts and Humanities | 179 |
| 6.4.3 | Yearly Growth of Citation Counts of the OA Publications                                   | 181 |
| 6.4.4 | Highly Influential Publications Based on Citation Counts                                  | 182 |
| 6.4.5 | Highly Prolific Journals Based on Number of OA Publications                               | 184 |
| 6.4.6 | Prolific Publishers Based on the Number of Open Access Publications                       | 185 |
| 6.5   | Assessing the Social, Intellectual and Conceptual Structure of OA Publications            | 186 |
| 6.5.1 | Co-authorship of Authors                                                                  | 187 |
| 6.5.2 | Co-authorship of Countries of OA Publications                                             | 188 |
| 6.5.3 | Keyword analysis of OA Publications                                                       | 189 |
| 6.5.4 | Identification of Highly Occurred Keywords                                                | 190 |
| 6.6   | Analysis of OA Publications                                                               | 192 |
| 6.6.1 | Distribution of OA Publication Routes                                                     | 192 |
| 6.6.2 | Year-wise Growth Chart of OA publishing Routes                                            | 193 |
| 6.6.3 | Distribution of OA Licences                                                               | 194 |
| 6.6.4 | Proportion of Open Access Articles by Host Type                                           | 195 |
| 6.6.5 | Distribution of Articles Based on Availability of Repository Copy                         | 196 |
| 6.6.6 | Distribution of Journals by OA and DOAJ Status                                            | 197 |
| 6.7   | Measuring of OA friendliness                                                              | 198 |
| 6.7.1 | Parameters of OA Friendliness Framework                                                   | 199 |
| 6.7.2 | Breakdown Scores of OA Publications under the OAF Framework                               | 200 |
| 6.7.3 | OA Friendliness Framework                                                                 | 201 |
| 6.8   | Gender Based Distribution of OA Publications                                              | 204 |
| 6.8.1 | Percentage Rate of Male and Female First Authorship                                       | 205 |
| 6.8.2 | Gender Ratio of OA Publications                                                           | 206 |
| 6.9   | Ranking of Central Universities Based on the Number of Open Access Publications           | 207 |
|       | References                                                                                | 210 |

|                                     |                                             |                |
|-------------------------------------|---------------------------------------------|----------------|
| <b>CHAPTER - 7</b>                  | <b>FINDINGS, CONCLUSION AND SUGGESTIONS</b> | <b>212-232</b> |
| 7.1                                 | Introduction                                | 212            |
| 7.2                                 | Hypothesis Testing                          | 220            |
| 7.3                                 | Conclusion                                  | 224            |
| 7.4                                 | Suggestions                                 | 228            |
| 7.5                                 | Scope for Future Research                   | 230            |
|                                     | References                                  | 232            |
| <b>Bibliography</b>                 |                                             | <b>233</b>     |
| <b>Biodata of the Candidate</b>     |                                             | <b>255</b>     |
| <b>Particulars of the Candidate</b> |                                             | <b>259</b>     |

## LIST OF TABLES

| <b>Table No.</b> | <b>Name of Table</b>                                                                             | <b>Page No.</b> |
|------------------|--------------------------------------------------------------------------------------------------|-----------------|
| 1.1              | Top Central universities of India based on NIRF ranking 2022 (top 1-100 & 101-150)               | 7               |
| 1.2              | Example of Parsing Unpaywall JSON Response Using GREL Expressions in OpenRefine                  | 14              |
| 5.1              | List of Central Universities of India                                                            | 126             |
| 6.1              | Framework of Data Analysis                                                                       | 154             |
| 6.2              | Overall Yearwise Growth of OA publications all the Selected Universities and Forecast the Growth | 157             |
| 6.3              | Top ten Influential Publications Based on Citation Counts                                        | 183             |
| 6.4              | List of Top Ten Prolific Journals Based on Number of OA Publications                             | 184             |
| 6.5              | Top Ten Prolific Publishers Based on the Number of OA Publications                               | 186             |
| 6.6              | Top Ten Highly Occurred Keywords                                                                 | 191             |
| 6.7              | List of Various Preferred OA Licenses                                                            | 195             |
| 6.8              | Parameters and their Assigned Weightage in the Simplified OA Friendliness                        | 200             |
| 6.9              | Total scores of OA publications for OAF framework                                                | 201             |
| 6.1              | Distribution of OA Friendliness Scores of Central Universities Using a Simplified OAF Framework  | 204             |
| 6.11             | Ranking of Central Universities Based on the Number of Open Access Publications                  | 208             |

## LIST OF FIGURES

| <b>Figure No.</b> | <b>Name of Figure</b>                                                           | <b>Page No.</b> |
|-------------------|---------------------------------------------------------------------------------|-----------------|
| 2.1               | Resources and Platforms for Literature Review                                   | 22              |
| 3.1               | Process of the publication of scholarly communication in peer-reviewed journals | 70              |
| 3.2               | Logo of open access                                                             | 73              |
| 3.3               | Growth of Open Access publications in India                                     | 75              |
| 3.4               | Overview of DOAJ                                                                | 89              |
| 3.5               | Homepage of ROAR                                                                | 90              |
| 3.6               | Homepage of DOAB                                                                | 90              |
| 3.7               | Overview of ePrints@IISc                                                        | 92              |
| 3.8               | Homepage of Shodhganga                                                          | 94              |
| 3.9               | Homepage of NDLI                                                                | 96              |
| 3.10              | Homepage of SWAYAM                                                              | 96              |
| 3.11              | Homepage of Indiarxiv                                                           | 97              |
| 3.12              | Homepage of ONOS                                                                | 98              |
| 3.13              | Licenses of Creative Commons                                                    | 104             |
| 4.1               | Homepage of The Carpentries                                                     | 111             |
| 4.2               | Homepage of Data Carpentry                                                      | 114             |
| 5.1               | Homepage of MoE's Website                                                       | 121             |
| 5.2               | Homepage of DHE Website                                                         | 123             |
| 5.3               | Homepage of UGC Website                                                         | 124             |
| 5.4               | Homepage of NAAC Website                                                        | 129             |
| 5.5               | Homepage of NIRF Website                                                        | 131             |
| 5.6               | Homepage of Jawaharlal Nehru University Official Website                        | 132             |
| 5.7               | Homepage of Jamia Millia Islamia Official Website                               | 133             |
| 5.8               | Homepage of Banaras Hindu University Official Website                           | 134             |
| 5.9               | Homepage of University of Hyderabad Official Website                            | 135             |
| 5.10              | Homepage of Aligarh Muslim University Official Website                          | 136             |
| 5.11              | Homepage of University of Delhi Official Website                                | 137             |
| 5.12              | Homepage of Central University of Kashmir Official Website                      | 138             |
| 5.13              | Homepage of Central University of Jammu Official Website                        | 139             |
| 5.14              | Homepage of Tezpur University Official Website                                  | 140             |
| 5.15              | Homepage of North-Eastern Hill University Official Website                      | 141             |
| 5.16              | Homepage of Pondicherry University Official                                     | 142             |

|      |                                                                         |     |
|------|-------------------------------------------------------------------------|-----|
|      | Website                                                                 |     |
| 5.17 | Homepage of Mizoram University Official Website                         | 143 |
| 5.18 | Homepage of Central University of Punjab Official Website               | 144 |
| 5.19 | Homepage of Central University of Tamil Nadu Official Website           | 145 |
| 5.20 | Homepage of Visva Bharati University Official Website                   | 146 |
| 5.21 | Homepage of Assam University Official Website                           | 147 |
| 5.22 | Homepage of Central University of Kerala Official Website               | 148 |
| 5.23 | Homepage of English & Foreign Languages University Official Website     | 149 |
| 5.24 | Homepage of Manipur University Official Website                         | 150 |
| 6.1  | Overall Yearwise Growth of OA Publications and Forecast the Growth      | 158 |
| 6.2  | Year-wise Growth of OA Publications of Jawaharlal Nehru University      | 159 |
| 6.3  | Year-wise Growth of OA Publications of Jamia Milia Islamia              | 160 |
| 6.4  | Year-wise Growth of OA Publications of Banaras Hindu University         | 161 |
| 6.5  | Year-wise Growth of OA Publications of University of Hyderabad          | 162 |
| 6.6  | Year-wise Growth of OA Publications of Aligarh Muslim University        | 163 |
| 6.7  | Year-wise Growth of OA Publications of University of Delhi              | 164 |
| 6.8  | Year-wise Growth of OA Publications of Central University of Kashmir    | 165 |
| 6.9  | Year-wise Growth of OA Publications of Central University of Jammu      | 166 |
| 6.10 | Year-wise Growth of OA Publications of Tezpur University                | 167 |
| 6.11 | Year-wise Growth of OA Publications of North Eastern Hill University    | 168 |
| 6.12 | Year-wise Growth of OA Publications of Pondicherry University           | 169 |
| 6.13 | Year-wise Growth of OA Publications of Mizoram University               | 170 |
| 6.14 | Year-wise Growth of OA Publications of Central University of Punjab     | 171 |
| 6.15 | Year-wise Growth of OA Publications of Central University of Tamil Nadu | 172 |
| 6.16 | Year-wise Growth of OA Publications of Visva-Bharati University         | 173 |
| 6.17 | Year-wise Growth of OA Publications of Assam                            | 174 |

|      |                                                                                                    |     |
|------|----------------------------------------------------------------------------------------------------|-----|
|      | University                                                                                         |     |
| 6.18 | Year-wise Growth of OA Publications of Central University of Kerala                                | 175 |
| 6.19 | Year-wise Growth of OA Publications of English & Foreign Languages University                      | 176 |
| 6.20 | Year-wise Growth of OA Publications of Manipur University                                          | 177 |
| 6.21 | Subject-wise Classification of OA Publications from the Selected Central Universities              | 179 |
| 6.22 | Distribution of OA Publications Trends in Sciences, Social Sciences and Arts and Humanities Domain | 180 |
| 6.23 | Yearly Growth of Citation Counts of the OA Publications                                            | 181 |
| 6.24 | Co-authorship of Authors                                                                           | 188 |
| 6.25 | Co-authorship of Countries                                                                         | 189 |
| 6.26 | Network visualization of keyword occurrences                                                       | 190 |
| 6.27 | Percentage-wise Distribution of OA Publication Routes                                              | 193 |
| 6.28 | Year-wise Growth Chart of OA Publishing Routes                                                     | 194 |
| 6.29 | Proportion of Open Access Articles by Host type                                                    | 196 |
| 6.30 | Distribution of Articles Based on Availability of Repository Copy                                  | 197 |
| 6.31 | Distribution of Journals by OA and DOAJ Status                                                     | 198 |
| 6.32 | Percentage Rate of Male and Female First Authorship of OA Publications                             | 206 |
| 6.33 | Female-to-male Author Ratio (57:100) Based on Open Access Publications                             | 207 |
| 6.34 | Ranking of Indian Central universities Based on Number of OA Publications                          | 209 |

## LIST OF ABBREVIATIONS

| <b>TERM</b>      | <b>DESCRIPTION</b>                                          |
|------------------|-------------------------------------------------------------|
| <b>AAS</b>       | Altmetric Attention Score                                   |
| <b>ANOVA</b>     | Analysis of Variance                                        |
| <b>APC</b>       | Article Processing Charge                                   |
| <b>API</b>       | Application Programming Interface.                          |
| <b>BBB</b>       | Budapest, Bethesda, and Berlin                              |
| <b>BMC</b>       | BioMed Central                                              |
| <b>BOAI</b>      | Budapest Open Access Initiative                             |
| <b>CBSE</b>      | Central Board of Secondary Education                        |
| <b>CC</b>        | Creative Commons                                            |
| <b>CODATA</b>    | Committee on Data for Science and Technology                |
| <b>CSIR</b>      | Council of Scientific & Industrial Research                 |
| <b>CWTS</b>      | Centre for Science and Technology Studies                   |
| <b>DHE</b>       | Department of Higher Education                              |
| <b>DOAB</b>      | Directory of Open Access Books                              |
| <b>DOAJ</b>      | Directory of Open Access Journals                           |
| <b>DOAR</b>      | Directory of Open Access Repository                         |
| <b>DOI</b>       | Digital Objective Identifier                                |
| <b>GOI</b>       | Government of India                                         |
| <b>GREL</b>      | General Refine Expression Language                          |
| <b>HEIs</b>      | Higher Education Institutions                               |
|                  | International Consortium for the Advancement of Academic    |
| <b>ICAAP</b>     | Publication                                                 |
| <b>ICMR</b>      | Indian Council of Medical Research                          |
|                  | Indian National Digital Library in Engineering Sciences and |
| <b>INDEST</b>    | Technology                                                  |
| <b>INFLIBNET</b> | Information and Library Network                             |
| <b>JSON</b>      | JavaScript Object Notation                                  |
| <b>LIS</b>       | Library and Information Science                             |
| <b>MDPI</b>      | (Multidisciplinary Digital Publishing Institute)            |

|                 |                                                                    |
|-----------------|--------------------------------------------------------------------|
| <b>MEDLINE</b>  | MEDlars onLINE                                                     |
| <b>MHRD</b>     | Ministry of Human Resource Development                             |
| <b>NAAC</b>     | National Assessment and Accreditation Council                      |
| <b>NCTE</b>     | National Council for Teacher Education                             |
| <b>NIOS</b>     | National Institute of Open Schooling                               |
| <b>NIRF</b>     | National Institutional Ranking Framework                           |
| <b>NKC</b>      | National Knowledge Commission                                      |
| <b>OA</b>       | Open Access                                                        |
| <b>OAAA</b>     | Open Access Altmetric Advantages                                   |
| <b>OACA</b>     | Open Access Citation Advantage                                     |
| <b>OAFI</b>     | Open Access Framework Indicators                                   |
| <b>OAI</b>      | Open Access Initiatives                                            |
| <b>OAI</b>      | Open Access India                                                  |
| <b>OAI-PMH</b>  | Open Archives Initiative Protocol for Metadata Harvesting          |
| <b>OCW</b>      | Open CourseWare                                                    |
| <b>ODbL</b>     | Open Database License                                              |
| <b>ONOS</b>     | One Nation One Subscription                                        |
| <b>OpenDOAR</b> | Open Directory of Open Access Repositories                         |
| <b>PLOS ONE</b> | Public Library of Science ONE                                      |
| <b>RDM</b>      | Research Data Management                                           |
| <b>REST</b>     | REpresentational State Transfer                                    |
| <b>RFID</b>     | Radio Frequency Identification                                     |
| <b>ROAR</b>     | Registry of Open Access Repositories                               |
| <b>ROARMAP</b>  | Registry of Open Access Repositories                               |
| <b>RoMEO</b>    | Rights MEtadata for Open archiving                                 |
| <b>SHERPA</b>   | Securing a Hybrid Environment for Research Preservation and Access |
| <b>SJR</b>      | Scimago Journal Rank                                               |
| <b>SNIP</b>     | Source Normalized Impact per Paper                                 |
| <b>SPSS</b>     | Statistical Package for the Social Sciences                        |
| <b>SSCI</b>     | Social Science Citation Index                                      |
| <b>SSRN</b>     | Social Science Research Network                                    |

|               |                                                                  |
|---------------|------------------------------------------------------------------|
| <b>STEM</b>   | Science, Technology, Engineering, and Mathematics                |
| <b>SWAYAM</b> | Study Webs of Active Learning for Young Aspiring Minds           |
| <b>UGC</b>    | University Grants Commission                                     |
| <b>UNESCO</b> | United Nations Educational, Scientific and Cultural Organization |

# **CHAPTER 1**

## **Introduction**

### **1.1. Introduction**

Research has always been a fundamental part for the development and integration of any subject and its scholarly community. The subject Library and Information Science is also not an exception but has obtained rapid changes and growth in different areas of research over time. The initiation of LIS research in India has started since 1950 by Dr. S. R. Ranganathan in the department of Library and Information Science, University of Delhi (Chandrashekara et al., 2009; Sa & Dora, 2019; Singh & Babbar, 2014). By the time of its initiation, a number of studies have been conducted by the LIS professionals and academicians to introduce new ideas, knowledge and theories. With time, the LIS field has undergone enormous changes with new ideas and facts through advancement of scholarly communications. In the present digital era, scholarly publishing is gaining immense importance and also the demand for research publications is at its peak in online platforms. The traditional publishing models and methods have been replaced by online journals and other forms. However, evaluating the research output is an essential step for measuring the quality and impact of the research, identification of research trends, future trends and the performances of researchers. Various tools and techniques have been introduced to measure research productivity and assess researcher's performance, collectively known as research metrics. The research metrics helps to identify the scientific structure of the research such as growth trend, collaboration pattern, highly active researchers, journals, organizations or countries based on the citation impact, H-index, impact factor that indicates the value of the work. The evolution of research metrics basically rooted from Ranganathan's Librametrics (1948), Alan Pritchard's Bibliometrics (1969), T. Braunin's Scientometrics (1977), Tomas Almind and Peter Ingwersen's Webometrics (1997) and Jason Priem's Altmetrics (2010). The application of metrics, especially Bibliometrics and Scientometrics, in the field of Library and Information Science has been growing significantly in recent years. Since LIS professionals are considered information providers, the application of metrics helps them stay updated on the latest developments in the field of research. Therefore, the study of Bibliometrics and Scientometrics is essential for staying informed about

the latest developments in the intellectual structure of scholarly communication and the contributions of scholars in any field. In recent years, there has been extensive debate on ‘Open Access’ in scientific communication at both national and international levels. In India, scientific research is funded by various institutions, organizations, and public or private agencies. The Government of India has mandated that all publicly funded research publications be made freely accessible to the public. Over time, several initiatives and changes have shaped the landscape of scientific communication in India. Therefore, it is essential to examine the acceptability and practices of Open Access in the publications of central universities in India.

#### **1.1.1. Open Access**

Since the last two decades, movement of Open Access have impacted the scholarly communication regarding the mode of its access. The Open Access Movement was initiated to make scholarly literature freely accessible to everyone, with the right to reuse it in a digital environment worldwide. The reason behind the movement is the rise of subscription cost of the journals and its barrier in accessing the scientific communication. The Open Access (OA) came into effect out of various efforts initiated by three eminent declarations, Budapest Open Access Initiative (BOAI) is the very first meet on 1 December, 2001 held in Budapest by the Open Society Institute. The BOAI was initiated with the aim to remove barriers in accessing scholarly literature and promote universal education and learning. The next initiative was taken by Bethesda statement in June 2003 followed by the Berlin declaration in October 2003 for free availability of scientific knowledge. Gradually, various academic institutions, libraries and research organization also came forward and joined in these initiatives against subscription-based models.

According to Peter Suber “Open access to scientific journal articles means online access without charge to readers or libraries. Committing to open access means dispensing with the financial, technical, and legal barriers that are designed to limit access to scientific research articles to paying customers. It means that, for the sake of accelerating research and sharing knowledge, publishers will recoup their costs from other sources”. Emergence of OA has paved the way towards

subscription free access of content and greater visibility of the scholarly literatures which is also beneficial for receiving more citation that indicates the impact of the work. However, the form of Open Access divided into two degrees i.e., Gratis and Libre (Prajapati, 2015). Gratis open access refers to the contents that are fully free of cost and universally accessible, Libre open access means contents that are freely accessible along with some added restriction for use. Apart from this, there are various routes of open access concerning its rights of access under Creative Common Licenses such as Gold, Green, Bronze and Hybrid (Jalal & Mukhopadhyay, 2022). In the Gold open access route, the publisher or the journal publishes the article in open access mode where the readers can freely download the content but the author have to pay the APC. Green open access provides the facility to self-archive in which an author has the right to deposit a final/accepted version of article of subscription-based journal in an institutional repository (Mering & Hoeve, 2020). Under Bronze open access readers can access the content online but not allowed for reuse because of the no license policy for the readers. However, another mode of access is added to the list as ‘Hybrid’ journals consist of open access and close access articles as per the subscription fee or authors charge.

The Open Access movement has also influenced Indian scientific communication. According to various studies, several initiatives have been undertaken to promote Open Access. In India, Indian National Academy was the first institution to sign the Berlin Declaration in 2004. In the study of the status of Indian OA journals and Repositories, Nazim et al. (2022) found India to be in the 15<sup>th</sup> and 17<sup>th</sup> rank with 317 journals in DOAJ, 98 repositories in OpenDOAR (Roy & Mukhopadhyay, 2022) and 135 repositories in ROAR. Recently, Government of India has implemented a policy named ‘One Nation One Subscription’ (ONOS) for promoting countrywide access to scientific and academic content from a single central negotiated mode for the benefit of the academic and research community. Various organizations and institutions have initiated for practicing open access publications in India.

Apart from various discussions regarding OA initiatives, policies, availability of OA journals or repositories available in DOAJ, ROAR, OpenDOAR etc., it is also necessary to adhere some indicators to measure the OA practices. Robinson-

Garcia, 2020 have measured the OA policies and research output of 963 institutions from Web of Science database based on Unpaywall. Roy & Mukhopadhyay, 2022 have measured the open access friendliness of top ten Indian central universities through OpenRefine and Unpaywall based on ranking framework.

### **1.1.2. Open Access Parameters**

Based on the Open Access Friendliness Indicator (OAFI) framework of Roy and Mukhopadhyay (2022), this study develops a five-parameter model to measure the Open Access performance of selected Indian central universities. While the original OAFI framework is based on four parameters, the present study has developed five parameters such as OA publication share, OA repository share, OA license availability, citation impact and Altmetric Attention Score. The five parameters are:

- i. OA Share:** OA share indicates the rate of OA publications contributed by the selected 19 central universities of India during the time period of 20 years (2005-2024) extracted from Unpaywall.
- ii. OA License Share:** OA license share refers to rights and permission associated which is an important component of OA publication specifically creative common licenses. The license status of the OA publications will be retrieved from Unpaywall. The OA share includes only green and gold share because these two routes clearly meet the definition of true Open Access, both in terms of accessibility and licensing (as per BOAI and UNESCO guidelines). Both of these routes present the most transparent and sustainable forms of OA.
- iii. OA Repository Share:** presents the proportion of Green OA publications archived in repositories, indicating institutional support for OA practices.
- iv. OA Citation Share:** the citation impact indicates the rate of interest of other researchers towards a particular publication which indicates the value of the work. The citation impact will indicate the value and impact of the OA publications from the selected central universities during the period.
- v. OA Altmetric Share:** The altmetric score is analysed to measure the impact of the OA publication in the socio-academic scenario in different social media platforms.

### **1.1.3. Data Carpentry**

Data carpentry is a newly emerging area which focuses on enhancing researcher's skills and knowledge for managing large amount of research data with implication of some tools and techniques. The word carpentry means to make and manage something, data Carpentry is considered as sister of software carpentry. Data carpentry is a great tool for data mining which introduced in January 2018 by a US based non-profit organization (<https://carpentries.org/>). 'The Carpentries' is emphasized to three carpentries such as- Software carpentry (2014), Data carpentry (2018) and Library carpentry (2018) with the mission to help its communities by providing data science skills through conducting programs and workshops. Software carpentry deals with software management and development activities; Library carpentry deals with library management skills using softwares and data carpentry primarily deals with management of research data effectively. Data carpentry basically focuses on promoting the computational skills that are required for data analysis, data management, reproducible data in every domain of research in an effective way. It is a new way of cleaning and wrangling data without any limitations of types and size by using different data carpentry tools. Apparently, since past few years the concept of data carpentry has been applied to various research areas as well as to the field of Library and Information Science for redefining large sets of data.

### **1.1.4. Central Universities in India**

In India the Central Universities are established by an Act of Parliament within the responsibility of department of Higher Education under Ministry of Education. The universities of India are basically recognized and funded by the University Grants Commission (UGC) that are enacted under the governance of University Grants Commission Act, 1956. Generally, there are 44 central universities in India out of which 10 central universities are under other Ministries (<https://www.education.gov.in/central-universities> accessed on 28.03.2023)

To analyze and evaluate the performance of the central universities, Government of India developed a ranking framework named as National

Institutional Ranking Framework (NIRF) in 2015, that ranks the universities based on the performance under five parameters. The performance parameters are; (1) Teaching Learning & Resources (TLR), (2) Research and Professional Practice (RP), (3) Graduation Outcomes (GO), (4) Outreach and Inclusivity (OI) and (5) Peer Perception. The framework is developed and used for ranking different academic institutions like IITs, NITs, University, College etc. released every year.

## **1.2. Significance of the Study**

In the present era, the importance of research has been doubled with time for growth and development, the research outputs are necessary for the scientific community whether for further research, decision making, policy framing, stake holders and many more. The open access led the availability of scholarly literatures in public domain allowing the public to use, print, reuse, download the full text edition and share the resources. Open Access is a mode of access to scholarly literatures in which the reader can freely access the content they want without the requirement of subscription through payment like the traditional subscription-based access. Open access is not only helpful for accessing information for free but diversely beneficial in areas such as for Authors it gives the opportunity to make their work visible at worldwide level that enables to increase visibility and get higher citation rate; then for academic institutions, they are beneficial for getting better visibility of their research works at global level as well as without the need for subscribing high-cost journals and promote knowledge at pace. However, various institutions and organizations have adopted open access measures but it is also necessary to study the open access compatibilities implementing parameters to identify the scenario of open access. In academic institutions, in the courses like Masters and Ph.D. level, research is widely practiced and higher research publication enables to achieve better ranking of faculties and institutions. The study is an attempt to identify the selected central universities of India's participation and acceptability of Open Access. The findings of the study will be helpful in designing policy for funding agencies, policy makers to look after the scenario of Open Access among the leading central universities of India.

### 1.3. Scope of the Study

The scope of the present study shall be limited to examine the present status and adaptability of open access publications in scholarly communication by selected central universities in India by applying the data carpentry tools based on the Scopus database. At present, there are total 44 central universities listed in the website of Ministry of Education (source: <https://www.education.gov.in/central-universities> dated 28.03.2023). To select the central universities for present study, NIRF ranking 2022 was considered and the central universities listed till rank band II was selected for this study. Thus, the scope of present study is further limited to 19 central universities that were ranked in rank band II of NIRF 2022 ranking as listed in Table-1. The publications data of selected central universities will be count from Scopus database and only that publications will be considered for present study. Further, the study shall also be limited for the 20 years from 2005-2024 as the emergence of OA movement took place in the year 2002.

**Table 1.1. Top Central universities of India based on NIRF ranking 2022 (top 1-100 & 101-150)**

| Sl. No. | Central Universities          | Year of establishment | State           | NIRF 2022 |
|---------|-------------------------------|-----------------------|-----------------|-----------|
| 1       | Jawaharlal Nehru University   | 1969                  | New Delhi       | 2         |
| 2       | Jamia Millia Islamia          | 1920                  | Delhi           | 3         |
| 3       | Banaras Hindu University      | 1916                  | Uttar Pradesh   | 6         |
| 4       | University of Hyderabad       | 1974                  | Telangana       | 10        |
| 5       | Aligarh Muslim University     | 1920                  | Uttar Pradesh   | 11        |
| 6       | University of Delhi           | 1922                  | New Delhi       | 13        |
| 7       | Central University of Kashmir | 2009                  | Jammu & Kashmir | 53        |
| 8       | Central University of Jammu   | 2011                  | Jammu & Kashmir | 56        |
| 9       | Tezpur University             | 1994                  | Assam           | 59        |
| 10      | North Eastern Hill University | 1973                  | Meghalaya       | 66        |

|    |                                        |      |             |          |
|----|----------------------------------------|------|-------------|----------|
| 11 | Pondicherry University                 | 1985 | Pondicherry | 68       |
| 12 | Mizoram University                     | 2001 | Mizoram     | 78       |
| 13 | Central University of Punjab           | 2009 | Punjab      | 81       |
| 14 | Central University of Tamil Nadu       | 2009 | Tamil Nadu  | 85       |
| 15 | Visva Bharati University               | 1921 | West Bengal | 98       |
| 16 | Assam University                       | 1994 | Assam       | 101-150* |
| 17 | Central University of Kerala           | 2009 | Kerala      | 101-150* |
| 18 | English & Foreign Languages University | 1958 | Telangana   | 101-150* |
| 19 | Manipur University                     | 1980 | Manipur     | 101-150* |

\*Rank Band II (101-150) of NIRF 2022 that list the central universities in an alphabetical order.

(Source: Respective University Websites Collected on 25<sup>th</sup> December, 2022)

#### 1.4. Research Design

A research design is the overall framework of a research study that guides the researcher in achieving the predetermined objectives of the study. It serves as a conceptual blueprint outlining the structure of the study, including the research questions, data collection methods, and analysis procedures. The design of the research plays a crucial role in determining and validating the reliability of the research findings. It helps determine the step-by-step process of conducting the study using a specific methodology, ensuring the research is systematic and focused (Khanday & Khanam, 2019).

##### 1.4.1. Statement of the Problem

In the present digital era, all the traditional publications have been shifted to digital publications from which the importance of open access has aroused. Open access basically allows free access to peer review full-text scholarly publications with very minimum to no restrictions with the right to read, download, share and print. Academic institutions are a platform where research is practiced at a great extent and research contents are the basic need in academics for scholarly communication.

According to some researches the academic institutions are increasingly publishing researches in Open Access platforms. However, it is necessary to analyse and evaluate the growing OA publication by application of various open access parameters for identifying the top ranked OA sources. The present study will evaluate the practices and adaptabilities of OA publications regarding the status, license, citation count and altmetric score for measuring the impact of the OA publications as well as determining the subject in which most of the publication are being published, the study will also identify the gender status of the first author for identifying the gender balance in the OA publications of the selected central universities of India.

#### **1.4.2. Objectives of the Study**

1. To assess the year-wise growth of open access (OA) publications between 2005 to 2024 and forecast the future growth of research of the selected central universities of India
2. To analyze the subject-wise distribution, social, intellectual and conceptual structures of OA publications trends by collaboration of authors and countries, citation impact, and key words analysis
3. To measure the open access friendliness of the publications of central universities based on OA compatibility parameters (Designed & Developed by Mukhopadhyay, 2022).
4. To compare the open access publications trends in Sciences, Social Sciences and Arts and Humanities Domain.
5. To find out the gender ratio of the Open Access publications of the selected central universities of India
6. To rank the central universities based on the number of Open Access publications.

#### **1.4.3. Hypothesis**

A hypothesis is a crucial component of the research process, formulated at the initial stage to transform the research question into a predictive statement. It

represents a tentative assumption made by the researcher, typically expressed as a relationship between dependent and independent variables (Singh, 2024). Since it is subject to empirical validation, the hypothesis remains provisional until tested. Its primary function is to guide the direction of the study, support the interpretation of observations, and ensure that the research progresses in a systematic and coherent manner.

The present study formulates three hypotheses to explore the relationship between Open Access (OA) publications of the selected central universities of India and various associated components. These hypotheses are outlined below:

**H1:** There is a significant correlation between the Open Access publication trends and the year of establishment of the central universities.

**H2:** There is a significant difference in the gender-wise author productivity in OA publications

**H3:** There is significant correlation between OA Publication Output and status of authors' designation

### **1.5. Research Methodology**

The present study aims to examine the Open Access friendliness and adoptability of the top 19 ranked Indian central universities. It analyzes the nature and patterns of OA publications using a well-defined framework grounded in the data carpentry approach. To achieve a holistic perspective, the study adopts both quantitative and qualitative research methods, integrating scientometric and altmetric analyses with data carpentry tools. This mixed-methods approach allows for a deeper understanding of institutional engagement with Open Access practices.

Scientometrics is an emerging and widely used tool for evaluating the performance and impact of scientific research. In the present study, scientometric parameters have been employed to examine the growth of Open Access (OA) research publications, assess the contributions of prolific research actors, visualize collaboration patterns, and conduct keyword analysis.

The advancement of the digital era has led to the emergence of altmetrics, a novel tool designed to capture the immediate impact of research on the general

public, complementing traditional citation-based metrics. This impact is measured by tracking the attention received by research publications across various social media platforms and online sources. The present study employs altmetrics to assess the societal impact of Open Access (OA) publications on the general public.

Data carpentry is another emerging tool for preparing, cleaning, and organizing large datasets to make them suitable for structured analysis and interpretation in research. In this study, data carpentry techniques were applied using OpenRefine to process both bibliographic and altmetric data. The Unpaywall API was used to determine the Open Access status of publications, while the Altmetric API retrieved real-time attention scores. These tools enabled metadata standardization, duplicate removal, and classification by access type and institution, ensuring data accuracy and supporting transparent, reproducible scientometric and altmetric analyses.

#### **1.5.1. Sample of the Study:**

The present study will examine the 19 central universities of India according to the NIRF 2022 ranking from the Rank band1 (1-100) and Rank band 2 (101-150) under 'University' category. The study will cover the open access publications of the selected 19 central universities of India as reflected in the Scopus and Unpaywall database during the time period of 20 years (2005-2024).

#### **1.5.2. Selection of Databases:**

This study solely relies on bibliographic data of research publication of the selected central universities of India. The Scopus database was used to collect bibliographic information of open access (OA) articles and reviews published by the selected Indian central universities. OpenRefine was used to clean and deduplicate the raw data retrieved from Scopus. Additionally, various API keys were integrated using General Refine Expression Language (GREL) expressions to enrich and standardize the dataset for analysis. To determine the open access status of the publications, Unpaywall data was utilized to validate the accessibility and categorize the OA types. The Altmetric score has of the OA publications has been retrieved from the Altmetric.com database. The gender of the selected authors was identified using the NamSor database, which predicts gender based on names and

country of origin. These databases were selected due to their extensive coverage and trusted data quality, making them well-suited for the purposes of this study.

- a) **Scopus Database:** Scopus is a multidisciplinary abstract and citation database, established in 2004 and introduced by Elsevier. It provides extensive access to global scientific literature, encompassing fields such as science, technology, medicine, social sciences, as well as arts and humanities (Elsevier, 2025). It is one of the largest databases of peer-reviewed literature, including scientific journals, books, and conference proceedings.
- b) **Unpaywall:** Unpaywall is an opensource database operated by Ourresearch that contains over 23 million of open-source content. The database contains more than 50,000 journals, open-access repositories and open data from various open-source platforms over the world including repositories of any universities, governments or opensource publishers and open indexes like DOAJ, Crossref, Pubmed Central etc. The data can be extracted with the help of DOI of the article in the database.
- c) **Open Refine:** OpenRefine is a free opensource desktop application developed by Google in the year 2010 specifically used for data cleaning and carpentry activities commonly known as data wrangling. This tool helps the researcher to filtering, cleaning and formatting large scale of data.
- d) **Altmetric (Altmetric.com):** Altmetric is one of the largest databases that track the online attention received by research publications across various social media platforms. It assesses the influence of scholarly research by monitoring its visibility and engagement across social media, news outlets, policy documents, and other online sources. Altmetric is a part of Digital Science and was launched in 2011 (Altmetric.com, 2022).
- e) **Namsor Database:** Namsor is one of the most trusted databases of names that uses artificial intelligence to identify names by gender, country of origin, ethnicity, and other name-related attributes. Namsor determines the gender of individuals and predict their likely geographic or ethnic origins by analyzing first and last names. Namsor supports various data formats and provides both

a user-friendly web interface and API access, allowing users to process large datasets efficiently (Namsor.app, 2025).

### 1.5.3. Data Collection Procedures

**a) Collection of Bibliographic Details:** Firstly, the top 19 central universities were identified and selected based on the NIRF Ranking 2022. Subsequently, the primary dataset was extracted from the Scopus database by using the name of each university as a search keyword under the “organization” field extracted on 10<sup>th</sup> January 2025. Only open access (OA) publications were considered for the study, limiting the results to articles published between 2005 and 2024. The data for each of the 19 universities was exported individually in csv format and then merged into a single file for further analysis, resulting in a total of 45,717 documents.

**b) Data Cleaning and OA Validation:** The dataset was cleaned, deduplicated, and structured using OpenRefine, during which 3,141 duplicate and irrelevant entries were removed, yielding a final dataset of 42,576 documents. These 42,576 OA publications were then analyzed to examine year-wise research growth, citation trends, collaborative research patterns (via network visualization), and keyword distribution using VOSviewer, which requires raw Scopus data for its analyses. Additionally, to verify the actual OA status and retrieve other related metadata for the publications, the Unpaywall database was integrated using its API within OpenRefine through GREL expressions. The API request was formulated as:

```
"https://api.unpaywall.org/v2/" + value +
"?email=saikiaswagata00@gmail.com"
```

where value represents the DOI of each publication. The Unpaywall API provides responses in JavaScript Object Notation (JSON) format by default. The JSON responses obtained through the Unpaywall API were parsed using OpenRefine’s GREL functions to extract relevant metadata fields such as *oa\_status*, *is\_oa*, *journal\_name*, *publisher*, and *best\_oa\_location.url* displayed in table 1.2. Moreover, the Unpaywall results revealed that, out of 42,576 OA publications, only 42,188 were confirmed as truly open access.

This discrepancy likely occurred because some DOIs may not have been indexed in the Unpaywall database, were incorrectly formatted, or correspond to articles that are no longer openly accessible due to changes in licensing or access policies. Therefore, these 42,188 OA documents have been considered for further open access analysis and for developing the OA compatibility framework.

**Table 1.2: Example of Parsing Unpaywall JSON Response Using GREL Expressions in OpenRefine**

| Unpaywall JSON response                                                                                                                                                                                      | GREL parsing expression                            | Parsed output |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|---------------|
| { "doi": "10.1109/access.2022.3195807", "journal_is_oa": true, "journal_is_in_doaj": true, "is_oa": true, "oa_status": "gold", "has_repository_copy": false, "license": "cc-by", "host_type": "publisher", } | value.parseJson()["is_oa"]                         | TRUE          |
|                                                                                                                                                                                                              | value.parseJson()["oa_status"]                     | Gold          |
|                                                                                                                                                                                                              | value.parseJson()["license"]                       | cc-by         |
|                                                                                                                                                                                                              | value.parseJson()["has_repository_copy"]           | FALSE         |
|                                                                                                                                                                                                              | value.parseJson()["best_oa_location"]["host_type"] | Publisher     |

(Source: Table by Researcher)

- c) Extraction of Altmetric Score:** The Altmetric Attention Score (AAS) for each publication was retrieved by integrating the Altmetric API into OpenRefine using an authorized API key.
- d) Gender Identification:** Moreover, to identify existing gender disparity among the OA publications, the NamSor database was utilized by subscribing to a monthly plan to determine the gender of the first authors. A list of selected first authors was prepared in a separate file by including both their first and last names, which was then uploaded to the NamSor database for gender identification.

#### 1.5.4. Data Analysis

The collected data will be scrutinized and verified using suitable analytics tools for further analysis. Similarly, the verified data will be visualized in tables and figures according to the requirement. Moreover, for performing the statistical analysis various tools will be used like MS Excel, SPSS to test the hypotheses that is formulated for the study.

**1.5.4.1. Data Analysis Tools:** The present study employed the following tools for data analysis:

- a) **Microsoft Excel:** Microsoft Excel is developed by Microsoft, is a powerful spreadsheet application used for organizing, analyzing, and managing data in a structured, tabular format. It offers a wide range of features that enable users to perform complex calculations, create visual representations such as charts and graphs, and efficiently handle large datasets.
- b) **Tableau:** Tableau is a leading tool for data visualization which converts raw data into interactive and shareable dashboards, charts, and reports. Tableau helps in uncovering patterns, trends, and insights from large datasets, making it a valuable tool for data-driven decision-making.
- c) **VOSviewer:** VOSviewer is a software tool for constructing and visualizing bibliometric networks. It helps users to create maps based on network data such as co-authorship, citation, co-citation, and keyword co-occurrence. It analyzes large-scale scientific datasets, VOSviewer offers powerful visualizations of relationships among publications, authors, journals, and terms, making it an essential tool for bibliometric and scientometric analysis.

#### 1.5.4.2. Hypothesis Testing

The hypotheses of this study were tested using the Jamovi statistical software, applying appropriate non-parametric techniques to examine relationships and differences in OA publication trends. Hypothesis 1 (H1) was tested using Spearman's rank-order correlation to assess the association between the year of establishment of central universities and their OA publication output, based on a dataset of 42,188 verified OA publications. Hypothesis 2 (H2) was evaluated

through a chi-square goodness-of-fit test to compare gender-wise author productivity in OA publications, using data from 28,014 authorship records. Hypothesis 3 (H3) was examined with the Kruskal–Wallis one-way ANOVA to test differences in OA publication output across four professional designations Professor, Associate Professor, Assistant Professor, and Research Scholar.

### **1.6. Style Manual Used**

The entire chapters of this thesis have been adhered to the guidelines outlined in the APA 7th edition style manual. The in-text citations, references, bibliography and overall writeup of this thesis has been formatted according to the guideline. Maintaining consistency in citation style throughout the text and reference list is essential for ensuring the clarity and credibility of the research.

### **1.7. Chapterization**

The thesis consists of seven chapters, each addressing its specific aspect of the research. The details of each chapter have been shortly described below:

#### **Chapter 1: Introduction**

This chapter provides a concise introduction to the concept of open access, its historical development, and its relevance in the scientific domain. It also highlights the objectives set for the study, along with its significance and scope. Furthermore, it outlines the research problem that prompted the investigation and describes the methods and tools employed. Finally, it presents the overall structure of the study, organized into chapter-wise divisions. This introductory chapter sets the foundation for understanding the rationale and direction of the entire research.

#### **Chapter 2: Literature Review**

This chapter identifies and reviews relevant research studies conducted in the field of open access to establish the foundation and validity of the present study. This chapter reviews 80 published works to develop the theoretical framework and conceptual foundation of the study presented in descending chronological order. It also outlines current information related to the scope of the research. The chapter is

organized into thematic sub-sections such as open science, open access evaluation, Data carpentry, gender disparity and related areas.

### **Chapter 3: Open Access: An Overview**

This chapter describes the concept of open access and provides a comprehensive understanding of its origin, significance, and broader impact on academic and scientific research. It traces the historical development of the open access movement, from the Budapest Open Access Initiative to current advancements both in global and national level. The chapter emphasizes the vital role of open access in enabling unrestricted knowledge sharing, encouraging collaboration, and driving innovation across various disciplines. It also outlines the multiple advantages of open access, such as greater research visibility and impact, increased public engagement, and the acceleration of scientific discovery. Finally, the chapter discusses the implications of open access, including the challenges and opportunities it presents for researchers, publishers, and the wider scholarly community.

### **Chapter 4: Data Carpentry: Conceptual Approach**

This chapter briefly explains the origin and history of data carpentry. It also explores the other associated Carpentries, such as Library Carpentry and Software Carpentry. Additionally, it highlights the role of data carpentry in enhancing data literacy and research skills among scholars and professionals.

### **Chapter 5: Profile of Selected Central Universities**

This chapter offers a comprehensive overview of the selected 19 central universities of India. It outlines the mission and vision of each university, highlights their academic departments, and includes illustrations from their official websites.

## **Chapter 6: Data Analysis and Interpretation**

This chapter forms the core of the study, presenting the final evaluation results based on the analysis of the research objectives. It systematically addresses each objective, using tables, figures, and graphs to ensure a clear and well-structured presentation of the findings.

## **Chapter 7: Findings, Conclusion and Suggestions**

This chapter presents a summary of the analysis based on the defined research objectives and discusses the significance of open access practices and their adoption by the top-ranked central universities in India. In addition, it offers valuable suggestions for future research directions that were beyond the scope of the present study.

## References

- Altmetric. (2025). *Altmetric*. <https://www.altmetric.com/>
- Chandrashekara, M., & Ramasesh, C. P. (2009). Library and information science research in India. In *Proceedings of the Asia-Pacific Conference on Library & Information Education & Practice* (pp. 530–537). Japan.
- Deori, M., Verma M. K. & Nazim, M. (2022). Open Access Availability of India's Scientific Research Funded by National and International Agencies. *DESIDOC Journal of Library & Information Technology*, 42(04) 234-245. 10.14429/djlit.42.4.17810
- Elsevier. (2025). *Scopus: Comprehensive, multidisciplinary, trusted abstract and citation database*. <https://www.elsevier.com/en-in/products/scopus>
- Jalal, S. K. & Mukhopadhyay, P. (2022). Assessing Open Access Friendliness of National Institutes of Technology (NITs): A Data Carpentry Approach. *DESIDOC Journal of Library & Information Technology*, 42(05), 331-338.
- Jalal, S. K. & Mukhopadhyay, P. (2022). Gender differences, data carpentry and bibliometric studies in Mathematics. *COLLNET Journal of Scientometrics and Information Management*, 16(2), 465-476. 10.1080/09737766.2022.2090873
- Jalal, S. K. & Mukhopadhyay, P. (2022). Measuring the Open Access Friendliness of the state universities through Data Carpentry. *SRELS Journal of Information Management*, 69 225-237.
- Jhamb, G. & Samim, A. (2017). Contribution to Open Access Repository by the Central Universities of India: A Case Study of Shodhganga. *Library Philosophy and Practice*. 1559,
- Khanday, S. A., & Khanam, D. (2019). The research design. *Journal of Critical Reviews*, 6(3), 1–4.
- Mering. M. & Hoeve, C. D. (2020). A Brief History to the Future of Open Access, *Serials Review*, 46(03), 1-6.
- Misra, D. P. & Agarwal, V. (2019). Open Access Publishing in India: Coverage, Relevance, and Future Perspectives. *Journal of Korean Medical Science*, 34(27), 1-9. <https://doi.org/10.3346/jkms.2019.34.e180>
- Mukhopadhyay, P. (2022). How green is my valley? Measuring open access friendliness of Indian Institutes of Technology (IITs) through data carpentry. In A. Biswas & M. Das Biswas (Eds.), *Panorama of open access: Progress, practices & prospects* (1st ed., pp. 67–89). Ess Ess.
- Nazim, M., Bhardwaj, R. K., Agrawal, A., & Bano, A. (2022c). Open access publishing in India: trends and policy perspectives. *Global Knowledge Memory and Communication*, 72(4/5), 437–451. <https://doi.org/10.1108/gkmc-09-2021-0158>

- Pandya, M. Y., Joorel, J. P. S. & Solanki, H. (2021). Research productivity of newly established central universities in India. *Annals of Library and Information Studies*, 68, 67-74.
- Prajapati, D. (2015) Open Access Products: Issues and Challenges, *International Journal of Research in Humanities & Social Sciences*, 3(6), 41- 45.
- Robinson-Garcia, N., Costas, R., & Leeuwen, T. N. van. (2020). Open Access uptake by universities worldwide. *PeerJ*, 8, e9410. 10.7717/peerj.9410
- Roy, A. & Mukhopadhyay, P. (2022). Measuring Open Access Friendliness of Indian Central Universities through Data Carpentry. *SRELS Journal of Information Management*, 59(03), 131-139.
- Roy, B. K., Biswas, S. C. & Mukhopadhyay, P. (2012). Open Access to scholarly information in India: Trends and Developments. *Journal of Library & Information Science*, 2(01) 89-101.
- Sa, M. K. & Dora, M. (2019). Research Productivity and Research Trends in the Library and Information Science Subject: A Study with reference to SCOPUS. *Library Philosophy and Practice (e-journal)*, 2661.
- Singh, S. P., & Babbar, P. (2014). Doctoral research in library and information science in India: Trends and issues. *DESIDOC Journal of Library & Information Technology*, 34(2), 170-180.
- Singh, S.S. (2024). Significance of hypothesis in legal research. *International journal of advanced research*, 12(06), 823-828. <http://dx.doi.org/10.21474/IJAR01/18945>

# **CHAPTER 2**

## **Literature Review**

## **2.1. Introduction**

A literature review is a comprehensive survey of existing academic outputs, such as books, scholarly publications, and other sources within a specific subject field, involving the critical evaluation and summary of these works (Ramdhani et al., 2014). It plays a crucial role in research by providing essential background information, highlighting existing knowledge, and identifying the research gap. Additionally, a literature review helps establish the context for the research, deepening the understanding of the topic. By emphasizing previous studies, it also underscores the future scope of the subject, guiding the direction of new inquiries and framing research questions. The primary aim of reviewing the literature is to discover what has already been accomplished in relation to the topic. While another primary aim to discover several research methods and data collection strategies, highlighting those that have been effective or ineffective in similar contexts (Gay et al., 2006). Reviewing the existing literatures helps the researcher to have a broader understanding of a specific topic or research area. Furthermore, reviewing existing literature is essential to avoid duplication and to ensure high-quality research that contributes new and valuable insights to the field.

### **2.1.1. Resources and Platforms for Literature Review**

Reviewing the existing literature requires systematically identifying and using appropriate sources and tools to search, collect, assess, and summarize relevant studies. To conduct the literature review, the present study employs the databases and platforms for identifying, accessing, and organizing relevant literature presented in Figure 2.1. The databases include, Scopus a multidisciplinary abstract and citation database that provides access to peer-reviewed literature covering various fields, including science, technology, medicine, and social sciences. Clarivate Analytics's Web of Science, a widely known platform that indexes high-impact journals and citation data across scientific disciplines. While Google Scholar, a free academic search engine that indexes scholarly articles, books, theses, and conference papers from a wide range of sources. ResearchGate is a scholarly network where researchers can share their publications, collaborate, and engage with other field experts.

PubMed, maintained by the U.S. National Library of Medicine, provides comprehensive access to biomedical and life sciences literature. SSRN (Social Science Research Network) a repository of preprints and working papers, particularly useful for accessing early-stage research in the social sciences. J-Gate works as a global e-journal portal that offers access to millions of journal articles across multiple subject areas. Finally, OpenAlex a newly introduced open index of scholarly publications, authors, institutions, and citations, designed for efficient and transparent academic research. Moreover, these platforms form the core information resources for locating, analyzing, and synthesizing relevant literature in this study.



**Figure 2.1: Resources and Platforms for Literature Review**

## **2.2. Literature Review**

In the current chapter, a total of eighty-three literatures were reviewed, gathered from various databases. These databases were chosen for their comprehensive coverage of scholarly works, ensuring a broad and diverse range of literature relevant to the research topic. The literatures have been searched using keywords like Open Access, Open Access Publications, Open Access initiatives, Open Access funding, gender

disparity, non-open access publications, data carpentry and Open Access routes. The publication years of the reviewed literature range between 2002 and 2025. The literature review in the current chapter has been organized into several distinct sub-sections. Each sub-section focuses on a specific aspect of the research topic, providing a detailed examination of relevant literature:

- The Concept of Open Access (5)
- Types and Routes of Open Access (9)
- Global and National Open Access Initiatives (7)
- Assessment of Open Access Publications (25)
- Gender Disparities in Scholarly Publishing (8)
- Comparative Evaluation of Open Access and Non-Open Access Publications (8)
- Research on Data Carpentry Practices (11)
- Impact of Social Media Attention and Citation Advantage of Open Access (10)

### **2.2.1. The Concept of Open Access**

This section covers the fundamental concept of Open Access (OA), highlighting its definition, historical evolution, and significance in scholarly communication. It emphasizes the principle of unrestricted access to research outputs and discusses how OA fosters wider dissemination and inclusive access to knowledge.

**Margoni and Peters (2016)** explores the significance of open access (OA) in academic publishing, emphasizing the importance of Creative Commons (CC) licenses in enabling it. It defines OA as the unrestricted availability of research online, allowing users to read, copy, distribute, and use works without financial, legal, or technical barriers. The study mentions the role of copyright in OA, noting that traditional publishing models often limit access by requiring copyright transfers from authors to publishers. In contrast, OA uses CC licenses to grant broad reuse rights while ensuring proper attribution. The paper details the six types of CC licenses, each offering varying degrees of reuse rights, with the most open being

CC0, which abandons all copyright claims. The paper concludes that OA, supported by standardized licensing like CC, democratizes access to knowledge, fosters innovation, and challenges the controlled structure of traditional academic publishing.

**McKiernan et al. (2016)** demonstrate that open science practices provide significant benefits to researchers. Open access articles receive significantly higher citation rates over non-OA articles. These articles also gain increased media coverage and social media engagement. Researchers practicing open science find more collaboration opportunities, enhanced job prospects, and greater chances of securing funding. Open access journals are achieving impact factors comparable to traditional journals, further supporting the credibility and impact of open research. Transparent peer review and open data sharing also contribute to improved research visibility and quality.

**Suber (2012)** described Open Access (OA) content as something which is freely available and accessible online with minimal licensing and copyright rules facilitating the opportunity to copy, distribute and re-use. The rise of OA has lessened the burden of high-cost journal subscription pays, cost of pay-per view and licences as well as the permission restrictions.

**Bailey (2006)** defined open access as freely available digital documents on internet which are typically scholarly works excluding the other works like, novel, self-help books, magazines and so on. The documents are available digitally because it is cost-effective; once the first copy of a work is published, it becomes simpler and more affordable to create multiple copies and distribute them online.

**Guerrero and Piqueras (2004)** provides a comprehensive overview of the emergence and implications of the open-access movement in scientific publishing. It discusses the financial models supporting open access, such as publication fees charged to authors or their funding institutions, contrasting them with traditional subscription-based models. It mentions about the major open-access projects like the Public Library of Science (PLOS) and BioMed Central, emphasizing their impact on

citation rates and visibility of research. Highlights about the increase in citation rates and visibility for open-access articles compared to traditional subscription-based publications. The study also addresses the controversies and challenges faced by the open-access movement, including funding, sustainability, and resistance from traditional publishers. It concludes by advocating for the widespread adoption of open access to democratize scientific knowledge and ensure equitable access to research findings globally.

### **2.2.2. Types and Routes of Open Access**

This part describes the various routes through which Open Access can be accomplished, such as Gold, Green, Hybrid, Bronze, and Diamond OA. It discusses the characteristics, advantages, and limitations of each route, offering perceptions into how researchers and institutions adopt different OA routes to publish their research works.

**Mishra and Shukla (2025)** examines the open access (OA) policies adopted by Indian institutions registered in the Registry of Open Access Repositories Mandatory Archiving Policies (ROARMAP). The study aims to analyze key aspects of these institutional policies, including policy color codes, types of content mandated, deposit locations, licensing conditions, embargo rules, and support for Gold OA. Using data extracted from ROARMAP, employing a descriptive analysis approach to assess the OA landscape in India. Results show that only 18 Indian institutions are listed in ROARMAP, with a significant portion not specifying policy color codes, important indicators of archiving permissions. Most institutions prefer depositing in institutional repositories and mandate manuscripts for submission. Few impose embargoes or licensing restrictions. Notably, around 77.8% lack clear Gold OA policies or funding for Article Processing Charges (APCs), indicating limited institutional support for this OA route. This is the first detailed analysis of Indian OA policies in ROARMAP.

**Zhang and Ma (2024)** investigate how various open access (OA) routes gold, hybrid, and bronze affect the societal impact of scientific articles. Using data from four biological journals by the Royal Society, the study finds that gold OA articles

are positively related to social media indicators like Twitter and Facebook counts but negatively related to web indicators such as blogs and news counts. Hybrid OA positively influences both social media and web indicators, while bronze OA shows a positive association with social media but a negative, even though non-significant, association with web indicators. The research highlights that OA policies can enhance societal impacts through different routes, suggesting that policymakers should consider these differences when promoting OA.

**Dufour et al. (2023)** investigates the feasibility of implementing direct funding mechanisms to support Diamond Open Access (OA) journals, which operate without Article Processing Charges (APCs). The objectives include assessing the financial needs of these journals, evaluating their capacity to manage direct funding, and proposing practical funding models. Using a survey conducted with over 1,000 Diamond OA journals, the study examined 26 publication acts, categorizing them into certification, material production, legal dissemination, and technical dissemination. The findings reveal that most Diamond OA journals already engage in some monetary transactions, particularly for material production and technical dissemination. However, many certification and legal dissemination acts are carried out without financial support, relying heavily on volunteer efforts or institutional backing. While 70% of these journals can handle both receiving and spending funds, additional financial support is needed to ease the burden on volunteers and enhance the publication process.

**Piwowar et al. (2019)** conducts a comprehensive projection of Open Access (OA) growth in scholarly publishing. Using data from 70 million journal articles and 2.8 million Unpaywall browser extension views, the authors model the past, present, and future trends in OA availability and readership. The study finds that OA articles especially Green, Gold, and Hybrid receive significantly more views than Closed or Bronze OA papers. In 2019, 31% of journal articles were OA, accounting for 52% of views. By 2025, the study predicts that 44% of articles will be OA, attracting 70% of total views. The paper uses statistical modelling and signal processing to estimate these trends and emphasizes that increasing OA availability leads to greater scholarly

impact and societal benefit. The study highlights the declining relevance of closed-access literature and suggests a transformative shift in research dissemination.

**Baro and Eze (2017)** investigated the factors influencing academic librarians in Nigeria when selecting OA journals for publication, as well as the challenges they encounter. Data was gathered via an online questionnaire distributed to 335 academic librarians across 57 institutions using SurveyMonkey software. The findings indicated that while most librarians are familiar with the gold OA route, they lack awareness of the diamond OA model. Impact factor emerged as the primary criterion for journal selection. Additionally, the study revealed that librarians have limited knowledge of their institution's repositories, with few utilizing ResearchGate for self-archiving. Barriers identified include APCs and low impact factors. The study suggests that librarians should participate in training and awareness programs to enhance their understanding of OA publishing.

**Beasley (2017)** examines the recent studies and reports concerning Article Processing Charges (APCs) and their implications for Open Access (OA) publishing. The paper analyzes the economic impact of APCs in Europe, and subsequent studies that explored the viability of APCs for global OA. It reveals various perspectives on APCs: while supporters see APCs as a transformative model that can replace subscription fees and promote OA, critics highlight the ethical dilemmas and economic barriers they pose, particularly for less affluent researchers and institutions. The study incorporates theoretical frameworks from political philosophers and innovation theorists like Clayton Christensen to further explore the limitations of APCs as merely sustaining innovations rather than disruptive ones necessary for ethical and equitable OA. The review underscores a need for models that better align with the original motivations of the OA movement, emphasizing social justice and inclusive access to scholarly knowledge.

**Nazim (2017)** conducted a bibliometric study of the Gold open access publications in India from the journals indexed in Web of Science database. To compare and evaluate the Gold OA contents between India and other countries was used Web of Science<sup>TM</sup>-Core Collection was used. The results show a rising trend of OA research

by Indian researchers. India occupies 10<sup>th</sup> position among top 20 countries in total research publications and scores 8<sup>th</sup> position in gold OA publications. It is found that Indian researchers prefer local journals to publish gold OA papers instead of foreign journals. The rate of Indian gold OA is much higher in the subject of Clinical, Preclinical, Health, Life Sciences and Physical Sciences than social sciences.

**Addair (2015)** described about the models of open Access such as Green OA, Gold OA, Gratis OA & Libre OA. The gold and green is considered as the complementary where the gold allows access to the content through journals and the green through repositories. On the other hand, Gratis OA allows access to content after user seeks permission for exceeding the fair use while Libre OA reduces some of the restriction of copyright and licensing, though they both are free of charge.

**Haschak (2007)** explores the evolution and impact of open-access scholarly publishing, specifically through the lens of Electronic Journal of Academic and Special Librarianship (E-JASL), a peer-reviewed electronic journal. The purpose is to illustrate the viability and benefits of the "Platinum Route" to open access, where publication costs are not transferred to authors or readers but are covered by academic institutions or consortia. The aim of the study is to demonstrate the practicality of founding and maintaining an open-access journal without commercial publisher involvement and highlighting the collaboration with the International Consortium for the Advancement of Academic Publication (ICAAP). Methodology involves author's personal experiences in launching and developing E-JASL. It also includes interactions with key collaborators and the step-by-step process of setting up the journal, addressing challenges like securing a stable platform and achieving permanent archiving. The results emphasize the successful establishment of E-JASL, its growth in readership and submissions, and the broader implications for academic publishing. The case study showcases how the journal achieved indexing and abstracting by major services, improved manuscript quality, and expanded its international reach, all while maintaining free access.

### **2.2.3. Global and National Open Access Initiatives**

This section outlines an overview about the significant Open Access initiatives undertaken at both global and national levels. It examines policy developments, funding mechanisms, and collaborative programs that promote OA practices, with a special focus on efforts in India and other developing countries.

**Nazim and Bhardwaj (2023)** analyze open access (OA) scholarly publishing patterns and OA policies across European countries. The study employs a descriptive research approach, utilizing data from various web resources, directories, and bibliographic databases such as DOAJ, OpenDOAR, SCImago, ROARMAP, and Web of Science. The findings reveal that European initiatives promoting OA are effective, with a significant increase in OA journals and repositories over the past two decades. Notably, 53% of the world's journals indexed in Scopus are published in Europe, with 23.7% being OA journals. Europe also hosts 34% of global OA repositories, and OA journal papers in Europe have grown at an annual rate of 14.3%. The average proportion of OA publications in European countries is 39.07%, higher than the global average of 30.16%, with a preference for the green OA route (79.41%) over the gold OA route (52.30%). Most European research funders and institutions mandate OA availability for research findings. While the study focuses on Europe, excluding other continents, and only describes OA policies without assessing their implementation, it provides valuable insights for policymakers and institutions globally. This study is pioneering in its comprehensive use of multiple data sources to investigate OA publishing in Europe.

**Pampel (2023)** aims to explore the role of Research-Performing Organizations (RPOs) in the open access (OA) transformation. The study uses a categorization approach to identify 22 spheres of activity related to OA within RPOs, including strategy and communication, services and infrastructures, business relationships with publishers, and collaborations. Methodologically, it draws on a systematic literature review and the author's extensive experience in promoting OA within a large scientific organization. The findings highlight that OA is a cross-cutting issue in RPOs, requiring collaboration both within and beyond these organizations. Challenges identified include the need for enhanced interaction between funding agencies and RPOs, as well as the significant role of libraries in advancing OA.

Future action areas are proposed for each of the 22 spheres of activity, emphasizing coordinated efforts to promote OA. This study provides a comprehensive framework for RPOs to systematically assess and enhance their OA activities, offering valuable insights for stakeholders involved in science policy, science management, and research support services.

**Jilani and Banerjee (2023)** investigates the relationship between Article Processing Charges (APCs) and journal indicators, specifically CiteScore, SNIP, and SJR, for gold open access articles published by Indian authors. The study determines the correlation between APCs and journal metrics, utilizing data extracted from the Scopus database. The methodology involved a quantitative and qualitative approach, where data from 22,308 articles published in 1,946 journals were analyzed using SPSS and Excel. Findings revealed that APCs had a negative correlation with the number of articles published but a positive and statistically significant correlation with citations, CiteScore, SNIP, and SJR. Additionally, the study highlighted that the highest number of articles and APCs were associated with the "Health Sciences" field. The research underscores the financial burden faced by authors, particularly in low- and middle-income countries like India, where funding for APCs is limited, potentially skewing knowledge dissemination towards more affluent institutions.

**Allen and Mehler (2019)** aims to assess the impact of open science practices on early career researchers (ECRs) in the quantitative life sciences, focusing on the benefits and challenges of registered reports (RRs) and preregistrations. The primary objectives are to determine the effectiveness of these practices in increasing research reliability and reducing publication bias while identifying associated challenges, such as restrictions on research flexibility and increased time costs. The methodology involves a mixed-methods approach, including surveys of 127 published biomedical and psychological science RRs and statistical analyses using the principle binomial test with an uninformed prior in JASP software. These methods compare the frequency of null findings in RRs to traditional literature estimates. Findings indicate that RRs report a significantly higher percentage of null results (60.5%) compared to traditional studies (5% to 20%), suggesting that open science practices enhance

scientific rigor and transparency. The benefits of these practices include greater faith in research outcomes and increased opportunities for ECRs to publish null findings. However, challenges such as increased time costs and the need for careful planning are also highlighted. Overall, the study concludes that open science practices are beneficial but require adjustments in research strategies and incentives for broader adoption.

**Joshi et al. (2012)** explores the significance and impact of open access (OA) on academic libraries. It defines OA as the free, immediate, and permanent online availability of research articles, allowing anyone with internet access to read, download, and use the content without restrictions. The authors highlight key OA declarations such as the Budapest Open Access Initiative, Bethesda Statement, and Berlin Declaration, which collectively promote the principle of free access to scholarly information. The paper categorizes OA into three types: green OA (self-archiving by authors), gold OA (journals providing free access), and hybrid OA (subscription journals with some free articles). The growth of OA journals, particularly through the Directory of Open Access Journals (DOAJ), is presented, with a notable increase in contributions from countries like the United States, Brazil, and India. The authors argue that OA alleviates the "scholarly crisis" faced by libraries due to rising journal costs and shrinking budgets. By embracing OA, libraries can better support research and learning, ensuring that valuable academic resources are accessible to a broader audience.

**Christian (2008)** have discussed about the necessary steps that needs to be taken by the Government, educational and research institutions of the developing countries to support Open access. It recommends about the funding support to its scholars, enhance Information and Communication Technology facilities, to spread more awareness on open access publications and policies, to promote collaboration between developed and developing countries. The paper highlights two initiatives designed to ensure the availability of open access journals in developing nations of the world: the Health Inter Network Access to Research Initiative (HINARI) for

biomedical and health information and Access to Global Online Research in Agriculture (AGORA) for agricultural related information.

**Lal (2008)** reviews the crucial role of open access in the dissemination of scientific knowledge and the various global initiatives aimed at promoting it. It highlights that the high and rising costs of scientific literature create significant barriers to knowledge access, particularly in developing countries. To address these challenges, several initiatives such as the Budapest Open Access Initiative, ECHO Charter, Bethesda Statement on Open Access Publishing, and Berlin Declaration have been launched, advocating for free access to scientific data and information. The study notes that digital technologies and the internet offer cost-effective and efficient means to disseminate scientific results, benefiting both producers and users of knowledge. The paper also discusses the outcomes of the World Summit on Information Society (WSIS), where CODATA presented the scientific community's perspectives, leading to the adoption of principles that support open access. CODATA, under the International Council of Science (ICSU), has been instrumental in promoting open access through recommendations and initiatives like the Global Information Commons for Science Initiative (GICSI).

#### **2.2.4. Assessment of Open Access Publications**

This sub-section evaluates the adoption, growth, and impact of OA publications in various disciplines and institutions. It emphasizes on metrics such as publication trends, citation patterns, licensing practices, and institutional contributions, providing a comprehensive view of OA uptake.

**Hazarika and Sudhier (2025)** examines the Open access publications in digital archaeology through the lens of OpenAlex database during 2012-2023. The study aims to year-wise OA availability (green, gold, hybrid, bronze), document type, OA license, top journals, publishers, authorship patterns, primary document locations and citation count. A total of 13,631 OA publications have been found and analyzed, cleaned using OpenRefine and MS Excel. The results reveal that the research in digital archaeology is significantly increasing with Gold OA being the predominant

category. The results highlight the widespread use of Creative Commons licenses mostly CC-BY-NC. Publishers like Springer Nature and Elsevier BV are the most prolific, while most of the OA publications are authored by a single author; however, multi-authored publications receive more citations. OA documents are primarily found in repositories and tend to receive more citations than closed-access ones.

**Hazarika and Sudhier (2024)** examines open access (OA) publishing trends in 10 central universities using scientometric analysis of 28,832 scholarly outputs (2004–2023) sourced from OpenAlex API. It assesses publication growth, citation impact, collaboration patterns, document types, authorship trends, OA repositories, and licensing models. The findings reveal a positive growth trend in research output, but closed access publications still dominate, limiting OA adoption. Tezpur University (TZU) and North Eastern Hill University (NEHU) emerged as the most productive, with Gold OA as the preferred model, followed by Green, Bronze, and Hybrid OA. CC-BY and CC-BY-NC-ND were the most used licenses, while SSRN, Research Square, and Zenodo were the top OA repositories. Scientific Reports and PLOS ONE had the highest citation impact, with Agricultural & Biological Sciences, Engineering, and Biochemistry & Genetics leading research areas. The study underscores the need for stronger institutional policies and financial support to enhance OA adoption and provides valuable insights for policymakers, academic administrators, and researchers to foster a culture of openness and collaboration in scholarly communication.

**Ali et al. (2024)** examines the adoption and impact of open access (OA) publishing in social sciences across top central universities in India. It aims to assess the growth of OA literature, the use of different OA routes (such as gold and green), and collaboration patterns among researchers. Using data from the Social Science Citation Index (SSCI) of the Web of Science database for the period 2003-2022, the study reveals that 30.40% of publications are OA, with Banaras Hindu University (BHU) leading in OA contributions. The findings indicate a consistent rise in OA publications, peaking in 2022, and show that OA publications receive higher average citations compared to closed-access papers. International collaborations, particularly with countries like the USA and UK, also result in higher citation rates, underscoring

the role of OA in boosting research visibility and academic impact in India's social sciences.

**Hazarika et al. (2024)** evaluates the open-access (OA) publications by Indian Non-Profit Organizations (NPOs) over the last twenty years. The study's aim is to provide a detailed analysis of the growth, licensing patterns, citations, authorship trends, and other aspects of the scholarly output from Indian NPOs. The objectives include identifying the annual growth of publications, exploring licensing patterns, analyzing authorship trends, identifying leading journals and publishers, assessing citation patterns, and major research areas. The study also emphasizes the vital role of NPOs in addressing various social, economic, and environmental issues in India, drawing data from the NGO Darpan portal. The study collects data from the OpenAlex scholarly catalog and conducts analyses with OpenRefine. It examines 89,149 scholarly publications, employing statistical and bibliometric methods. The findings indicate a positive growth in OA publications, with 57.74% of papers being openly accessible. Gold OA is the most common type, comprising 69.61% of the papers in 2023. Licensing data show that 63.75% of OA papers have licenses, and a significant number of these papers are multi-authored, with those having more than ten authors receiving 60.12% of citations. "Medknow" emerges as the top publisher, and "The Indian Journal of Ophthalmology" is the leading journal. Noteworthy contributions to OA literature come from repositories like SSRN and PubMed. Among the top 30 research areas, Medicine is the most prevalent. The study offers critical insights for policymakers, researchers, and organizations, highlighting the need for ongoing efforts to promote transparency and the democratization of knowledge within the non-profit sector.

**Kampa et al. (2023)** have evaluated the gold open access publications published in Web of Science database and expenditure of article processing charge (APC) expenses in India during 2020. The study has found total 26,127 articles in gold open access in all the subjects. India has spent 17 million USD for APC and the highest is paid by the health and medical science subjects. However, 81% share is given to commercial publishers like Springer, Elsevier, MDPI.

**Deori, Verma and Nazim (2022)** studied the scenario of India's Open access researches with context to national and international funded agencies from Scopus database. The study found total 150638 funded research publications out of which 44166 publications were open access. Most of the funded publications were under available under green route followed by gold and bronze. Bangladesh Council of Scientific and Industrial Research ranks 1st in International funding agencies, Department of Science and Technology, India tops the list of government funding bodies, Indian Institute of Technology Bombay has the highest funded publications, from the department of Chemistry maximum funded publications are published, the journal Scientific Reports produces the most funded publications.

**Nazim, (2021)** studied the open access research publications by the Indian academic research institutions. 36 universities have been selected on basis of CWTS Leiden Ranking database 2020, the analysis is carried out concerning overall OA publications, its type (gold, green and bronze) and subject distribution of OA publications. The results reveal that out of total publications of the selected universities, only 23% publications are accessible openly, regarding the type of OA 'Green' OA publications are observed with 17 % of its occurrence. Most of the OA publications are published in the subject Biomedical and Health science.

**Barik and Jena (2021)** explores the landscape of open access publications in India, highlighting various government and organizational initiatives that support open access journals in the country. Scopus was utilized to examine research publications from India that appeared in open access journals. The findings reveal a concerning low proportion of contributions, with only 2,90,152 (12.00%) of the 22,32,811 Indian publications indexed in Scopus being published in open access journals. According to the Directory of Open Access Journals (DOAJ), as of March 31, 2020, India has registered a total of 286 open access journals in the DOAJ. India's contribution to global open access journals stands at a mere 1.97%. The study also delves into various government and private initiatives supporting open access journals, highlights leading funders promoting open access, identifies prominent authors in the field, and outlines the major research areas where open access publications are

growing. This study serves as a valuable resource for new researchers considering publishing their work in open access journals.

**Jain et al. (2021)** have studied on the barriers of Article Processing Charges (APC) in publishing articles. It is mentioned that the low- and middle-income countries are free from paying the APC but India is not counted under the free category and often ask for the APC by most of the journals. As a result, the individual researchers have to suffer in publishing articles by paying huge amount of APCs. The study has suggested the researchers to opt for Green and Platinum OA mode for sustainability in long run because of its free accessibility.

**Pandya, Joorel and Solanki, (2021)** assessed the research productivity of the newly established 12 central universities in India as published from 2009-2019 on Scopus database. It is found 5469 records out of which 3927 were research articles and 748 records found openly available and analyzed using bibliometrix package of R Software. The results indicates that the research of central universities is progressing along with a good collaboration level among researchers. Maximum researches are conducted in the fields of Chemistry and Central University of Rajasthan has contributed the maximum publications.

**Greussing et al. (2020)** investigates the factors influencing researchers' decisions to engage in Open Access (OA) publishing, focusing on the biomedical and health informatics field. The study aims to explore the perceptions, motivations, and behaviours of researchers towards OA, considering individual attitudes and institutional conditions. The methodology employed includes group discussions and interviews with 42 researchers from various global regions and seniority levels. The results reveal a general support for the idea of making scientific knowledge freely accessible, yet hesitancy remains due to concerns about article processing charges and the quality of OA journals. The study highlights the need for a deeper understanding of the institutional factors and policies that shape researchers' publishing behaviours, emphasizing the complex interplay between individual attitudes and external influences on the adoption of OA models. This comprehensive

approach provides insights into the challenges and opportunities of OA publishing, contributing to the broader discourse on scholarly communication

**Fraser et al. (2019)** explores the relationship between open access (OA) publishing and altmetrics, focusing on how accessibility influences online engagement with scientific research. The objectives were to quantify the correlation between different types of OA (e.g., Gold, Green, Bronze) and altmetric indicators like tweets, Mendeley reads, and mentions in blogs or news articles. The study utilized a random sample of 1,000,000 articles from the Unpaywall database, categorized by access type, and matched with bibliometric databases such as Web of Science and Scopus. Altmetrics data were retrieved using Altmetric.com, focusing on six primary indicators. Results indicated that bronze OA articles typically had the highest altmetric counts, followed by Green OA, while Closed Access articles consistently had the lowest counts. Variability was also observed across subject areas and countries, suggesting that both the type of OA and the context in which research is published significantly influence its online impact.

**Schultz et al. (2019)** focuses on the effectiveness of Open Access (OA) finding tools designed to locate freely accessible scholarly articles. The aim was to evaluate and compare four OA tools such as Open Access Button, Unpaywall, Lazy Scholar, and Kopernio against Google Scholar to determine which could most effectively retrieve OA versions of academic papers. The methodology involved using each tool to search for OA versions of 1,000 articles published in 2015 and 2016, primarily from the fields of Applied Physics and Oncology. The tools were tested within the Chrome browser, and their success in finding OA articles was recorded, along with instances of false positives. Results indicated that Google Scholar outperformed all the tools, locating 94% of the OA articles. However, the OA tools still found unique OA versions not captured by Google Scholar, suggesting their utility as complementary resources. Lazy Scholar, Unpaywall, and Open Access Button were more successful than Kopernio, which had the lowest performance.

**Misra and Agarwal (2019)** have studied the trend of open access publishing in India, found that Indian journals are significantly increasing in OA repositories like

Pubmed central and Directory of Open Access Journals. The study also discussed the challenges faced there regarding predatory journals, amount of publication charges for gold type publications. Mentioned about a program named 'Plan S (Science)' that is the latest development in scientific community developed by 11 funding agencies in Europe.

**Kirtania (2018)** analyzes the growth and impact of Indian open access (OA) social science research from 2008 to 2017, covering 1,195 papers indexed in Scopus. It aims to evaluate research trends, authorship patterns, institutional contributions, and citation impact. Using bibliometric techniques such as Relative Growth Rate, Degree of Collaboration, and Correlation Coefficient, the study reveals a steady increase in OA publications, with IIM Bangalore being the most productive institution and IIMB Management Review the leading journal. The authorship trend shows a dominance of joint authorship (Degree of Collaboration: 0.84), and India ranks 16th globally in OA social science research, leading in Southeast Asia. Citation analysis indicates that 60% of the papers received citations, with 6,078 total citations and a positive correlation ( $r = 0.89$ ) between publications and citations. The USA, UK, and Australia are India's top collaborating countries. The study concludes that OA publishing has significantly enhanced the visibility and impact of Indian social science research, encouraged collaboration and increased citation influence, and recommended sustained institutional support for future growth in OA research.

**Jhamb and Samim (2017)** studied the contribution of the central universities in India to Open Access Repository of Shodhganga. It is found that out of 46 central universities, 25 central university's research productivities are available in Shodhganga. Out of total 18378 records, Aligarh Muslim University has the maximum research outputs followed by Jawaharlal Nehru University (JNU), highest number of theses submitted in the year 2015, faculties from Science departments are the leading contributors in Shodhganga.

**Poplašen and Hebrang Grgić (2016)** examines the relationship between altmetric and bibliometric indicators, focusing on whether Open Access (OA) articles achieve higher altmetric scores compared to non-OA articles. Using data from

Altmetric.com's top 100 articles of 2014, the study compares altmetric scores, which reflect social media engagement, with traditional citation counts from Scopus, Web of Science, and Google Scholar. The findings reveal no significant altmetric advantage for OA articles, although OA articles are more widely shared on social media. Additionally, there is a weak correlation between altmetric scores and citation counts, suggesting that altmetrics capture different dimensions of scholarly impact than traditional bibliometrics, emphasizing their growing relevance in evaluating research visibility.

**Tennant et al. (2016)** reviewed the open access literature to measure its impact on three areas like economic, academic and societal. The results showed that in academics, open access paved the way for more citations for researchers, with the added benefit of facilitating the non-academic dissemination of work. In terms of economic impact, open access has benefited innovative enterprises by providing free access to resources. Moreover, there is a strong societal impact, particularly in promoting citizen science initiatives and supporting researchers in developing countries. The review also highlights that open access has the potential to significantly reduce costs for both publishers and research funders, while offering economic advantages to journals that traditionally rely on subscription models.

**Pontika and Rozenberga (2015)** examines the strategies employed by UK Higher Education Institutions (HEIs) to ensure compliance with funders' open access (OA) policies, particularly those from the Research Councils UK (RCUK) and the Higher Education Funding Council for England (HEFCE). These policies, introduced to promote free access to scholarly literature, have required HEIs to adopt new practices, including managing article processing charges (APCs), promoting OA through advocacy, and monitoring compliance. The case study of Royal Holloway, University of London, highlights the institution's efforts to navigate these requirements, focusing on the challenges of policy implementation, particularly in the areas of APC administration, embargo periods, and the choice of appropriate licensing. The study emphasizes the importance of strong communication and collaboration within institutions to meet these challenges, as well as the broader impact of these policies on shifting researchers' publishing habits.

**Solomon and Björk (2011)** investigates the financial aspects of open access (OA) publishing, with a particular focus on publication fees or article processing charges (APCs). The objectives of the study are to identify the sources of funding for APCs across different disciplines, understand the factors influencing authors' choice of journals, and determine the maximum APCs that authors are willing to pay. The study conducted a survey targeting 1,038 corresponding authors who had recently published in 74 OA journals that charge APCs, covering a broad range of disciplines. The survey collected data on the funding sources for APCs, author's past publishing experiences, and the criteria they consider when selecting a journal. The study found that the most significant factors influencing journal choice were the fit of the article within the journal's scope, the perceived quality of the journal (often indicated by its impact factor), and the speed of the publication process. While OA status was an important consideration for many authors, it was secondary to these other factors. The study also revealed that sources of funding for APCs varied significantly across disciplines, with grant funding being more prevalent in the sciences and personal funds more common in the humanities and social sciences.

**Miguel et al. (2011)** aims to analyze the proliferation of open access (OA) journals indexed in Scopus and their impact on scientific visibility. The study distinguishes between two OA models: the "gold road," which involves immediate OA publication, and the "green road," which allows self-archiving. Using a dataset of approximately 17,000 active journals from Scopus and combining information from databases such as DOAJ, SHERPA/RoMEO, and SCImago Journal Rank, the authors examine the geographical and disciplinary distribution of OA journals. The methodology involved categorizing journals by OA model and assessing their impact using citation and visibility metrics. Findings reveal that the green road journals outnumber gold road journals across all disciplines, with peripheral regions producing more gold road journals. However, visibility is mainly driven by journal quality rather than OA status. Green road journals, despite lower proportions of self-archived articles, tend to achieve higher visibility than gold road ones, suggesting that OA alone does not guarantee increased scientific impact.

**Pinfield (2010)** examines the financial aspects of open access (OA) publishing, focusing on the institutional responses to the evolving OA landscape. The study's objective is to explore how research institutions, particularly in the UK, are adapting to the growing need for funding OA publication charges. The methodology includes a detailed analysis of the international and UK-specific contexts of OA funding, supported by surveys conducted among UK higher education institutions. Data from various UK institutions, including a specific case study of the University of Nottingham's institutional OA fund, provide insights into the practicalities of managing OA funds. Findings indicate that while some institutions have established centralized OA funds, a significant majority have yet to implement formal mechanisms to support authors with OA publication fees. The University of Nottingham's experience reveals that central coordination, clear policies, and proactive support are crucial for the successful implementation of OA funds. However, the uptake and usage of such funds remain relatively low, highlighting the need for ongoing institutional efforts and broader acceptance of OA publishing models.

**Davis et al. (2008)** investigates whether open access (OA) publishing influences article downloads and citations. Its objective is to measure the impact of free access to scientific literature on readership and citations through a randomized controlled trial. A total of 1,619 articles published across 11 journals of the American Physiological Society were randomly assigned to either open access (treatment group) or subscription access (control group). The researchers measured the effect of open access on downloads (full text, PDF, and abstract) and the number of unique visitors. The findings revealed that open access articles saw significantly higher full text (89%) and PDF downloads (42%), as well as more unique visitors (23%), within the first six months of publication compared to subscription-based articles. However, no citation advantage was observed for open access articles after one year, as the citation rate for open access articles was 59% versus 63% for subscription-based articles. Regression analyses confirmed that open access did not provide a citation benefit, challenging prior assumptions about the "citation advantage" of open access.

Thus, while open access increases readership, it does not necessarily lead to higher citation rates.

**Warlick and Vaughan (2007)** have studied on the factors for choosing open access publication by the faculty of biomedical subject from University of North Carolina at Chapel Hill (UNC-Chapel Hill) and Duke University. Interview is conducted to understand the perspective of the faculties. The open access publication was counted from PubMed and PubMed central. Researchers have conducted a semi-structured interview with the prolific OA authors regarding their intention for publishing in OA journals. Their perspective towards open access publishing models were also taken into account. The faculties were categories into Assistant Professors, Associate professor and Professor. The results reveal that the faculty prefer to publish in OA journals because of the visibility and larger reader community which offers free access and more exposure. However, speed of publication and the copyright policies. But the authors fees claimed by some OA journals are indeed a challenge for them. According to the faculties, maximum visibility and exposure not be enough for publishing in OA journals over the traditional subscription-based journals only if the quality matter is discussed over there.

**Antelman (2004)** investigates whether open-access (OA) articles have a greater research impact compared to closed-access articles. Analysing the publications from the subjects mathematics, electrical and electronic engineering, political science, and philosophy, the study found that OA articles generally receive more citations. This trend was particularly strong in mathematics and political science. Despite variability across disciplines, the findings suggest that OA enhances research visibility and dissemination. The study emphasizes the importance of promoting OA practices through institutional repositories and OA journals to maximize the reach and impact of scholarly work, supporting broader access to academic research.

### 2.2.5. Gender Disparities in Scholarly Publishing

**Samaniego et al. (2023)** explores the relationship between research productivity and compensation in academia, with a focus on gender disparities. Using data from 3033 researchers across STEM and Social and Behavioral Sciences (SBS) disciplines at 17 R1 universities, the study finds that cumulative research productivity, measured by the h-index, is more strongly linked to compensation for men than for women, particularly in STEM fields. The authors argue that social role theory and gender biases in salary negotiations may contribute to this disparity. The findings suggest that institutional pay equity analyses should incorporate scientific performance metrics to address gender pay gaps effectively. The study emphasizes that while productivity is positively correlated with salary, the intensity of this relationship is gendered, being more pronounced for men, especially in male-dominated fields like STEM. The research highlights the need for continued examination and reform in how academic institutions evaluate and reward scholarly performance, ensuring that gender equity is achieved across all disciplines.

**Uribe-Bohorquez et al. (2023)** explores the gender disparities in the academic accounting field, focusing on the barriers women face in career progression. The objectives include examining the historical context of gender inequality in accounting, analyzing the representation of women in various academic roles, and understanding the impact of systemic discrimination on their career development. The methodology employed includes a review of existing literature on gender issues in academia and accounting, with a particular focus on studies that highlight the underrepresentation of women in senior positions, tenure roles, and top-tier publications. The paper synthesizes data from various sources to identify patterns of inequality and to understand the structural factors that contribute to these disparities. The findings reveal that women in accounting academia are disproportionately represented in lower-ranking, part-time, or non-tenure-track positions. They are often assigned more teaching and service tasks, which hinders their research productivity and visibility, crucial for career advancement. The study also highlights the ongoing impact of patriarchal structures and societal expectations that continue to

disadvantage women in the field. The paper concludes by calling for further research to address these inequalities and to develop strategies that promote gender equality in academic accounting.

**Kwon et al. (2023)** investigates the impact of the COVID-19 pandemic on research productivity, with a particular focus on gender disparities. The study aims to understand how the pandemic affected male and female researchers differently, particularly in terms of their academic output. The primary aim is to quantify the changes in research productivity during the pandemic and explore the factors contributing to these changes, particularly the increased burden of childcare and housework on female researchers. The study seeks to identify the conditions under which female researchers were more adversely affected and to assess the extent of these gender disparities globally. The study utilized a large-scale dataset from the Microsoft Academic Graph (MAG), encompassing over 15 million publications and nearly 12 million authors between 2016 and 2020. The study also considered various factors such as career stage, institutional prestige, and national characteristics like gender equality and COVID-19 severity. The study found a significant decline in research productivity for female researchers in 2020, particularly in first author positions. This decline was most pronounced among mid-career researchers, those affiliated with less prestigious institutions, and those from countries with lower gender equality and higher COVID-19 mortality rates. The findings underscore the gendered impact of the pandemic, highlighting the increased vulnerability of female researchers to career disruptions due to the pandemic's effects.

**Beaudry et al. (2023)** have studied the gender disparities in scientific publication output among African researchers. The study's objectives include examining the factors influencing publication productivity, such as career stage, workload, mobility, collaboration, and gender-specific challenges. The study utilizes a web-based survey conducted in 2016, which gathered responses from 6,875 African researchers across various fields. The data were analyzed using multivariate regressions to assess the impact of gender and other variables on publication output. The findings reveal that women in Africa publish less frequently than their male counterparts, primarily due

to care-work, household responsibilities, and limited mobility. However, when controlling for factors like research funding and hours devoted to academic tasks, women are as productive as men. The study concludes that the traditional academic career model, which assumes a continuous publication trajectory, disadvantages women, and calls for broader institutional reforms to support gender equality in research.

**Nygaard et al. (2022)** have conducted Norwegian bibliometric study to evaluate the women's research performance. It examined four clusters of indicators publication volume, publication type, authorship, and impact or quality across 12 indicators in total. This study examines how gender differences in research productivity and performance change when accounting for publication practices, scientific field, institutional affiliation, academic position, and age. The findings reveal that most gender disparities at the aggregate level diminish or disappear after disaggregation, highlighting that comparing similar groups ("apples with apples") reduces perceived gender gaps. The study suggests avoiding aggregate figures for designing interventions and instead tailoring gender equality measures to specific contexts. It emphasizes that while gender matters, compositional factors play a larger role, and the relationship between aggregate and disaggregate figures is complex and context-dependent.

**Rachid et al. (2021)** have examined the women faculty's research productivity in the field of medicine across different department. The study has been carried out using bibliometric analysis through Scopus database published between 2009 to 2018 from the American University of Beirut. The results revealed that 29 % faculty are women and 18% women's position is professor. Men were more frequently the last authors and corresponding authors. Within the MD subgroup, there were no significant gender differences in the number of publications, H-index, or total citations. However, women MDs were notably underrepresented as last authors. Among PhD faculty, males had higher H-indices and were more commonly the last and corresponding authors. The study summarises that women in the medical faculty were underrepresented across most departments, higher academic ranks, and senior

research authorship roles. The lack of significant differences in H-indices was partially attributed to the later year of appointment among female faculty.

**Taha et al. (2021)** conducted a meta-analysis of 16 leading neurosurgical journals from 2002 to 2019 using MEDLINE data to examine gender disparities in authorship and their effects on career progression within the field. The study identified 66,546 research articles, successfully identifying gender for 96% of the 127,809 authors analyzed. Results showed that female first authorship increased significantly from 5.8% in 2002 to 17.2% in 2019, while female senior authorship rose from 5.5% to 12.0% in the same period. The Journal of Neurosurgery: Pediatrics had the highest proportion of female first authors (33.5%), while the Asian Journal of Neurosurgery had the most female senior authors (23.8%). Notably, articles were more likely to have a female first author if the senior author was female. The study highlights that while female authorship in neurosurgical literature has grown, the slower increase in female senior authorship suggests ongoing disparities in career advancement for women in neurosurgery.

**Nguyen et al. (2021)** explores the Vietnamese gender-based authorship scenario of Open Access publishing in the discipline of Social Sciences and Humanities. The analysis is performed using Bayesian analysis technique on total dataset of 3122 research publications of both the disciplines. It is found from the analysis that the of mix-gender authorship is mostly published in gold open-access. However, it is also noted that female as single author or a group of female authors have a smaller number of OA publications than those of male single authors. The results show the existence of gender disparity in Open Access publishing. Thus, the study recommends the financial and policy sustenance to promote open science movement.

**Zhu (2017)** investigates UK academics' attitudes toward and engagement with open access (OA) publishing. Based on a survey of over 1800 respondents from 12 Russell Group universities, the study finds that while 93% support the principle of OA, only 61% have published through OA channels. Significant disparities exist based on discipline, gender, age, and seniority, with senior male academics in Medical and Natural Sciences being more active in OA publishing. Awareness of OA policies and

repositories, along with belief in OA citation advantage, strongly influence engagement. High Article Processing Charges (APCs), perceived quality concerns, and limited awareness are key barriers. Green OA is more common than Gold OA, and academics prioritize journal reputation over OA availability. The paper concludes with recommendations for institutional strategies to increase OA adoption and support.

#### **2.2.6. Comparative Evaluation of Open Access and Non-Open Access Publications**

Here it consists of studies that compares the citation impact, visibility, and scholarly reach of OA versus non-OA publications. It presents evidence from multiple disciplines to understand the benefits and limitations of each model in terms of academic influence and readership

**Hidalgo et al. (2023)** analyzed faculty publications from fully open access (OA) and non-OA journals indexed in the Web of Science to assess researchers' use of OA journals and compare the impact of their OA versus non-OA publications. Results showed that, on average, non-OA papers received more citations overall. Citations for non-OA papers were higher in six of the eleven years studied, while other years showed no significant citation advantage. In physics and entomology, non-OA articles consistently had a citation advantage, while in biological sciences, OA papers had a citation advantage in certain years, especially in Google Scholar. For papers from 2014 and 2015, there was no clear citation advantage in either group.

**Sohani et al. (2021)** explores the challenges and opportunities associated with open access (OA) publishing compared to non-OA models. The study's objective is to analyze the benefits and drawbacks of OA publishing for journals and authors. The methodology employed is a narrative review, where the authors searched databases like Scopus and Web of Science for relevant articles. Out of the articles reviewed, 24 were selected for a detailed analysis based on their focus on the challenges and opportunities of OA publishing. The findings highlight several challenges with OA publishing, including the financial burden of publishing fees, lower citation rates for OA articles without Article Processing Charges (APCs), and the generally lower

scholarly output of some OA journals compared to subscription-based journals. However, the study also identifies significant opportunities with OA publishing, such as increased visibility and higher citation rates for OA articles, as well as the rapid growth of OA journals and the potential for enhanced scientific collaboration. The study concludes that while OA publishing offers considerable advantages, particularly in terms of visibility and accessibility, the quality and impact of OA journals can vary, and financial considerations remain a significant barrier.

**AlRyalat et al. (2019)** compares open access (OA) and non-OA medical journals using citation metrics and scholarly output. Data from the 2017 Scopus list of 5,835 medical journals were analyzed, focusing on metrics like CiteScore, percent cited, and Source Normalized Impact Per Paper (SNIP). The findings revealed that OA journals significantly outperformed non-OA journals in terms of CiteScore, percent cited, and SNIP (all  $p < 0.001$ ). However, non-OA journals had a higher scholarly output, indicating more articles published per year. Among major publishers, Springer Nature had the highest proportion of OA articles at 31.5%, while Wiley-Blackwell had the lowest at 4.4%. The study concludes that, despite non-OA journals producing more articles, OA journals achieve better citation metrics, reflecting their growing impact and visibility in the medical field.

**Salisbury et al. (2017)** analyzed faculty publications from fully open access (OA) and non-OA journals indexed in the Web of Science to assess researchers' use of OA journals and compare the impact of their OA versus non-OA publications. Results showed that, on average, non-OA papers received more citations overall. Citations for non-OA papers were higher in six of the eleven years studied, while other years showed no significant citation advantage. In physics and entomology, non-OA articles consistently had a citation advantage, while in biological sciences, OA papers had a citation advantage in certain years, especially in Google Scholar. For papers from 2014 and 2015, there was no clear citation advantage in either group.

#### **2.2.7. Research on Data Carpentry Practices**

This section reviews studies that have employed data carpentry approaches in bibliometric analysis, with a particular focus on tools such as OpenRefine,

Unpaywall, and Altmetric. These tools play a crucial role in refining raw datasets, ensuring accuracy, and integrating diverse sources of information. By enabling systematic data cleaning, deduplication, and enrichment, they provide a stronger foundation for evaluating Open Access (OA) trends and scholarly outputs. Such approaches not only enhance the reliability of findings but also facilitate deeper insights into publication patterns, citation impact, and the broader visibility of research in the academic landscape.

**Roy, Shukla and Tripathi (2025)** analyzes Open Access (OA) publishing trends in State Agricultural Universities (SAUs) of India using data from OpenAlex, a comprehensive open scholarly index. The study aims to understand the extent of OA adoption in agricultural research institutions, assess publication patterns, and evaluate the citation impact of OA literature. The study employs bibliometric analysis to examine the volume of OA publications, institutional contributions, and the proportion of research outputs published in OA platforms. By categorizing different OA types—Gold, Green, Hybrid, and Bronze—the research provides a comparative analysis of how SAUs are engaging with open scholarly communication. The study also investigates citation metrics to determine whether OA publications have a higher impact compared to closed-access research outputs. Findings reveal significant variations in OA adoption across SAUs, with some universities actively contributing to open literature while others remain limited in their participation. The study identifies key institutions leading in OA publishing and highlights the challenges that hinder widespread adoption, such as lack of institutional mandates, inadequate funding, and limited awareness about OA benefits. Additionally, the research underscores the role of government policies and funding agencies in shaping OA practices in agricultural research. The implications of this study are crucial for policymakers, librarians, and researchers, as it provides insights into how OA can enhance research visibility and accessibility. By addressing gaps in OA adoption, SAUs can contribute more effectively to global agricultural knowledge dissemination. The study concludes with recommendations for strengthening OA initiatives in Indian agricultural universities, including policy reforms, institutional support, and increased advocacy for open scholarship.

**Roy and Shukla (2024)** examine Indian open-access (OA) dairy research publications from 2013–2022 using Scopus data. Employing tools like OpenRefine, OpenAlex, Dimensions.ai, and Altmetric.com, it highlights that 35.26% of publications are OA, with Gold OA being the most prominent. Articles dominate as the primary document type, and the CC-BY license is the most common. The findings show that OA publications receive higher citation and altmetric attention scores compared to closed access. Among OA categories, Hybrid OA had the highest citation ratio. Key contributors include ICAR-National Dairy Research Institute, while Elsevier BV lead among publishers. Journals like "Journal of Food Science and Technology" and "Veterinary World" featured prominently. Multiple authorship patterns, particularly three-author collaborations, were prevalent. The study also discusses the growth of DOI-enabled publications and the significant licensing gap in Green OA publications. Limitations include the study's reliance on Scopus and a 10-year data span. Future research is recommended to incorporate additional datasets and extended timelines for broader insights. This study provides valuable insights into the evolving landscape of OA in Indian dairy research.

**Roy, Shukla, and Das (2024)** analysed the Open Access friendliness of the leading deemed universities of India employing data carpentry. The data has been collected from Web of Science database published between 2011-2020. The open access friendliness is measured based on two criteria i.e, share of OA publications and their licensing details. The findings indicate that 29.15% of the total publications were distributed through four open access (OA) routes: Green OA, Gold OA, Hybrid OA, and Bronze OA. Among these, Gold OA accounted for the largest share at 43.85%. Additionally, out of 13,066 articles (56.86% of the total), a legal license was applied, with CC-BY being the most commonly used license. The study highlights JSS Academy of Higher Education and Research as the most open-access-friendly institution, ranking first with an Open Access Friendliness (OAF) score of 68.46.

**Mazumder et al. (2023)** have employed the data carpentry approach to identify the hidden research impact of the private Higher Institutions of India. The research publications have been covered using Scopus database and the secondary data has been taken from the other databases like Dimensions.ai, Mendeley.com, Altmetric.com and Unpaywall.org. The aim of the study is to compare between

citation and altmetric attention and to identify the advantages of open access. The results reveal that the institutions which publishes mostly multidisciplinary research has the larger coverage of altmetric data than the medical, technical, and management institutions. There is a positive correlation between citation and altmetric mentions and the Open access publications receives more altmetric attention than non-open access publications. The study also reveals that the Twitter event is highly covered among the altmetric data of the research publications.

**Jalal and Mukhopadhyay (2022)** conducted a bibliometric study through data carpentry approaches to measure the gender variation in Mathematics research confining to Scopus database during 2016-2020. The collection and analysis of data the study used tools like Unpaywall for extracting the open access publications, OpenRefine for cleaning and filtering the data and Gender-API database for identifying the gender of the researcher. The result found that 73% of researchers were male and 27 % were female in the publications of Mathematics and also found 93.86% researches have DOI and there is an increase in the ORCID rate.

Mukhopadhyay (2022) has examined the open access approaches of the Indian Institute of Technology (IITs) based on Open Access Framework Indicators (OAFI). The OAFI considers open access factors like publication status, license, citation and altmetric data of the publications based on a data carpentry tool. The analysis found the newer IITs to be in the highest positions under OAFI ranking system, Indian Institute of Technology Gandhinagar to achieve top position in open access publication rate and citation count, Indian Institute of Technology Bhubaneswar obtained top position in open access license share and Indian Institute of Technology Ropar achieved the highest open access altmetric score.

**Roy and Mukhopadhyay (2022)** assessed the open access functionalities of the selected National Institutes of Technology (NITs) based on NIRF ranking through a Data Carpentry approach, using OpenRefine for data cleaning and Unpaywall for identifying open access publications. The analysis, conducted for the period 2012–2021 using the Scopus database, focused on measuring the Open Access Friendliness parameters. The ranking reveals that Sardar Vallabhbhai National Institute of Technology, Surat achieved the highest score of 52 out of a 100-point scale. Their findings emphasized not only the variation in OA adoption among NITs but also the

growing importance of evaluating institutional performance through structured OA metrics, which can guide policy formulation and strategic improvements.

**Roy and Mukhopadhyay (2022)** have analyzed the status of open access publications of selected state universities in a data carpentry approach using the tool named OpenRefine to measure the open access functionalities. The study extracted the data from Scopus database published from 2012-2021, the analysis revealed that 98% of the state universities have achieved above 50 points out of 100-point scale, the universities that are newly established are at good score level in open access assessment. The ranking indicates that King Georges Medical University tops the list in case of OA publications and its citation, Panjab University has the greater value in license use in OA publications and Delhi Technological University has achieved maximum social value through Almetric score.

**Roy and Mukhopadhyay (2022)** selected the top ten Indian central universities to measure the open access compatibilities of their publications using a Data Carpentry approach with OpenRefine. The study employed a 100-point scale ranking framework based on two key indicators: OA publication share and OA license share. The results revealed that Visva-Bharati University secured the highest position in the ranking system with a score of 64 out of 100, highlighting its stronger commitment to open access compared to its peers. This work laid a foundation for subsequent studies, including the present research, which applies a simplified version of their OA friendliness framework with additional parameters to assess the openness of selected central universities in greater depth.

**Robinson-Garcia, Costas, and Leeuwen (2020)** conducted an analysis of measuring the OA publications of Worldwide universities on the basis of some predefined indicators concerning its policy and practices. The study has selected total of 963 institutions based on Leiden Ranking and the data has been extracted from the Web of Science database, for tracking the OA status Unpaywall is used. It is found that out of 41% of total publications are openly accessible 'Green' is the most common type of OA with 77% followed by Gold with 33%. The results show that Brazilian universities consist maximum of Gold OA publications.

**Roy, Biswas, and Mukhopadhyay (2012)** studied the trends and development of Open Access scholarly information in India. The study analyses various OA

channels, journals, OA Archive, Open Course Ware initiatives (OCW), Digital Library Projects, Meta data Harvesting Services and the role of government in supporting OA. The findings revealed that OA initiatives and OA channels are increasing in India and governing bodies like UGC, NKC, CSIR and ICMR have taken certain initiatives for open access content. In India, 65 institutions are registered in OA archive like Registry of Open Access Repository (ROAR) and Directory of Open Access Repository (DOAR), Digital Library projects like Indian National Digital Library in Engineering Sciences and Technology (INDEST), Vidyanidhi, Electronic Theses and Dissertation Project (INFLIBNET), Indian Parliament Library have been developed.

#### **2.2.8. Impact of Social Media Attention and Citation Advantage of Open Access**

This part explores the relationship between Open Access (OA) and its visibility across various social media platforms. It emphasizes the role of altmetrics as an alternative measure for capturing both societal and academic impact beyond traditional citations. By tracking mentions, shares, and discussions on platforms like Twitter, Facebook, blogs, and news outlets, altmetrics provide valuable insights into how OA publications engage wider audiences. The discussion further highlights how increased online visibility and engagement often translate into higher citation counts, underscoring the dual advantage of OA in enhancing scholarly recognition while broadening public reach.

**S and R (2024)** aimed to evaluate the societal and academic impact of digital humanities (DH) research using Altmetrics and traditional citation analysis. The data has been collected from the Scopus database on digital humanities, resulted in 3,765 publications, narrowing it to 860 publications with both altmetric scores and traditional citations for analysis. Altmetric Explorer has been employed for altmetric data and statistical tools like Spearman's correlation to explore relationships between citations and altmetric scores. The study also used Mann-Whitney U-tests to analyze access type impacts. The findings revealed a moderate positive correlation between altmetric attention scores and traditional citation counts, emphasizing that publications with greater social media engagement tended to receive higher citations. Green open access publications demonstrated a clear advantage in terms of altmetric

scores, Dimensions citations, and Scopus citations. Additionally, the study observed that books gained quicker social media attention than articles or chapters. Among social media platforms, Mendeley readership and Twitter mentions were significant contributors to the altmetric impact. Overall, the research highlighted the growing importance of altmetrics in measuring the impact of emerging fields like digital humanities, particularly when traditional citations take time to accumulate.

**Huang et al. (2024)** explores the relationship between OA and citation diversity by examining citations across geographic locations, institutions, subregions, regions, and fields of research. It seeks to measure the broader dissemination of OA research, contributing to debates about the benefits of OA in reaching diverse audiences. Utilizing large-scale bibliographic data from 19 million research outputs and 420 million citation links spanning 2010–2019, the study employed diversity metrics like the Shannon Entropy and Gini-Simpson Index to assess citation diversity. Data were sourced from platforms like Crossref Metadata and Microsoft Academic Graph (MAG), with outputs categorized into OA types (Gold, Green, Closed). Statistical analysis, supported by Python and SQL, enabled comprehensive comparisons across diverse citation actor groups. The results reveal a consistent OA citation diversity advantage, with OA outputs receiving more diverse citations than closed-access outputs. Green OA, particularly through repositories, showed a stronger impact compared to Gold OA. The study highlights that OA research benefits traditionally prestigious research centers while gradually improving access for underrepresented regions.

**Mukherjee et al. (2023)** evaluated the OA publications under the sub-categories of medical science field to explore the presence of Altmetric data. The primary data has been collected from the Scopus database during 2012-2021 with at least one India-based author. Further three platforms have been used such as Unpaywall.org, Mendeley.com and Altmetric.com through the use of OpenRefine and REST/API calls. The study has also examined the Open access altmetric advantages (OAAA) and Categorical OAAA (COAAA) in seven different altmetric platforms. The results of the study found a low altmetric attention but an increase in the growth trend over the past. Among the altmetric platforms, Mendeley is found to have the maximum

coverage. In the field of health policy has received the maximum altmetric attention while the field of drug guides receives the lowest score. Furthermore, open access (OA) articles have received significantly higher coverage in altmetrics compared to non-OA articles, with bronze OA articles being the most prominent. Among the disciplines, news outlets have consistently highlighted the notable altmetric benefits of OA articles. Specifically, bronze and hybrid OA categories exhibit the most substantial altmetric advantages.

**Vadhera et al. (2022)** evaluates the relationship between open access (OA) publishing and social media attention in orthopaedic and sports medicine literature. A cross-sectional analysis of 2143 articles (246 OA and 1897 subscription access, SA) from five high-impact hybrid journals (2019) revealed that OA articles had significantly higher Altmetric Attention Scores (AAS) (mean 62.4 vs. 18.4) and citation rates (mean 17.0 vs. 8.6) compared to SA articles ( $P < .001$ ). Multivariable regression identified OA status, higher institutional collaboration, epidemiological studies, and conflict-of-interest disclosures as significant predictors of higher AAS. OA articles demonstrated broader dissemination, translating into increased social media attention and citations. The findings underscore the potential of OA publishing in hybrid journals to enhance research visibility and impact, emphasizing its value for wider scientific communication and audience engagement.

**B and H (2021)** aimed to analyze the adoption of Open Access (OA) publishing by researchers at Tumkur University, assess funding sources for OA publications, and evaluate the citation impact of OA versus non-OA articles. Using data from the Web of Science database, the study examined 516 articles published between 2011 and 2020. Statistical analyses, including an independent samples t-test via SPSS, and visualizations using VOSviewer were employed. The findings revealed that 19.57% of the articles were published through OA routes, with 63.17% of these funded under the gold OA model and 30.98% through green OA. Citation analysis showed that OA articles had a mean of 17.32 citations compared to 18.03 for non-OA articles, with a significant p-value of 0.004 indicating notable differences. Collaboration data highlighted international partnerships with countries like the USA, Canada, and Taiwan, while chemistry and material science emerged as the most productive

disciplines. Despite strong contributions in science and technology, the study noted a lack of research output in arts, social sciences, and humanities, suggesting a need for increased productivity in these areas to enhance the university's academic standing.

**Langham-Putrow et al. (2021)** investigated the Open Access Citation Advantage (OACA) aiming to compare citation rates between open access (OA) and non-OA articles to determine if OA status influences citations. The study collected the data from 17 databases covering multiple disciplines and included 134 studies published since 2001, all featuring direct OA vs. non-OA comparisons. The study evaluated various OA models (green, gold, hybrid) and disciplines, assessing citations and Altmetric scores. The findings revealed that 47.8% of studies confirmed OACA, 27.6% found no advantage, and 23.9% observed OACA in subsets like specific disciplines or journals. Factors such as selection bias, early view effects, and discipline-specific practices influenced results, highlighting the need for standardized bibliometric reporting. Despite heterogeneity, the review underscores the growing interest in OACA and its implications for scholarly communication.

**Taylor (2020)** examines the altmetric attention advantage (OAAA) of open access (OA) books and chapters in the humanities and social sciences using data from Dimensions and Altmetric.com. It analyses 32,222 books (5% OA) and 220,527 chapters (7% OA), comparing their altmetric presence across indicators like Twitter, blogs, news, policy documents, and Mendeley. OA books and chapters consistently show higher altmetric attention than non-OA counterparts, particularly on social media, blogs, and policy documents. The findings reveals that while OA books have lower Mendeley readership compared to non-OA books, OA chapters have higher readership. Disciplinary differences exist, with Economics and Psychology showing the highest OA rates. The study identifies challenges like limited metadata and the low number of OA books but confirms that OA facilitates broader societal impact. It emphasizes the importance of promoting OA for books and chapters to enhance visibility, engagement, and non-academic impact.

**Cintra et al. (2018)** examines the impact of open access (OA) on citation and social media metrics for articles published in leading Information Science journals.

Examining the 16 hybrid journals with high impact factors, the research compared citation counts and Altmetric scores for OA and non-OA articles, using data from Web of Science, Google Scholar, and Altmetric.com over two time periods. Results confirmed the Open Access Citation Advantage (OACA), with OA articles particularly those made immediately available through Article Processing Charges (APC) receiving higher citations and social media mentions. Green road OA articles archived in institutional repositories also showed benefits but to a lesser extent. While OA significantly boosts visibility and impact, the study emphasized that article quality remains a key driver of citations. Additionally, Altmetric scores were found to reflect immediate attention but showed limited long-term growth. The findings suggest that encouraging OA adoption could enhance the dissemination and influence of scholarly work in Information Science.

**Ferreras-Fernández et al. (2016)** highlights the benefits of open access (OA) repositories in enhancing the accessibility, visibility, and impact of PhD theses, focusing on grey literature often overlooked in scholarly communication. Using a sample of 125 e-theses from the University of Salamanca's institutional repository (Gredos), the study analyzed visits, downloads, and citations obtained via repository statistics and Google Scholar. Results show that OA repositories significantly enhance the visibility and usage of these e-theses while contributing to a notable citation rate, thereby increasing their academic impact. A Kruskal-Wallis's test revealed variations in these metrics across different knowledge areas. By providing empirical evidence, the study underscores the value of OA repositories as effective channels for disseminating grey literature, which is traditionally challenging to track and utilize. The findings reinforce the importance of OA in advancing the reach and influence of unpublished academic work, establishing repositories as vital tools in scientific communication.

**Kousha and Abdoli (2010)** investigates the citation advantage of self-archived Open Access (OA) agriculture research compared to non-OA papers. Using a sample of 400 articles from ISI-indexed agriculture journals in 2005, it found that OA articles had a median of four citations, double that of non-OA articles. Journal-level analysis from 2005 to 2007 revealed that OA journals had a lower average impact factor

(0.29) than non-OA journals (0.65). Additionally, an assessment of 100 OA and 100 non-OA Food and Agriculture Organization (FAO) publications showed that OA documents had a significantly higher mean citation count (1.73 vs. 0.28). Data sources included ISI, Scopus, Google, and Google Scholar. The results clearly indicate a citation advantage for self-archived OA articles, suggesting that making agricultural research openly accessible, even when published in non-OA journals, can substantially enhance its visibility and impact. This emphasizes the value of self-archiving in increasing the citation reach of agricultural research.

### **2.3. Research Gap**

Based on the literature review, it has been observed that several studies have been conducted on various aspects of Open Access (OA) publications, each with different scopes, methodologies, and objectives. However, no prior research has specifically addressed the Open Access parameters, time period coverage, and institutional focus adopted in the present study. Furthermore, there is a notable absence of studies employing a data carpentry approach to evaluate OA publications in the context of Indian central universities. Therefore, this study makes a novel attempt to conduct an in-depth analysis of the Open Access output of selected central universities, aiming to bridge the existing research gap and contribute meaningful insights to the field.

## References

- Addair, K. (2015). *Open access: The importance of open information*. <https://doi.org/10.13140/RG.2.1.5098.6324>
- Ali, A., Nazim, M., & Ahmad, S. (2024). An empirical investigation of open access scholarly publishing trends in social sciences at high-ranked central universities of India. *Global Knowledge, Memory and Communication*. Advance online publication. <https://doi.org/10.1108/GKMC-02-2024-0102>
- Allen, C., & Mehler, D. M. A. (2019). Open science challenges, benefits and tips in early career and beyond. *PLoS Biology*, 17(5), e3000246. <https://doi.org/10.1371/journal.pbio.3000246>
- AlRyalat, S. A., Saleh, M., Alaqraa, M., Alfukaha, A., Alkayed, Y., Abaza, M., Saa, H. A., & Alshamiry, M. (2019). The impact of the open-access status on journal indices: a review of medical journals. *F1000Research*, 8, 266. <https://doi.org/10.12688/f1000research.17979.1>
- Antelman, K. (2004). Do Open-Access articles have a greater research impact? *College & Research Libraries*, 65(5), 372–382. <https://doi.org/10.5860/crl.65.5.372>
- B, R., & H, R. B (2021). Preferences and Citation Impact of Open Access Publishing by Indian Research Community Indian Research Community. *Library Philosophy & Practice*.
- Bailey, C. W. (2006). What is open access? In *Elsevier eBooks* (pp. 13–26). <https://doi.org/10.1016/b978-1-84334-203-8.50002-9>
- Barik, N., & Jena, P. (2021). Does India move toward open access of publications? *Journal of Archival Organization*, 18(1–2), 51–62. <https://doi.org/10.1080/15332748.2021.1992203>
- Baro, E. E., & Eze, M. E. (2017). Perceptions, preferences of scholarly publishing in open access routes. *Information and Learning Sciences*, 118(3/4), 152–169. <https://doi.org/10.1108/ils-03-2017-0015>
- Beasley, G. (2017b). Article processing charges: A new route to open access? *Information Services & Use*, 36(3–4), 163–170. <https://doi.org/10.3233/isu-160815>
- Beaudry, C., Prozesky, H., St-Pierre, C., & Mirnezami, S. R. (2023). Factors that affect scientific publication in Africa—A gender perspective. *Frontiers in Research Metrics and Analytics*, 8. <https://doi.org/10.3389/frma.2023.1040823>

- Christian, G. E. (2008) Open access initiative and the developing world. *African journal of Library, Archives and Information Science*, 18(1), 1-22.
- Cintra, P. R., Furnival, A. C., & Milanez, D. H. (2018). The impact of open access citation and social media on leading top Information Science journals. *Investigación Bibliotecológica Archivonomía Bibliotecología E Información*, 32(77), 117. <https://doi.org/10.22201/iibi.24488321xe.2018.77.57874>
- Davis, P. M., Lewenstein, B. V., Simon, D. H., Booth, J. G., & Connolly, M. J. L. (2008). Open access publishing, article downloads, and citations: randomised controlled trial. *BMJ*, 337(jul31 1), a568. <https://doi.org/10.1136/bmj.a568>
- Dufour, Q., Pontille, D., & Torny, D. (2023). Supporting diamond open access journals. Interest and feasibility of direct funding mechanisms. *bioRxiv (Cold Spring Harbor Laboratory)*. <https://doi.org/10.1101/2023.05.03.539231>
- Ferreras-Fernández, T., García-Peñalvo, F., Merlo-Vega, J. A., & Martín-Rodero, H. (2016). Providing open access to PhD theses: visibility and citation benefits. *Program Electronic Library and Information Systems*, 50(4), 399–416. <https://doi.org/10.1108/prog-04-2016-0039>
- Fraser, N., Momeni, F., Mayr, P., & Peters, I. (2019). *Altmetrics and Open Access: Exploring Drivers and Effects*. ZBW – Leibniz Information Centre for Economics.
- Gay, L. R., Mills, G. E., & Airasian, P. W. (2006). *Educational research: Competencies for analysis and applications* (8th ed.). Merrill Prentice Hall. <https://web.cortland.edu/shis/651/LitRevOverview.pdf>
- Greussing, E., Kuballa, S., Taddicken, M., Schulze, M., Mielke, C., & Haux, R. (2020). Drivers and obstacles of open access publishing. A qualitative investigation of individual and institutional factors. *Frontiers in Communication*, 5. <https://doi.org/10.3389/fcomm.2020.587465>
- Guerrero, R. and Piqueras, M. (2004). Open access. A turning point in scientific publication. *International Microbiology*, 7, 157-161.
- Haschak, P. G. (2007). The ‘platinum route’ to open access: a case study of EJASL: The Electronic Journal of Academic and Special Librarianship. *Information Research*, 12(4).
- Hazarika, R., & Sudhier, K. (2025). The growth and impact of global open-access publications in digital archaeology: insights from OpenAlex. *Information Discovery and Delivery*. <https://doi.org/10.1108/idd-08-2024-0125>
- Hazarika, R., & Sudhier, K. G. (2024). Mapping Open Access Publishing Trends in Central Universities of North East India: A Scientometric Approach. *Science*

- Hazarika, R., Roy, A., & Sudhier, K. (2024). Mapping the open access publications of Indian non-profit organizations over the last 20 years based on OpenAlex insights. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-02-2024-0106>
- Hidalgo, D. B., Bravo, M. V. C., & Iturralde, W. M. P. (2023). Comparative study of Open Access and Non-Open Access journals in subject area Energy. *OALib*, 10(07), 1–11. <https://doi.org/10.4236/oalib.1110426>
- Huang, C., Neylon, C., Montgomery, L., Hosking, R., Diprose, J. P., Handcock, R. N., & Wilson, K. (2024b). Open access research outputs receive more diverse citations. *Scientometrics*, 129(2), 825–845. <https://doi.org/10.1007/s11192-023-04894-0>
- Jain, V. K., Iyengar, K. P., & Vaishya, R. (2021). Article processing charge may be a barrier to publishing. *Journal of Clinical Orthopaedics and Trauma*, 14, 14–16. <https://doi.org/10.1016/j.jcot.2020.10.039>
- Jalal, S. K. & Mukhopadhyay, P. (2022) Assessing Open Access Friendliness of National Institutes of Technology (NITs): A Data Carpentry Approach, *DESIDOC Journal of Library & Information Technology*, 42(05), 331-338.
- Jalal, S. K. & Mukhopadhyay, P. (2022) Gender differences, data carpentry and bibliometric studies in Mathematics. *COLLNET Journal of Scientometrics and Information Management*, 16(2), 465-476. [10.1080/09737766.2022.2090873](https://doi.org/10.1080/09737766.2022.2090873)
- Jhamb, G. & Samim, A. (2017). Contribution to Open Access Repository by the Central Universities of India: A Case Study of Shodhganga. *Library Philosophy and Practice*. 1559,
- Jilani, M., & Banerjee, A. (2023). Correlation of article processing charges with journal metrics: A study of gold open access journals from India. *South African Journal of Library and Information Science*, 89(1).
- Joshi, A. N., Vatnal, R. M., & Manjunath, G. A. (2012). Open access initiatives: A boon to academic libraries. *Library Philosophy and Practice*, 1.
- Kampa, R. J., Sa, M. K. & Dora, M., (2023). Publications in gold open access and article processing charge expenditure: evidence from Indian scholarly output. *Current Science*, 125(10), 1057-1062. [10.18520/cs/v125/i10/1057-1062](https://doi.org/10.18520/cs/v125/i10/1057-1062)
- Kirtania, D. K. (2018). Bibliometric study of Indian open access social science literature. *Library Philosophy and Practice (e-journal)*

- Kousha, K., & Abdoli, M. (2010). The citation impact of Open Access agricultural research. *Online Information Review*, 34(5), 772–785. <https://doi.org/10.1108/14684521011084618>
- Kwon, E., Yun, J., & Kang, J. (2023). The effect of the COVID-19 pandemic on gendered research productivity and its correlates. *Journal of Informetrics*, 17(1), 101380. <https://doi.org/10.1016/j.joi.2023.101380>
- Lal, K. (2008). Open access: Major issues and global initiatives. *DESIDOC Journal of Library & Information Technology*, 28(1), 67-71.
- Langham-Putrow, A., Bakker, C., & Riegelman, A. (2021). Is the open access citation advantage real? A systematic review of the citation of open access and subscription-based articles. *PLoS ONE*, 16(6), e0253129. <https://doi.org/10.1371/journal.pone.0253129>
- M, K, S & A, R. K., (2024). Tracing The Scholarly Footprints of Digital Humanities: A Comparative Study on Citations and Altmetric Attention. *South India Journal of Social Sciences*, 22(3), 124-134.
- Margoni, T., & Peters, D. M. (2016). Creative Commons licenses: Empowering open access. *Creative Commons*. <https://creativecommons.org/licenses/by/4.0/legalcode>
- Mazumder, J., Nath, A., Mukherjee, S. P., Pakira, A. K., & Jana, S. (2023). Measuring alternative research impact of private higher education institutions of India through data carpentry. *DESIDOC Journal of Library & Information Technology*, 43(06), 414–425. <https://doi.org/10.14429/djlit.43.06.19045>
- McKiernan, E. C., Bourne, P. E., Brown, C. T., Buck, S., Kenall, A., Lin, J., McDougall, D., Nosek, B. A., Ram, K., Soderberg, C. K., Spies, J. R., Thaney, K., Updegrove, A., Woo, K. H., & Yarkoni, T. (2016). How open science helps researchers succeed. *eLife*, 5. <https://doi.org/10.7554/elif.16800>
- Miguel, S., Chinchilla-Rodriguez, Z., & De Moya-Anegón, F. (2011). Open access and Scopus: A new approach to scientific visibility from the standpoint of access. *Journal of the American Society for Information Science and Technology*, 62(6), 1130–1145. <https://doi.org/10.1002/asi.21532>
- Mishra, S. and Shukla, A. (2025). Open access policies of Indian institutions: Based on ROARMAP. *Digital Library Perspectives, ahead-of-print*(ahead-of-print). <https://doi.org/10.1108/DLP-12-2024-0192>
- Misra, D. P. & Agarwal, V. (2019). Open Access Publishing in India: Coverage, Relevance, and Future Perspectives. *Journal of Korean Medical Science*, 34(27), 1-9. doi- <https://doi.org/10.3346/jkms.2019.34.e180>

- Mukherjee, S., Nath, A., Mazumder, J., & Jana, S. (2023). Does openness of articles get higher attention in altmetric? An investigation of medical discipline. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-05-2023-0180>
- Mukhopadhyay, P. (2022). How green is my valley? Measuring open access friendliness of Indian Institutes of Technology (IITs) through data carpentry. In A. Biswas & M. Das Biswas (Eds.), *Panorama of open access: Progress, practices & prospects* (1st ed., pp. 67–89). Ess Ess.
- Nazim, M. (2017). Bibliometric analysis of gold open access in India. *International Information & Library Review*, 50(1), 13–23. <https://doi.org/10.1080/10572317.2017.1326246>
- Nazim, M. (2021). Analysing open access uptake by academic and research institutions in India. *DESIDOC Journal of Library & Information Technology*, 41(02), 108–115. <https://doi.org/10.14429/djlit.41.02.16324>
- Nazim, M., & Bhardwaj, R. K. (2023). Open access initiatives in European countries: analysis of trends and policies. *Digital Library Perspectives*, 39(3), 371–392. <https://doi.org/10.1108/dlp-06-2022-0051>
- Nazim, M., Bhardwaj, R. K., Agrawal, A., & Bano, A. (2022b). Open access publishing in India: trends and policy perspectives. *Global Knowledge Memory and Communication*, 72(4/5), 437–451. <https://doi.org/10.1108/gkmc-09-2021-0158>
- Nguyen, H., Nguyen, M., Le, T., Ho, M., & Vuong, Q. (2021). Open access publishing probabilities based on gender and authorship structures in Vietnam. *Publications*, 9(4), 45. <https://doi.org/10.3390/publications9040045>
- Nygaard, L. P., Aksnes, D. W., & Piro, F. N. (2022). Identifying gender disparities in research performance: the importance of comparing apples with apples. *Higher Education*, 84(5), 1127–1142. <https://doi.org/10.1007/s10734-022-00820-0>
- Pampel, H. (2023). Promoting open access in Research-Performing Organizations: spheres of activity, challenges, and future action areas. *Publications*, 11(3), 44. <https://doi.org/10.3390/publications11030044>
- Pandya, M. Y., Joorel, J. P. S. & Solanki, H. (2021). Research productivity of newly established central universities in India, *Annals of Library and Information Studies*, 68, 67-74.
- Pinfield, S. (2010). Paying for open access? Institutional funding streams and OA publication charges. *Learned Publishing*, 23(1), 39–52. <https://doi.org/10.1087/20100108>

- Piwowar, H., Priem, J., & Orr, R. (2019). The Future of OA: A large-scale analysis projecting Open Access publication and readership. *bioRxiv (Cold Spring Harbor Laboratory)*. <https://doi.org/10.1101/795310>
- Pontika, N., & Rozenberga, D. (2015). Developing strategies to ensure compliance with funders' open access policies. *Insights the UKSG Journal*, 28(1), 32–36. <https://doi.org/10.1629/uksg.168>
- Poplašen, L. M., & Hebrang Grgić, I. (2016). Altmetric and bibliometric scores: Does open access matter? *Qualitative and Quantitative Methods in Libraries (QQML)*, 5, 451-460.
- Rachid, E., Noureddine, T., Tamim, H., Makki, M., Naalbandian, S., & Al-Haddad, C. (2021). Gender disparity in research productivity across departments in the faculty of medicine: a bibliometric analysis. *Scientometrics*, 126(6), 4715–4731. <https://doi.org/10.1007/s11192-021-03953-8>
- Ramdhani, A., Ramdhani, M.A. & Amin, A.S. (2014). Writing a Literature Review Research Paper: A step-by-step approach. *International Journal of Basic and Applied Science*. 3(1), 47-56. <https://digilib.uinsgd.ac.id/5129/1/08IJBAS%283%29%281%29.pdf>
- Robinson-Garcia, N., Costas, R., & Leeuwen, T. N. van. (2020). Open Access uptake by universities worldwide. *PeerJ*, 8, e9410. doi: 10.7717/peerj.9410
- Roy, A. & Mukhopadhyay, P. (2022). Measuring Open Access Friendliness of Indian Central Universities through Data Carpentry, *SRELS Journal of Information Management*, 59(03), 131-139.
- Roy, A. & Mukhopadhyay, P. (2022). Measuring the open access friendliness of the state universities in India through data carpentry. *Annals of Library and Information Studies*, 69(3). <https://doi.org/10.56042/alis.v69i3.63837>
- Roy, A., & Mukhopadhyay, P. (2022). Assessing open access friendliness of National Institutes of Technology (NITs) a data carpentry approach. *DESIDOC Journal of Library & Information Technology*, 42(5), 331–338. <https://doi.org/10.14429/djlit.42.5.18263>
- Roy, A., & Shukla, A. (2024). Unveiling the Status of Open Access Dairy Research in India through Data Carpentry. *Journal of Data Science Informetrics and Citation Studies*, 3(1), 01–10. <https://doi.org/10.5530/jcitation.3.1.1>
- Roy, A., Shukla, A. & Das, T. K. (2024). Unveiling the Open Access Friendliness of NIRF Ranked Deemed Universities of India through Data Carpentry. *Library Herald* 62(3), 293- 306.

- Roy, A., Shukla, A. & Tripathi, A. (2025). Exploring Open Access Trends in State Agricultural Universities of India: Insights from OpenAlex. *Annals of Library and Information Studies*, 72(01). <https://doi.org/10.56042/alis.v72i1.14179>
- Roy, B. K., Biswas, S. C. & Mukhopadhyay, P. (2012). Open Access to scholarly information in India: Trends and Developments. *Journal of Library & Information Science*, 2(01), 89-101.
- Salisbury, L., Chowdhury, A. R., & Smith, J. J. (2017). Faculty Publications from a Research University: The Scholarly Impact of Open Access versus Non-Open Access. *Science & Technology Libraries*, 36(2), 187–199. <https://doi.org/10.1080/0194262x.2016.1273815>
- Samaniego, C., Lindner, P., Kazmi, M. A., Dirr, B. A., Kong, D. T., Jeff-Eke, E., & Spitzmueller, C. (2023). Higher research productivity = more pay? Gender pay-for-productivity inequity across disciplines. *Scientometrics*, 128(2), 1395–1407. <https://doi.org/10.1007/s11192-022-04513-4>
- Schultz, T. A., Azadbakht, E., Bull, J., Bucy, R., & Floyd, J. (2019). Assessing the Effectiveness of Open Access Finding Tools. *Information Technology and Libraries*, 38(3), 82–90.
- Sohani, F., Shekofteh, M., Shahbodaghi, A., & Jambarsang, S. (2021). Journals on the road: Open access or non-open access? *Library Philosophy and Practice*, 6276. University of Nebraska - Lincoln. <https://digitalcommons.unl.edu/libphilprac/6276>
- Solomon, D. J., & Björk, B. (2011). Publication fees in open access publishing: Sources of funding and factors influencing choice of journal. *Journal of the American Society for Information Science and Technology*, 63(1), 98–107. <https://doi.org/10.1002/asi.21660>
- Suber, P. (2012). *Open access*. <https://library.oapen.org/handle/20.500.12657/26065>
- Taha, B., Sadda, P., Winston, G., Odigie, E., Londono, C., Greenfield, J. P., Pannullo, S. C., & Hoffman, C. (2021). Increases in female academic productivity and female mentorship highlight sustained progress in previously identified neurosurgical gender disparities. *Neurosurgical FOCUS*, 50(3), E3. <https://doi.org/10.3171/2020.12.focus20939>
- Taylor, M. (2020). An altmetric attention advantage for open access books in the humanities and social sciences. *Scientometrics*, 125(3), 2523–2543. <https://doi.org/10.1007/s11192-020-03735-8>
- Tennant, J. P., Waldner, F., Jacques, D. C., Masuzzo, P., Collister, L. B., & Hartgerink, C. H. J. (2016). The academic, economic and societal impacts of Open Access: an evidence-based review. *F1000Research*, 5, 632. <https://doi.org/10.12688/f1000research.8460.3>

- Uribe-Bohorquez, M., Rivera-Ordóñez, J., & García-Sánchez, I. (2023). Gender disparities in accounting academia: analysis from the lens of publications. *Scientometrics*, 128(7), 3827–3865. <https://doi.org/10.1007/s11192-023-04718-1>
- Vadhera, A. S., Lee, J. S., Veloso, I. L., Khan, Z. A., Trasolini, N. A., Gursoy, S., Kunze, K. N., Chahla, J., & Verma, N. N. (2022). Open Access Articles Garner Increased Social Media Attention and Citation Rates Compared With Subscription Access Research Articles: An Altmetrics-Based Analysis. *The American Journal of Sports Medicine*, 50(13), 3690–3697. <https://doi.org/10.1177/03635465221124885>
- Warlick, S. E. and Vaughan, K. T. L., (2007). Factors influencing publication choice: why faculty choose open access, *Biomedical Digital Libraries*, 4(1), 1-12. 10.1186/1742-5581-4-1
- Zhang, L., & Ma, L. (2024). Different open access routes, varying societal impacts: evidence from the Royal Society biological journals. *Scientometrics*, 129(6), 3407–3431. <https://doi.org/10.1007/s11192-024-05032-0>
- Zhu, Y. (2017). Who support open access publishing? Gender, discipline, seniority and other factors associated with academics' OA practice. *Scientometrics*, 111(2), 557–579. <https://doi.org/10.1007/s11192-017-2316-z>

## **CHAPTER 3**

### **Open Access: An Overview**

### 3.1. Scholarly Communication

The term ‘scholarly communication’ comprises of two words ‘scholarly’ which means activities related to academia or research and the word ‘communication’ refers to disseminating the scholarly information among the peers. The scholarly activity is about the results, methods, new processes and products (Fjällbrant, 1997). Scholarly communication is also known as scholarly literature, scholarly publication (Lederberg, 1993), research publication and academic publishing. In simple terms, scholarly communication is a result of academic or research practices made available to its community through publication. ACRL (2004) defines scholarly communication as “the system through which research and other scholarly writings are created, evaluated for quality, disseminated to the scholarly community, and preserved for future use. The system includes both formal means of communication, such as publication in peer-reviewed journals, and informal channels, such as electronic listservs”. Lyman and Chodorow (1998) state that the origins of scholarly communication can be traced to the growing prominence of information technology (IT) in scholarly research. According to them, the scholarly communication is "introduced to include both print publication and digital communication within a single functional schema. Borgman (2000) defines scholarly communication as “the study of how scholars in any discipline (e.g. physical, biological, social and behavioural sciences, humanities and technology) utilise and communicate information through formal and informal networks”.

Scholarly communication can be delivered through two means i.e., *Formal* and *Informal*. Informal scholarly communication is delivered among a widely scattered group of people such as face-to-face discussion, personal interaction etc. De Solla Price (1963) have introduced the term ‘invisible college’ to refer the concept of informal communication. On the other hand, formal scholarly communication is delivered in the form of published documents such as books, journal, monograph, reports, letters, memos, conference proceedings, monographs, etc (Mukherjee, 2009). Published documents often considered as more reliable and valuable in the academic community for future use also. Sir Issac Newton and Hooke mostly rely on extensive written communication (Nikam and H, 2009).

### **3.1.1. Evolution of Scholarly Communication**

Scholarly communication has undergone significant transformation over centuries, evolving to technological advancements and societal changes. From the era of traditional print publishing to the digital age, the ways researchers share and access knowledge have gradually evolved.

#### **3.1.1.1. Era of Traditional Print Publishing**

Johannes Gutenberg's invention of the movable-type printing press in the mid-15th century (around 1440) is widely regarded as a revolutionary moment in the history of publishing. The format of print journal has played a significant role in science for more than 300 years (Shuttleworth & Charnley, 2016). The traditional print publishing era marks the beginning of structured scholarly communication. It started in the 17th century with the world's first scientific journal, *Journal des Scavans*, published on January 5, 1665, in Paris, primarily focusing on science, religion, and the humanities. Shortly afterward, the journal *Philosophical Transactions of the Royal Society* was published on March 6, 1665, in England, introducing the peer-reviewed model of scientific publishing (Kulkarni et al., 2020). Gradually, various initiatives have been taken across the world, for instance, *The American Journal of Science (AJS)* was published from USA in 1818. The Asiatic Society of India pioneered scholarly publishing in Asia by launching its first journal in 1788. Originally titled as *Asiatic Researches or Transactions of the Society Instituted in Bengal* now known as the *Journal of the Asiatic Society*. These early journals laid the groundwork for modern scholarly communication by providing a formal platform for recording discoveries. However, there were some limitations with these journals because of their irregularity in their publication schedules and disseminated within specific geographic areas only.

#### **3.1.1.2. The Rise of Academic Journals:**

The 18th and 19th centuries marked a period of significant academic developments with the establishment of universities and the rise of research institutions worldwide. As disciplines evolved in complexity, specialized journals emerged to serve the needs of different fields from physics to history (Bod, 2013). These journals became the main source for scholars to disseminate their findings, theories, for the advancement of knowledge in their respective subject domains. The growth of scientific journals

linked with the growth of academic institutions facilitating the spread of knowledge and fostering academic communities.

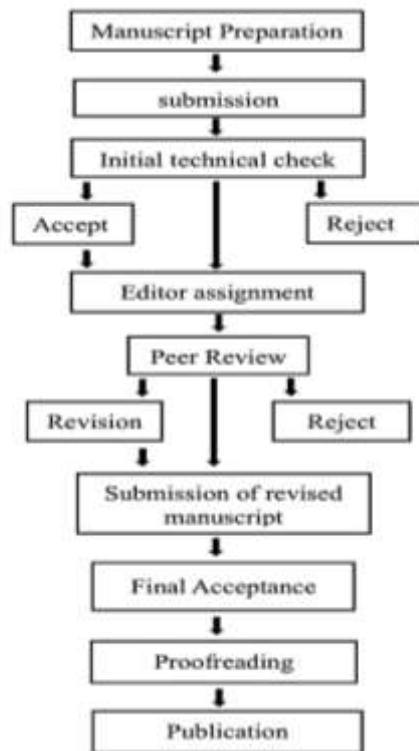
#### **3.1.1.3. Era of Electronic Publishing:**

The emergence of the World Wide Web (WWW) in the late 20th century marked the beginning of electronic publishing, highlighting key milestones such as the development of the internet, the launch of early e-journals, and the rise of digital repositories (Ling et al., 1996). In 1945, Vannevar Bush envisioned a system for storing and accessing scientific information. With advances in technology, his vision has developed into the concept of 'electronic journals' an appealing yet evolving tool for publishers, librarians, and scholars to share and access knowledge effectively (Calabrese, 1992). There are certain limitations of print publications, such as rising subscription costs, less effective peer-review process and limited accessibility (Oppenheim, 2008). This has prompted researchers and academicians worldwide to adopt electronic scholarly publishing for its faster, effective peer-reviewed, more cost-effective, and globally accessible nature. Electronic publishing includes digital versions of print publications and born-digital materials that were never available in print (Bashorum, et al., 2013). Publishing scholarly communication electronically has benefited both authors and readers in numerous ways, allowing research findings to be showcased on a global level.

#### **i. Process of Scholarly Publishing:**

Preparing a manuscript for publication involves following a standard format and undergoing rigorous peer-review processes to ensure quality and integrity. A well-structured manuscript typically includes an introduction, objectives, methodology, data analysis and interpretation, results, and discussion, supported by proper citations and references to original sources. Once complete, the manuscript is submitted to a journal that aligns with its scope. It then undergoes a thorough peer-review process, ensuring the research meets high scientific standards before acceptance (Kington et al., 2021). Feasibly the most significant turning point in academic publishing came with the introduction of peer review in the 20th century. Peer review became an essential part of the academic publishing process, introducing a formal mechanism for assessing the quality and rigor of research before it could be published (Berkenkotter, 1995). The peer review process helped ensure that published papers

met high academic standards, addressing concerns about reliability, validity, and potential biases in research. Peer review assesses the credibility and value of the research, with subject experts evaluating its quality and rigor. The entire process of research publication is shown in figure 3.1.



**Figure 3.1: Process of the publication of scholarly communication in peer-reviewed journals**

(Source: by researcher)

### 3.2. Open Access Movement

A major milestone in the digital age of academic publishing is the rise of the open access (OA) movement. The origin of the emergence of Open Access has been primarily driven by two factors like rising cost of journals and advent of digital revolution (Bjork, 2004). While, other factors like maximum global collaboration, higher visibility of works and seeking of public access to funded research also impacted the OA scenario. The OA movement began in 2002 with various initiatives led by organizations worldwide (Sawant, 2012). The primary goal of this movement is to ensure the protection of authors' intellectual property and their rights while promoting broader access to research (Mashroofa, 2016). Over the past few decades,

most academic journals have transitioned to online publishing, making it easier to access research digitally. However, instead of becoming more affordable, the subscription fees for these journals have skyrocketed, leading to a problem known as the serial crisis (Maharana et al., 2023). Libraries, which operate on fixed or limited budgets, are finding it increasingly difficult to afford all the journals needed by their students, researchers, and faculty. The rising costs often outpace the growth of library budgets, forcing libraries to cut back on subscriptions. This creates significant barriers to accessing knowledge, widens the gap between well-funded and less-funded institutions, and hampers the overall progress of education and research. In response to these challenges, the Open Access movement has gained momentum globally. Its aim is to empower researchers by protecting their work and expanding its reach to a wider audience, thus promoting equity in access to knowledge and fostering the advancement of research.

### **3.3. What is Open Access?**

In simple terms, the word 'open' denotes the availability of something for people to use. Similarly, in the context of research publications, 'open access' indicates that accessing the publication doesn't involve any technical, financial, or permission barriers. (Laakso et al., 2011). It specifically applies to scholarly works such as academic books, journal articles, book chapters, conference proceedings, and research reports, but excludes non-academic materials like novels, magazines, self-help books, and similar content. This distinction emphasizes that OA is dedicated to the unrestricted sharing of academic and research-based knowledge. Open access is a broad global initiative aimed at providing unrestricted and free online access to academic resources, including research publications and data. A publication is considered "open access" when it is free from financial, legal, or technical restrictions, allowing anyone to read, download, copy, distribute, print, search, or use the content for educational or other purposes, as long as it complies with legal agreements (openaccess.nl, 2025). OA works are available online because, once the initial digital version of a work is created, it requires minimal additional costs to produce and distribute copies over the internet (Bailey, 2006). OA is essentially a

publishing model of scientific communication that makes content available to the public at no cost, in contrast to the traditional subscription-based model.

### **3.3.1. Definitions of Open Access:**

Different eminent personalities, organisation and institution has given various definitions to this evolving concept of Open Access (OA). Some of the popular definitions has been highlighted below:

According to Budapest Open Access Initiative (BOAI) (2002), "By 'open access' to this literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited."

The Berlin Declaration (2003) and the Bethesda Statement (2003) define an Open Access publication as one that fulfils the following two criteria:

- i. The author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship, as well as the right to make small numbers of printed copies for their personal use (Berlin Declaration, 2003; Bethesda Statement, 2003).
- ii. A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in a suitable standard electronic format is deposited immediately upon initial publication in at least one online repository that is supported by an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving (Berlin Declaration, 2003; Bethesda Statement, 2003).

Suber (2004) also defined it as “Open Access (OA) literature is digital, online, free of charge and free of most copyright and licensing restrictions. What make it possible are the internet and the consent of the author or copyright-holder”.

UNESCO's definition of Open Access (2012):

"Open Access is the practice of providing free, immediate, and online access to research outputs, including peer-reviewed scholarly articles, books, data, and other resources, without financial, legal, or technical barriers. This contributes to knowledge sharing, empowering people and communities, and supporting the advancement of science, education, and culture."



**Figure 3.2: Logo of open access**

(Source:

[https://commons.wikimedia.org/wiki/File:Open\\_Access\\_logo\\_PLoS\\_white.svg](https://commons.wikimedia.org/wiki/File:Open_Access_logo_PLoS_white.svg))

### **3.4. Why Open Access?**

Open access holds immense importance in the landscape of academia and research, as it ensures the free dissemination of knowledge, fosters greater collaboration among researchers, promotes equity by removing financial barriers, and accelerates the overall progress of science and education on a global scale. Further reasons have been given below:

- i. **Increased research impact:** One of the primary advantages of Open Access is its potential to increase citation scores, which serve as a key indicator of research impact. Numerous studies have provided evidence supporting the correlation between Open Access and higher citation rates (Bautista-Puig et al.,

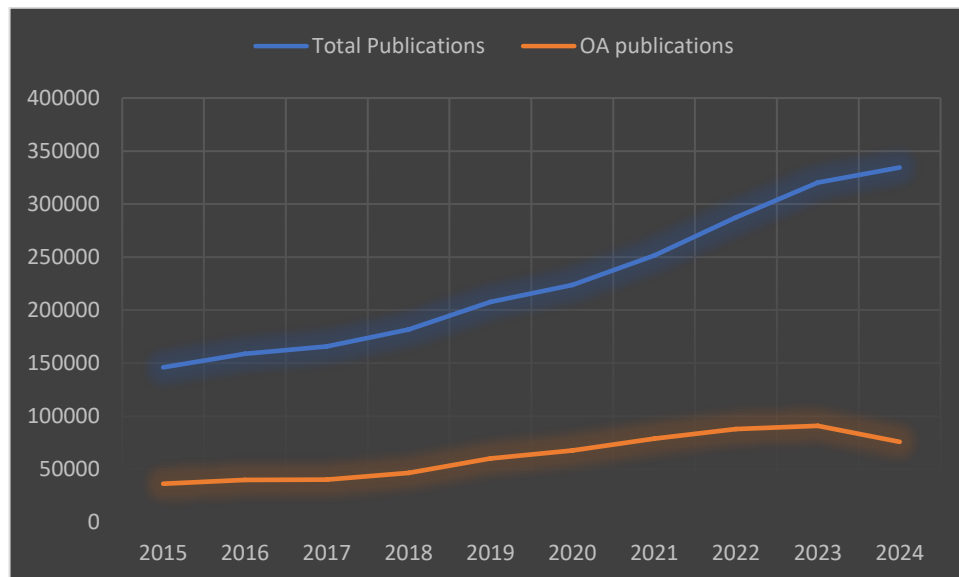
2020; Huang et al., 2024; Piwowar et al., 2018), highlighting its role in enhancing the visibility and accessibility of scholarly work)

- ii. **Greater public engagement:** Open Access enhances public engagement by providing free access to content for everyone, regardless of their academic, social, or financial background. By promoting inclusivity, it facilitates knowledge sharing, supports lifelong learning, and strengthens the connection between academia and society
- iii. **Promote scientific Collaboration:** Open Access publications attract a wide range of researchers from across the globe, fostering collaboration and encouraging joint research efforts. By breaking down paywall barriers, Open Access enables scholars from diverse regions and institutions, including those with limited financial resources, to access and contribute to cutting-edge research, thereby promoting inclusivity and accelerating global scientific progress (Springer Nature, 2025).
- iv. **Removing of price barrier:** The rise of the serial crisis toward the end of the 20th century caused significant stress among libraries, as their limited budgets prevented them from subscribing to the journals they needed. The emergence of Open Access has eased this issue by removing price barriers, enabling free access to scholarly journals (MDPI, 2025).
- v. **Copyright and Licensing:** Open Access works are often managed under Creative Commons (CC) licenses, which safeguard the rights of authors while ensuring their works remain accessible and reusable within the boundaries of the specified licenses.
- vi. **Fulfilling funder requirement:** Funding agencies, governments, and institutions have established Open Access policies requiring research works funded by them to be published under the OA model, either in repositories or Open Access journals. This initiative aims to enhance the accessibility of research, foster innovation, and ensure that publicly funded research benefits a broader audience.

#### 3.4.1. Open Access Publications

Research publications are primary sources of information resulting from a proper inquiry or investigation, disseminated among the scientific community through

online or printed journals. Open Access (OA) publications refer to journal articles that are freely available online to the public, eliminating financial and technical barriers. Previously, high subscription costs for printed journals limited access to research. However, with the rise of the internet and strong advocacy from researchers, Open Access has transformed scientific publishing, promoting wider knowledge dissemination, increased citations, and greater global research collaboration. The emergence of open-access publishing was driven by the need to overcome the restrictions and exclusivity of traditional scholarly publishing models. The growth of different OA journals and repositories has given rise to open access publications. Figure 3.3 illustrates the growth of Open Access (OA) publications in India over the past decade based on data from the Scopus database. The trend shows a steady increase in OA publications over the years, followed by a slight decline in 2024. This decline could be attributed to factors such as shifts in publishing preferences, policy changes, or increased publication charges, making it more challenging for researchers to publish in OA journals.



**Figure 3.3: Growth of Open Access publications in India**

(Source: Scopus)

### 3.5. Open Access Routes:

- i. There are different types of open access routes based on the level and type of access they provide, as outlined below:

- ii. **Gold Open Access:** Gold Open Access allows authors to publish their work in an open access journal, making it freely available to readers immediately upon publication. This is typically achieved by paying an Article Processing Charge (APC), which may be covered by the author, their institution, or funding agencies. The APC can be covered by the author, funding agencies, institutions, or other supporting sources. An APC is a fee imposed by the publisher on the author for publishing their work. BioMed Central (BMC) is considered the first academic publisher to introduce APCs (Beasley, 2016). Upon acceptance of the article, the publisher makes it available to all readers at the time of publication, typically under a Creative Commons (CC) license. Generally, articles are submitted to fully OA journals, where all content is openly accessible, or to hybrid journals, which publish both open and closed-access content. Even though the article is freely available to all, the author still retains the copyright. However, most restrictions on reuse and redistribution are removed under the assigned Creative Commons (CC) license, allowing broader dissemination and use of the work.
- iii. **Green Open Access:** Also known as Self-Archiving, the Green OA route enables authors to deposit a version of their manuscript (preprint, postprint, or publisher's accepted version) in an institutional repository, subject repository, or personal website. Journals or publishers establish self-archiving policies, which outline the terms and conditions for open access, including which version of the article can be deposited and when it can be made publicly accessible, often subject to an embargo period (Springer, 2025). An embargo period is a fixed duration, typically 6 or 12 months, during which access to the article is restricted before it becomes openly available. In Green OA, the copyright generally remains with the publisher or the affiliated society, and restrictions are placed on how the article can be reused. These policies ensure controlled dissemination of the article while complying with open access principles.
- iv. **Bronze Open Access:** It is another form of open access that is less popular than gold and green open access. In bronze open access, the article is made freely available on the publisher's website without APC charges from the author. However, the article is only freely accessible for a limited period of time.

Although the articles can be accessed for free on the publisher's websites, they do not have a Creative Commons license, meaning they cannot be reused or deposited in other locations.

- v. **Hybrid Open Access:** Hybrid Open Access refers to a publishing model that combines elements of both closed access and open access publishing. In this model, traditional subscription-based journals offer authors the option to make their individual articles openly accessible by paying an Article Processing Charge (APC). As a result, the journal includes a mix of content—some articles remain behind a paywall and are accessible only to subscribers or institutions with subscriptions, while others are freely available to anyone.
- vi. **Diamond/Platinum Open Access:** In the Diamond Open Access route (also known as Platinum Open Access), articles are made freely accessible by the journal without requiring Article Processing Charges (APCs) (Dufour et al., 2023). Authors do not need to pay APCs to publish their work, nor do readers have to pay to access the articles. Such journals are typically funded by institutions, universities, government grants, or other organizations that support open access publishing.
- vii. **Delayed Open Access:** Delayed open-access journals are subscription-based publications that offer free online access to articles after an embargo period followed by their initial release (Laakso & Björk, 2013)
- viii. **Black Open Access:** The Black Open Access route refers to the illegal publication of articles that are made freely accessible without proper authorization (Björk, 2017). These publications are not licensed correctly, do not grant legal rights for reuse, and are shared online illegally.
- ix. **Gratis Open Access:** Gratis Open Access articles are freely accessible for reading without charge, but they may come with certain restrictions on reuse. These articles are available to the public for free, but their reuse is governed by specific conditions, often outlined in the licensing agreement.
- x. **Libre Open Access:** In Libre Open Access, articles can be freely read and accessed without any permission barriers. They can also be reused, redistributed, and adapted, typically under open licenses like Creative Commons, which allow for broader rights of use without restrictions.

- xi. **3.6. Brief History of Open Access**
- xii. The history of Open Access encompasses a wide range of movements and initiatives led by individuals, research communities, advocacy groups, academic institutions, funding agencies, and governmental organizations. Among the most influential initiatives are the BBB (Budapest, Bethesda, and Berlin) declarations, which have played a crucial role in shaping the Open Access movement explained below:

**3.6.1. Budapest Open Access Initiative (BOAI):** The Budapest Open Access Initiative (BOAI) is considered a milestone movement in the history of Open Access. It began with a call for a meeting by the Open Society Institute (OSI), held in Budapest, Hungary, on December 1-2, 2001, where individuals from diverse fields, including librarians, scientists, and researchers, came together to promote Open Access. The aim was to foster the wider dissemination of knowledge and accelerate the progress of science by making scholarly literature freely available to all without any barriers (BOAI, 2002). The Budapest Open Access Initiative has played a crucial role in promoting the Open Access movement, influencing the development of similar declarations and policies across various academic fields and institutions. BOAI is also the first to give the definition of OA. It has significantly contributed to the broader democratization of knowledge. To achieve open access in the scholarly literatures, BOAI has adopted two complementary strategies for self-archiving and launch of OA journals briefly explained below:

- a) **Self-archiving:** First, scholars need the tools and assistance to deposit their refereed journal articles in open electronic archives, a practice commonly called, self-archiving. When these archives conform to standards created by the Open Archives Initiative, then search engines and other tools can treat the separate archives as one. Users then need not know which archives exist or where they are located in order to find and make use of their contents (BOAI, 2025).
- b) **Open-access Journals:** Second, scholars need the means to launch a new generation of journals committed to open access, and to help existing journals that elect to make the transition to open access. Because journal articles should be disseminated as widely as possible, these new journals will no longer invoke

copyright to restrict access to and use of the material they publish. Instead, they will use copyright and other tools to ensure permanent open access to all the articles they publish. Because price is a barrier to access, these new journals will not charge subscription or access fees, and will turn to other methods for covering their expenses. There are many alternative sources of funds for this purpose, including the foundations and governments that fund research, the universities and laboratories that employ researchers, endowments set up by discipline or institution, friends of the cause of open access, profits from the sale of add-ons to the basic texts, funds freed up by the demise or cancellation of journals charging traditional subscription or access fees, or even contributions from the researchers themselves. There is no need to favor one of these solutions over the others for all disciplines or nations, and no need to stop looking for other, creative alternatives (BOAI, 2025).

**3.6.2. Bethesda Statement on Open Access Publishing (2003):** Similarly, in April 2003, another major meeting on OA was held at the headquarters of the Howard Hughes Medical Institute in Chevy Chase, Maryland. The meeting resulted in the Bethesda Statement on Open Access Publishing. It highlights the commitment to make biomedical research, their findings and discoveries to be freely available to drive scientific progress and enhance healthcare outcomes on a global scale. According to Bethesda Statement:

- a) The author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship, as well as the right to make small numbers of printed copies for their personal use.
- b) A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in a suitable standard electronic format is deposited immediately upon initial publication in at least one online repository that is supported by an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving (for the biomedical sciences,

PubMed Central is such a repository)(Bethesda Statement, 2025). The statement primarily highlights three working groups (Bethesda Statement, 2003; Suber et al., 2003;).

1) Statement of the Institutions and Funding Agencies Working Group: The organizations sponsor and nurture scientific research to promote the creation and dissemination of new ideas and knowledge for the public benefit. To realize the benefits of this change requires a corresponding fundamental change in the policies regarding publication by the grantees and faculty. (a) Encourage faculty/grant recipients to publish their work according to the principles of the open access model, to maximize the access and benefit to scientists, scholars and the public throughout the world. (b) Realize that moving to open and free access, though probably decreasing total costs, may displace some costs to the individual researcher through page charges, or to publishers through decreased revenues, and organization pledge to help defray these costs. To this end organization agree to help fund the necessary expenses of publication under the open access model of individual papers in peer-reviewed journals (subject to reasonable limits based on market conditions and services provided). (c) Reaffirm the principle that only the intrinsic merit of the work, and not the title of the journal in which a candidate's work is published, will be considered in appointments, promotions, merit awards or grants. (d) Organization will regard a record of open access publication as evidence of service to the community, in evaluation of applications for faculty appointments, promotions and grants (Suber et al., 2003).

2) Statement of the Libraries & Publishers Working Group: Libraries and publishers should make every effort to hasten this transition in a fashion that does not disrupt the orderly dissemination of scientific information (Suber et al., 2003).

Libraries propose to: a) Develop and support mechanisms to make the transition to open access publishing and to provide examples of these mechanisms to the community. b) In education and outreach activities, give high priority to teaching the users about the benefits of open access publishing and open access journals. c) List and highlight open access journals in the catalogs and other relevant databases.

Journal publishers propose to: a) Commit to providing an open access option for any research article published in any of the journals they publish. b) Declare a specific

timetable for transition of journals to open access models. c) Work with other publishers of open access works and interested parties to develop tools for authors and publishers to facilitate publication of manuscripts in standard electronic formats suitable for archival storage and efficient searching. d) Ensure that open access models requiring author fees lower barriers to researchers at demonstrated financial disadvantage, particularly those from developing countries.

3) Statement of Scientists and Scientific Societies Working Group: Scientific research is an interdependent process whereby each experiment is informed by the results of others. The scientists who perform research and the professional societies that represent them have a great interest in ensuring that research results are disseminated as immediately, broadly and effectively as possible. Electronic publication of research results offers the opportunity and the obligation to share research results, ideas and discoveries freely with the scientific community and the public (Suber et al., 2003).

Consequently:

- a) Bethesda Statement endorses the principles of the open access model.
- b) Recognize that publishing is a fundamental part of the research process, and the costs of publishing are a fundamental cost of doing research.
- c) Scientific societies agree to affirm their strong support for the open access model and their commitment to ultimately achieve open access for all the works they publish. They will share information on the steps they are taking to achieve open access with the community they serve and with others who might benefit from their experience.
- d) Scientists agree to manifest their support for open access by selectively publishing in, reviewing for and editing for open access journals and journals that are effectively making the transition to open access.
- e) Scientists agree to advocate changes in promotion and tenure evaluation in order to recognize the community contribution of open access publishing and to recognize

the intrinsic merit of individual articles without regard to the titles of the journals in which they appear.

f) Scientists and societies agree that education is an indispensable part of achieving open access, and commit to educate their colleagues, members and the public about the importance of open access and why they support it.

**3.6.3. Berline Declaration on Open Access to Knowledge in the Sciences and Humanities:** The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities was drafted as part of the first "Berlin Conference" on October 20-21, 2003, which focused on the development of new web-based research environments. This conference was organized by the Max Planck Society in collaboration with the European Cultural Heritage Online (ECHO) project which was signed by over 200 leading organizations, including the Indian National Science Academy, New Delhi. It outlines a comprehensive roadmap for the promotion and implementation of Open Access, advocating for the free and unrestricted dissemination of scientific and scholarly knowledge. The declaration emphasizes the importance of digital access, encourages researchers and institutions to make their work openly available, and supports policies that facilitate global knowledge sharing across disciplines. However, Berlin declaration supporting the transition to electronic open access intended to make progress by (Berlin Declaration, 2003):

- Encouraging our researchers/grant recipients to publish their work according to the principles of the open access paradigm.
- Encouraging the holders of cultural heritage to support open access by providing their resources on the Internet.
- Developing means and ways to evaluate open access contributions and online-journals in order to maintain the standards of quality assurance and good scientific practice.
- Advocating that open access publication be recognized in promotion and tenure evaluation.

- Advocating the intrinsic merit of contributions to an open access infrastructure by software tool development, content provision, metadata creation, or the publication of individual articles.

#### **3.6.4. International Federation of Library Associations and Institutions (IFLA)**

##### **Statement on Open Access to Scholarly Literature and Research**

**Documentation:** The statement was adopted by the IFLA Governing Board at its meeting in The Hague on December 5, 2003. In the same year, IFLA also signed the Berlin Declaration and joined the Open Access movement. IFLA is committed to broadening access to information for all, in line with the Glasgow Declaration on Libraries, Information Services, and Intellectual Freedom. Since then, IFLA has actively promoted policies and initiatives that enhance access to scholarly literature. IFLA strongly supports the Open Access movement and welcomes the launch of many OA-compliant publications (IFLA, 2004). By recognising the significant roles of authors, publishers, editors, libraries and institutions involved in recording and dissemination of research. Thus, it advocates the following OA principles for wider availability of scholarly literature and research documentation:

- A. Acknowledgement and defence of the moral rights of authors, especially the rights of attribution and integrity.
- B. Adoption of effective peer review processes to assure the quality of scholarly literature irrespective of mode of publication.
- C. Resolute opposition to governmental, commercial or institutional censorship of the publications deriving from research and scholarship.
- D. Succession to the public domain of all scholarly literature and research documentation at the expiration of the limited period of copyright protection provided by law, which period should be limited to a reasonable time, and the exercise of fair use provisions, unhindered by technological or other constraints, to ensure ready access by researchers and the general public during the period of protection.
- E. Implementation of measures to overcome information inequality by enabling both publication of quality assured scholarly literature and research documentation

by researchers and scholars who may be disadvantaged, and also ensuring effective and affordable access for the peoples of developing nations and all who experience disadvantage including the disabled.

F. Support for collaborative initiatives to develop sustainable open access publishing models and facilities including encouragement, such as the removal of contractual obstacles, for authors to make scholarly literature and research documentation available without charge.

G. Implementation of legal, contractual and technical mechanisms to ensure the preservation and perpetual availability, usability and authenticity of all scholarly literature and research documentation.

#### **3.6.5. Australian Research Information Infrastructure Committee Statement**

**(ARIIC):** The ARIIC Statement was released in 2005 as part of Australia's efforts to improve research information access and infrastructure. The statement emphasized the importance of Open Access in maximizing the visibility, impact, and accessibility of publicly funded research. It highlighted the need for collaborative initiatives, sustainable repositories, and policies that support free and unrestricted access to scholarly outputs.

#### **3.6.6. Organization for Economic Cooperation and Development (OECD)'s Declaration on Access to Research Data from Public Funding:**

The statement was adopted on January 30, 2004, by the Organisation for Economic Co-operation and Development (OECD). This declaration urges member countries to promote open access to research data funded by public resources, aiming to enhance scientific progress, innovation, and international collaboration (Hoeyer et al., 2008). The communiqué represents a consensus on key issues discussed during the OECD Committee for Scientific and Technological Policy meeting at the ministerial level in Paris. It was signed by representatives from 34 countries. It emphasizes the importance of data accessibility, quality, and interoperability while addressing legal, ethical, and economic considerations.

- i. **3.6.7. Delhi Declaration on Open Access:** The declaration was declared on 14 February 2018, which becomes another prominent initiative to join the global

open access movement (Das, 2018). The prime aim is to advocate open access to research and scholarly publications, primarily focused on the South Asian region. The Delhi Declaration on Open Access was primarily spearheaded by Open Access India (OAI), a prominent advocacy group for open access. Within just two weeks of its launch, the Declaration garnered support from over 120 signatories, including individuals and organizations from India and other countries in the Global South. The initiative has also received backing from key entities such as UNESCO's Knowledge Societies Division, IFLA RSCAO, and the Forum for Open Access in SAARC. The Declaration was launched on the sixteenth anniversary of the Budapest Open Access Initiative (BOAI). The declaration was drafted by a group of researchers and professionals dedicated to expanding access to research outputs for the benefit of the public in India. It is directed at scientific communities, scholarly societies, publishers, funders, universities, and research institutions, with the goal of encouraging greater openness in science and research communications. The Declaration was first conceptualized at the UNESCO-NDL India Workshop in New Delhi (October 2017) and publicly drafted during OpenCon New Delhi (February 2018). After discussions by India's OA community, a 10-section Declaration was finalized. It aims to improve access to research in the Global South and promote research dissemination. The 10-point agenda of the Delhi Declaration on Open Access (DDOA) is summarized below (Open Access India, 2018):

- ii. To advocate for the practice of Open Science (sharing research methods and results openly which will avoid “reinventing the wheel”) and adoption of open technologies for the development of models for sharing science and scholarship (Open Scholarship) to accelerate the progress of research and to address the real societal challenges.
- iii. To strive to publish our interim research outputs as preprints or post-prints (e.g. Institutional Repositories) and encourage our peers and supervisors to do the same to make our research open and actionable in a timely manner.
- iv. To practice and encourage researchers and scientists to implement openness in peer-reviewing and other editorial services, influence the scholarly societies to flip their journals into Open Access and will contribute for the development of

whitelist of Open Access journals in India adhering to the “Principles of Transparency and Best Practice in Scholarly Publishing”.

- v. To garner support of the relevant stakeholders (scholars, journal editorial teams, university libraries, research funders, authorities’ in-charge of dissemination of scholarship in higher education) for spearheading the Open Access movement.
- vi. To take forward the concept of Open Access to further bring all the publicly funded research outputs (not limited to journal literature alone) to be freely available under open licenses to the public to use, reuse and share in any media in open formats.
- vii. To impress upon policy makers to adopt an open evaluation system for research and an institutional reward system for practicing openness in science, scientific communications and academic research across disciplines including Humanities and Social Sciences.
- viii. To support and work for an alternate reward system in recognition and promotion not in terms of the ‘Impact Factor’ of the journals, but the ‘Impact’ of the articles/scholarship in science and the society and impress upon all the scientists/scholars, research funders, research institutes, universities, academies and scholarly societies to sign the San Francisco Declaration on Research Assessment (DORA).
- ix. To strongly agree with the Joint COAR-UNESCO Statement on Open Access, Jussieu Call and Dakar Declaration. And will also follow the international initiative Open Access 2020, to develop roadmaps to support sustainable Open Access scholarly communication models which are free of charge for the authors and free of charge availability to the readers.
- x. While learning from South cooperation on Open Access, will work for developing a framework for Open Access in India and South Asia: National Policies for Open Access and country-specific action plans will be formulated aimed at making Open Access as the default in India and South Asia, by 2025.
- xi. For creating more awareness on Open Access, infrastructure, capacity building, funding and policy mechanisms, as well as incentivizing for the Open Access, we come forward to share success stories, studies and discussions during the Open Access Week.

### 3.7. Open Access Initiatives

OA initiatives refer to efforts, policies, and programs aimed at providing free, unrestricted access to scholarly research, publications, and data from different parts of the world. These initiatives promote the dissemination of knowledge without financial, legal, or technical barriers, ensuring that research outputs are accessible to everyone, including researchers, students, and the public. The initiatives include, OA repositories or OA journals complying with the Open Archiving standards. The standards known as the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), which enables Open Access platforms to generate metadata and store it on their servers, allowing others to access and retrieve the information. The following initiatives are:

- **arXiv.org:** It is the first centralized archive for physics research, established in 1991 found by Paul Ginsperg and managed by Cornell University. Initially focused on physics, it has since expanded to include fields such as mathematics, computer science, quantitative biology, statistics, electrical engineering, systems science, and economics. This open-access repository enables researchers to share preprints, disseminate findings rapidly, and receive early feedback from the global scientific community. By allowing free access to scholarly work, arXiv.org plays a crucial role in promoting knowledge exchange, accelerating scientific advancements, and supporting open science initiatives.
- **PubMed Central (PMC):** PubMed Central is a free digital archive containing life sciences and biomedical literature, maintained by the U.S. National Institutes of Health's National Library of Medicine (NIH/NLM). PubMed is a part of the National Library of Medicine (NLM) at the U.S. National Institutes of Health (NIH). Established in 2000, it currently holds more than 10 million full-text articles in these disciplines. It serves as a valuable resource for researchers, healthcare professionals, and the general public worldwide. As a crucial repository of peer-reviewed research, PMC ensures long-term preservation and open access to scholarly articles, supporting global scientific advancement and evidence-based healthcare.
- **BioMed Central (BMC):** BioMed Central (BMC) is a UK-based independent open-access publisher in the areas of biomedicine, physical sciences,

mathematics, and engineering. Founded in 2000 as part of the Current Science Group, it was acquired by Springer Nature in 2008 and is considered one of the first and largest open-access science publishers. BMC publishes more than 250 peer reviewed science, technology, and medical journals online. It has played a pioneering role in promoting open-access publishing, ensuring unrestricted access to high-quality research worldwide.

- **Public Library of Science (PLOS):** The Public Library of Science (PLOS) is a non-profit publisher of open access journals in science and medical literature, established in 2000. PLoS launched its first journal, *PLOS Biology*, in October 2003, followed by *PLOS Medicine* in 2004. Over the years, PLoS has expanded its portfolio to include several other discipline-specific open access journals, such as *PLOS Computational Biology*, *PLOS Genetics*, *PLOS Pathogens*, *PLOS ONE*, and *PLOS Neglected Tropical Diseases*. Committed to advancing open science, PLoS ensures that all its publications are freely accessible, promoting global knowledge dissemination and collaboration.
- **OAIster:** OAIster is an online bibliographic index that aggregates open-access materials using the OAI-PMH protocol. It was launched in 2002 at the University of Michigan with funding from the Andrew W. Mellon Foundation. The initiative aimed to create a centralized retrieval service for openly accessible digital library resources contributed by the research library community.
- **Directory of Open Access Journals (DOAJ):** The Directory of Open Access Journals (DOAJ) is a significant milestone in the Open Access movement, launched on February 14, 2003, by Lund University Libraries in Sweden. It serves as a comprehensive index of Open Access journals worldwide, providing unrestricted access to scholarly content. Supported by a global community spanning 45 countries and 36 languages, DOAJ aims to enhance the accessibility, visibility, and quality of peer-reviewed Open Access journals. All articles in DOAJ are licensed under the Creative Commons Attribution-ShareAlike License, ensuring compliance with open content copyright standards.



**Figure 3.4: Overview of DOAJ**

(Source: <https://doaj.org/>)

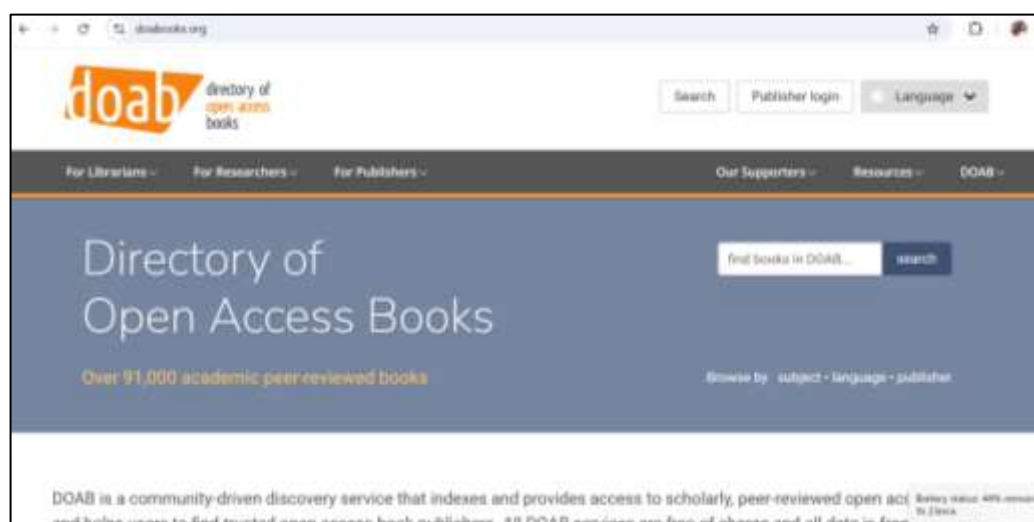
- **Directories of Open Access Repositories (OpenDOAR):** It was launched in 2005 and is maintained by the University of Nottingham under the SHERPA umbrella of services. It was developed in collaboration with Lund University and is funded by the Open Science Institute, Jisc, the Consortium of Research Libraries (CURL), and SPARC Europe. OpenDOAR provides a comprehensive directory of open access repositories that host a diverse range of scholarly content such as journal articles, theses, dissertations, conference papers, books, book chapters, reports, working papers, and datasets. It lists more than 5,771 repositories worldwide.
- **Registry of Open Access Repository (ROAR):** The Registry of Open Access Repositories (ROAR) is a major open-access directory created by EPrints at the University of Southampton, UK, in 2003 (Xia, 2011). Initially launched as the Institutional Archives Registry, it was renamed as the Registry of Open Access Repositories in 2006. ROAR aims to promote the growth of open access by tracking and updating the development of repositories worldwide. It provides a comprehensive database of institutional and subject-based repositories, offering insights into their growth, content, and accessibility.



**Figure 3.5: Homepage of ROAR**

(Source: <https://roar.eprints.org/>)

- **Directory of Open Access Books (DOAB):** The DOAB is a free discovery service that provides access to over 91,000 academic peer-reviewed open access books. Launched in 2012 by the OAPEN Foundation, DOAB aims to increase the discoverability of open access books and supports open science by providing a trusted platform for high-quality academic publications. It collaborates with publishers worldwide to ensure transparency and accessibility, making scholarly content freely available to researchers, students, and the general public.



**Figure 3.6: Homepage of DOAB**

(Source: <https://roar.eprints.org/>)

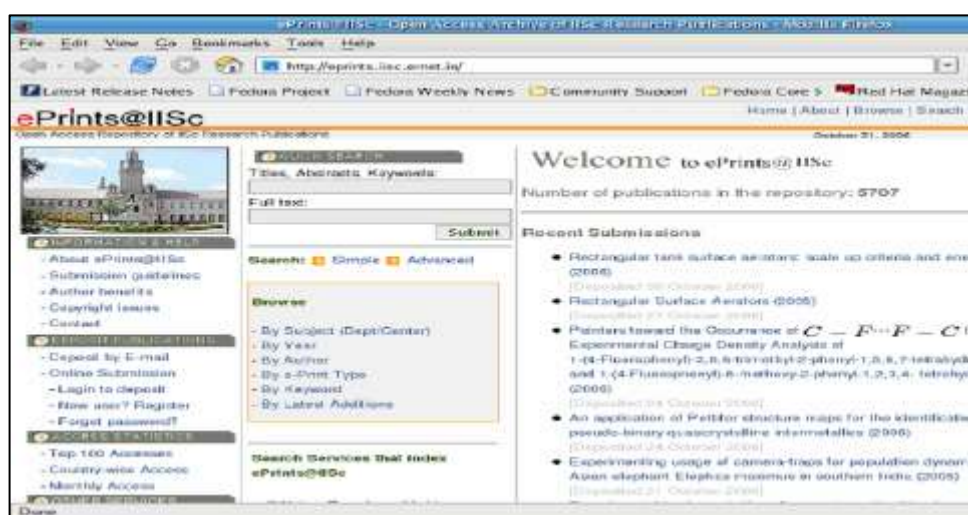
- **The Scientific Electronic Library Online (SciELO):** The SciELO is a cooperative electronic publishing model and bibliographic database that provides free access to scientific journals from Latin American, Caribbean, and Iberian countries, with the aim of wider visibility and accessibility of their scholarly literature. The project was initially started in Brazil in 1998, now publishes over 1 thousand journals and about 50 thousand articles per year.

### 3.8. Open Access Initiative in India

Open Access has gained significant emphasis in India, leading to various initiatives and actions by individuals, organizations, and institutions. Government policies, open-access journals, and open-access repositories have played a crucial role in advancing free knowledge dissemination in the country. An Open Access repository is an online database that provides free access to scholarly outputs, including articles, audio-visual materials, research data, and other academic resources. India ranks fourth in terms of repository count among Asian countries (Parray et al., 2023). By removing paywall barriers, Open Access enhances citation rates, fosters academic collaboration, and contributes to the global exchange of information (Loan & Mushtaq, 2018). The journey of Open Access initiatives in India began in 1998 with the launch of the first Open Access journal, *Pramana* (Singh, 2016). Later, in 2003, two OA journals the Indian Academy of Sciences' journal and *Pramana: Journal of Physics* became the first to be added to the Directory of Open Access Journals (DOAJ). Moreover, in 2004, several workshops on Open Access and Institutional Repositories were organized by the Indian National Science Academy (INSA), Delhi, and the M.S. Swaminathan Research Foundation (MSSRF), Bangalore, to promote awareness and adoption of open-access practices MSSRF (2004). Moreover, the following initiatives are some of the notable landmarks of India's open access movement:

- **ePrints@IISc:** The Open Access movement in India formally gained momentum in 2002 with the establishment of the country's first OA repository, *ePrints@IISc*, by the Indian Institute of Science (IISc), Bangalore under the leadership of T.B. Rajasekhar (Jayakanth et al., 2008). It provides free access to

research outputs, including journal articles, conference papers, technical reports, and theses authored by IISc researchers. The repository is built using EPrints software and supports the principles of open access by making scholarly content freely available to the public.



**Figure 3.7: Overview of ePrints@IISc**

(Source: <https://eprints.iisc.ac.in/index.html>)

- **The Indian Academy of Sciences:** It is established in 1934, a prestigious institution and one of the three major science academies in India. In addition to its wide range of activities, the academy plays a significant role in publishing scientific journals that feature research from India and around the world. Although these journals are mainly produced in print format, they are also made freely available on the internet for wider access.
- **Vidyanidhi:** It is India's digital library and e-repository for electronic theses and dissertations (ETDs), was launched in 2003. It is hosted by the University of Mysore and serves as a platform for scholars to deposit and access doctoral theses and dissertations, promoting open access to academic research in India.
- **Indian National Science Academy (INSA):** INSA is founded and registered as a society in 1934. In 2004, it became the first institution in India to sign the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, marking a significant milestone in the country's Open Access movement (Nazim, 2021).
- **Open J-Gate (OJ):** Launched in February 2006, Open J-Gate (OJ) is a free database of Open Access journals developed and hosted by Informatics (India) Ltd. It

serves as the open access version of the subscription-based J-Gate service. Open J-Gate facilitates seamless access to a vast collection of journal articles by linking directly to the full-text versions available on publishers' websites (Sathyanarayana, 2008).

- **Shodhganga & ShodhGangotri:** In 2009, the University Grants Commission (UGC) mandated that every higher education institution in India must submit an electronic copy of its M.Phil. and Ph.D. dissertations and theses to the Information and Library Network (INFLIBNET) Centre before awarding the degree. This initiative aimed to ensure wider accessibility, transparency, and preservation of scholarly research produced by Indian universities. To facilitate this, INFLIBNET introduced Shodhganga in 2011, a free digital repository designed to host electronic theses and dissertations (ETDs) submitted by research scholars across the country. This platform provides open access to a vast collection of academic research, promoting knowledge sharing and scholarly communication. In addition to Shodhganga, INFLIBNET launched ShodhGangotri, a complementary repository that serves as a platform for research proposals and synopses submitted by Ph.D. scholars. By offering access to research in its early stages, ShodhGangotri enables greater academic collaboration and helps researchers stay updated on ongoing studies.



**Figure 3.8: Homepage of Shodhganga**

(Source: <https://shodhganga.inflibnet.ac.in/>)

- National Knowledge Commission (NKC):** In 2007, the National Knowledge Commission (NKC) proposed the implementation of an Open Access (OA) mandate for publicly funded research. It also advocated for government funding to support OA digitization initiatives and the development of a sustainable financial model for OA journals in India. Additionally, the National Knowledge Commission, a prominent advisory body in the education sector, put forward a pioneering recommendation promoting Open Educational Resources (OER). Recognizing the significant potential of digital resources, the Commission emphasized the transformative role of OER in enhancing both the accessibility and quality of education in India (NKC, 2009).
- Indian Medlars Centre (IMC):** established by the Indian Council of Medical Research (ICMR), provides open access to biomedical research and literature through its databases, IndMED and MedIND. These resources have been instrumental in making biomedical knowledge freely accessible to researchers and healthcare professionals in India and beyond.

- **Open Access India (OAI):** The OAI is formed in 2011 to create awareness among the academic community including students, researchers, faculties and policy makers about the access the publicly funded research in India. The prime aim of OAI is to advocating open access, open data and open education in India by an advocacy group. The community members firmly believe that Open Access plays a crucial role in enhancing the availability and accessibility of research outputs funded by public resources, ensuring that knowledge is shared widely and benefits a larger audience. Similarly, Open Data, including government data and publicly funded research data, when made freely available, can stimulate innovation, drive scientific advancements, and support the creation of new tools and technologies for societal development.
- **National Repository of Open Educational Resources:** The National Repository of Open Educational Resources (NROER) was created by CIET, NCERT, and officially launched on August 13, 2013, during the National Conference on ICT for School Education in New Delhi. This initiative was carried out in collaboration with the Department of School Education and Literacy under the Ministry of Human Resource Development, Government of India. NROER offers a vast collection of educational materials across various subjects and in multiple Indian languages, catering to students at the primary, secondary, and senior secondary levels. Its contents are licensed under CC BY-SA (Creative Commons Attribution-Share Alike).
- **National Digital Library of India (NDLI):** NDLI is a digital repository that provides free access to a vast collection of educational resources, including journal articles, textbooks, lecture notes, videos, and audiobooks. It was launched in 2016, sponsored and guided by the Ministry of Education, Government of India, under the National Mission on Education through Information and Communication Technology (NMEICT). Developed and managed by the Indian Institute of Technology (IIT) Kharagpur, NDLI offers content in multiple languages, including Hindi, English, Bengali, Marathi, Tamil, Telugu, Gujarati, Urdu, Malayalam, and Kannada, making it accessible to a diverse range of learners across India.



**Figure 3.9: Homepage of NDLI**

(Source: <https://ndl.iitkgp.ac.in/>)

- **SWAYAM:** SWAYAM stands for Study Webs of Active Learning for Young Aspiring Minds launched on 9 July 2017. The programme is initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. SWAYAM aims to provide free, high-quality online education to students, teachers, and lifelong learners across the country.



**Figure 3.10: Homepage of SWAYAM**

(Source: <https://swayam.gov.in/>)

- **IndiaRxiv:** IndiaRxiv launched in 2019, is India's preprint repository initiated by the Open Access India community. It is hosted by the Society for Promotion of

Horticulture in Bengaluru, providing a platform for researchers to share and access preprints across various disciplines.



**Figure 3.11: Homepage of IndiRxiv**

(Source: <https://ops.iihr.res.in/index.php/IndiaRxiv>)

- **One Nation One Subscription (ONOS):** The One Nation One Subscription (ONOS) initiative is a significant step by the Government of India to democratize access to scholarly research and academic resources across the country. It was launched on January 1, 2025, under the Department of Higher Education. The initiative aims to secure national licenses for e-journal and database subscriptions from leading journal publishers. It includes a total of 30 major international publishers, ensuring that all journals under their umbrella will be accessible to students, faculty members, and researchers from participating institutions (ONOS, 2025). Access to these journals will be coordinated by the INFLIBNET Centre.



**Figure 3.12: Homepage of ONOS**

(Source: <https://www.onos.gov.in/>)

### 3.9. Open Access Policies and Mandates

The Open access policies and mandates refers to set of rules and regulations adopted by different governing bodies, funding agencies and institutions regarding the publishing of research work in freely accessible platforms. Various well-known organisations have adopted open access policy and mandates for making work published freely.

- **WHO Policy on Open Access:** The WHO asserts that universal access to publicly funded research, including research data, is essential for addressing 21st-century public health challenges. Its open access policy aims to guarantee that the published outcomes of its initiatives are freely available and reusable by the public, aligning with its core mission (WHO, 2025). The WHO is also a member of cOAlition S, and its open access policy aligns with the principles of Plan S, which advocates for immediate and unrestricted access to publicly funded research. The policy applies to:

1. articles or chapters that are authored or co-authored by WHO staff or by individuals or institutions funded in whole or in part by WHO and published by external publishers;
2. publications published by WHO.

- **NIH Public Access Policy:** On December 17, 2024, NIH issued its updated Public Access Policy. The 2024 Public Access Policy is effective for manuscripts accepted for publication on or after December 31, 2025. Until then, NIH's current (2008) Public Access Policy remains in effect. To view the 2024 policy and supplemental guidance, please visit the NIH Office of Science Policy. To advance science and improve human health, NIH makes the peer-reviewed articles it funds publicly available on PubMed Central. The NIH Public Access Policy requires scientists to submit final peer-reviewed journal manuscripts that arise from NIH funds to PubMed Central immediately upon acceptance for publication.
- **ROARMAP:** Registry of Open Access Repository Mandates and Policies (ROARMAP) the companion to ROAR, is a searchable global database that tracks the development of open access mandates and policies. It documents policies implemented by universities, research institutions, and funding agencies that mandate researchers to make their peer-reviewed research articles openly accessible by depositing them in an open access repository. According to ROARMAP data from the second quarter of 2018, a total of 708 research organizations had mandates requiring their research output to be published in Institutional Repositories.
- **Coalition S:** Coalition S is a group of international research funders launched in 2018 to support Plan S, promoting immediate open access to publicly funded research. Led by Science Europe and backed by the European Commission and European Research Council (ERC), it enforces policies requiring researchers to publish in fully open-access journals or repositories under Creative Commons licenses. Coalition S opposes hybrid models and aims to eliminate paywalls, ensuring global knowledge sharing and faster scientific progress.
- **Plan S:** Plan S is an open-access publishing mandate launched in September 2018, supported by Coalition S, a group of national research funding organizations. It requires that scientific publications resulting from publicly funded research must be made immediately available in open-access journals, repositories, or platforms without embargo. Plan S aims to accelerate the transition to full open access, ensuring that publicly funded research is freely accessible to all. It enforces strict compliance guidelines, including publishing in open-access venues, retaining

copyright under a CC BY license, and prohibiting hybrid open-access models that charge both subscriptions and article processing fees.

- **SPARC (Scholarly Publishing and Academic Resources Coalition):** SPARC (Scholarly Publishing and Academic Resources Coalition) is a global advocacy organization focused on making research and education more accessible. Founded in 1998 by the Association of Research Libraries (ARL), SPARC promotes open access (OA), open data, and open education to foster a more equitable and transparent scholarly communication system. SPARC has a membership network of more than 200 institutions, along with several supporting organizations. Additionally, its counterpart, SPARC Europe, comprises over 70 members spread across 14 countries.
- **United Nations Educational, Scientific and Cultural Organization (UNESCO):** UNESCO strongly advocates for Open Access (OA) to promote free knowledge-sharing in education, research, and culture. Its Open Access Policy (2013) ensures that all UNESCO publications are freely available under Creative Commons (CC BY-SA 3.0 IGO) licensing. UNESCO encourages member states to implement national OA policies, supports the development of repositories, and provides training on Open Science principles. Key initiatives include the Global Open Access Portal (GOAP), the UNESCO Recommendation on Open Science (2021), and the UNESCO Open Science Toolkit, all aimed at fostering inclusive and accessible scientific research to support global development and innovation.

India has made significant strides in promoting Open Access (OA) to scientific and scholarly research through various policies and mandates initiated by government agencies, research institutions, and funding bodies. These efforts aim to enhance the accessibility, visibility, and impact of publicly funded research while fostering collaboration and knowledge dissemination. Subsequently, several other institutions, including the Council of Scientific and Industrial Research (CSIR), the Indian Council of Agricultural Research (ICAR), and the University Grants Commission (UGC), have actively participated in the Open Access movement by developing their own OA policies. Some of the major policies are as follows:

- The National Institute of Technology (NIT), Rourkela was the first institution in India to implement an Open Access mandate (Gutam et al., 2010). During the 93rd Indian Science Congress, held in Hyderabad in January 2006, a proposal for an 'Optimal National Open Access Policy for India' was presented. Subsequently, in May 2006, NIT Rourkela became the first institution in the country to officially adopt a mandated Open Access policy.
- In 2011, the Council of Scientific and Industrial Research (CSIR), one of the world's largest publicly funded R&D organizations, adopted an Open Access mandate. It required that all CSIR-supported research papers be made openly accessible by depositing them in an institutional repository. Additionally, CSIR transitioned all its journals to Open Access.
- In September 2013, the Indian Council of Agricultural Research (ICAR), the world's largest network of agricultural research and education institutes, implemented a policy mandating that all ICAR publications be made openly accessible by depositing them in institutional repositories.
- The Department of Biotechnology (DBT) and the Department of Science and Technology (DST), under the Ministry of Science and Technology's guidance, have jointly introduced a new Open Access policy for research funded by these departments. As per this policy, researchers receiving funding from DST and DBT must upload the final version of their papers to their institutional website or a relevant Open Access repository within two weeks of journal acceptance. In 2015, DBT and DST collaboratively implemented this policy and launched the 'ScienceCentral.in' portal to serve as a centralized platform for Institutional Repositories of DST-DBT-supported institutes.

### **3.10. Licensing Approach in Open Access**

The increasing adoption of open access (OA) publishing has intensified the challenge by emphasizing both the right to freely access scholarly content and the right to reuse it in various ways (Gulley, 2013). Open access aims to provide free and unrestricted availability of scholarly work, often through specific licensing agreements. These licenses allow authors to retain copyright while permitting widespread distribution and reuse under certain conditions. By eliminating barriers such as subscription fees

or paywalls, open access ensures that research is accessible to a global audience, including researchers, educators, policymakers, and the general public. Licensing frameworks like Creative Commons are commonly used to define the terms of reuse, ensuring that authors receive credit for their work while allowing others to reuse it (Margoni & Peters, 2016).

**3.10.1. Creative Commons Licenses:** Most Open Access (OA) articles are published under Creative Commons (CC) licenses, which enable authors to define the conditions for the use and distribution of their work (Braybrooke, 2021). According to creative Commons there are six different kinds of licences, includes:

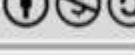
- 1) CC BY (Attribution):** Allows users to distribute, adapt, remix, and build upon the work in any form, including for commercial purposes, as long as proper attribution is given to the original creator. The key requirement of this license is that credit must always be provided to the original author. This license maximizes accessibility and reuse, making it one of the most permissive and widely used CC licenses.
- 2) CC BY-SA (Attribution-ShareAlike):** Similar to CC BY, this license allows users to distribute, adapt, remix, and build upon the work in any form, including for commercial purposes, as long as proper attribution is given to the original creator. However, a key requirement of this license is that any adaptations or derivative works must be shared under the same terms, ensuring that future modifications remain open and freely accessible.
- 3) CC BY-NC (Attribution-NonCommercial):** This license allows others to remix, adapt, and build upon the work for non-commercial purposes. While their new creations must acknowledge the original author and remain non-commercial, they are not required to license their derivative works under the same terms. This provides flexibility in how the adapted content is shared while restricting commercial use.
- 4) CC BY-NC-SA:** This license allows users to remix, adapt, and build upon the work for non-commercial purposes, provided that proper credit is given to the original creator. If the work is modified or adapted, the resulting creation must be licensed under the same terms. This ensures that all derivative works remain non-

commercial and freely accessible, fostering a spirit of open collaboration while maintaining the original licensing conditions.

**5) CC BY-ND (Attribution-NoDerivs):** This license allows users to copy and distribute the work in its original, unchanged form through any medium, including for commercial purposes, as long as proper attribution is given to the original creator. A key restriction of this license is that no derivatives or adaptations of the work are permitted, ensuring that the content remains unaltered while still allowing broad distribution.

**6) CC BY-NC-ND:** This license allows users to copy and distribute the work in its original, unchanged form through any medium, but only for non-commercial purposes, as long as proper attribution is given to the original creator. The key requirement of this license is that credit must always be provided to the original author, while prohibiting any modifications, derivatives, or adaptations of the work.

- **CC0 (Public Domain Dedication):** This license is a public dedication tool that enables creators to waive their copyright and place their work in the worldwide public domain. CC0 (also known as CC Zero) allows anyone to copy, remix, adapt, distribute, and build upon the work in any medium, with no restrictions or conditions, even for commercial purposes.

|  <b>creative commons</b><br><b>LICENSES</b> |                                              | Copy & Publish                                                                      | Attribution Required                                                                 | Commercial Use                                                                        | Modify & Adapt                                                                        | Change License                                                                        |
|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                             | <b>Public Domain</b>                         |    |    |    |    |    |
|                                             | <b>BY</b><br>Attribution                     |    |    |    |    |    |
|                                             | <b>BY-SA</b><br>Attribution ShareAlike       |    |    |    |    |    |
|                                             | <b>BY-ND</b><br>Attribution NoDerivs         |    |    |    |    |    |
|                                             | <b>BY-NC</b><br>Attribution NonCommercial    |    |    |    |    |    |
|                                             | <b>BY-NC-SA</b><br>Attrib NonComm ShareAlike |    |    |    |    |    |
|                                           | <b>BY-NC-ND</b><br>Attrib NonComm NoDerivs   |  |  |  |  |  |

**Figure 3.13: Licenses of Creative Commons**

(Source:<https://s3.amazonaws.com/libapps/accounts/22603/images/CC-License-Chart.png>)

## References

- Association of College and Research Libraries. (2004). *Principles and strategies for the reform of scholarly communication*. <http://www.ala.org/ala/acrl/acrlpubs/whitepapers/principlesstrategies.htm>
- Bailey, C. W., Jr. (2006). What is open access? In *Open access: Key strategic, technical, and economic aspects*. Chandos Publishing. [https://www.researchgate.net/publication/351973017\\_What\\_Is\\_Open\\_Access](https://www.researchgate.net/publication/351973017_What_Is_Open_Access)
- Basorum, M. T., Jain, P., Sebina, P. M., & Kalusopa, T. (2013). The evolution of electronic publishing: A literature review. *Transnational Journal of Science and Technology*, 3(4).
- Bautista-Puig, N., Lopez-Illescas, C., De Moya-Anegon, F., Guerrero-Bote, V., & Moed, H. F. (2020). Do journals flipping to gold open access show an OA citation or publication advantage? *Scientometrics*, 124(3), 2551–2575. <https://doi.org/10.1007/s11192-020-03546-x>
- Beasley, G. (2016). Article processing charges: A new route to open access? *Information Services & Use*, 36(3–4), 163–170. <https://doi.org/10.3233/isu-160815>
- Berkenkotter, C. (1995). The power and the perils of peer review. *Rhetoric Review*, 13(2), 245–248. <https://doi.org/10.2307/465828>
- Berlin Declaration. (2003). *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities*. <https://openaccess.mpg.de/Berlin-Declaration>
- Björk, B. (2017). Gold, green, and black open access. *Learned Publishing*, 30(2), 173–175. <https://doi.org/10.1002/leap.1096>
- Bjork, B.C. (2004). Open access to scientific publications-an analysis of the barriers to change? *Information Research*, 9(2). available at: <http://informationr.net/ir/9-2/paper170.html>
- Borgman, C.L. (2000). Digital libraries and continuum of scholarly communication. *Journal of Documentation* 56 (4) 412-430.
- Budapest Open Access Initiative. (2002). *Budapest Open Access Initiative*. <https://www.budapestopenaccessinitiative.org/>
- Calabrese, A. (1992). Changing times for scholarly communication: The case of the electronic journal. *Technology in Society*, 14(2), 199–220. [https://doi.org/10.1016/0160-791x\(92\)90004-t](https://doi.org/10.1016/0160-791x(92)90004-t)
- Creative Commons. (n.d.). *About CC licenses*. <https://creativecommons.org/share-your-work/cclicenses/>
- Das, A. K. (2018). Delhi declaration on open access 2018: An overview. *Annals of Library and Information Studies (ALIS)*, 65(1), 83-84.
- De Solla Price, D. J. (1963). *Little science, big science*. Columbia University Press.

- Dufour, Q., Pontille, D., & Torny, D. (2023). Supporting diamond open access journals. Interest and feasibility of direct funding mechanisms. *bioRxiv* (Cold Spring Harbor Laboratory). <https://doi.org/10.1101/2023.05.03.539231>
- Fjällbrant, N. (1997). Scholarly communication: Historical development and new possibilities. *Proceedings of the IATUL Conferences* (Paper 5). <https://docs.lib.purdue.edu/iatul/1997/papers/5>
- Gulley, N. (2013). Creative Commons: challenges and solutions for researchers; a publisher's perspective of copyright in an open access environment. *Insights the UKSG Journal*, 26(2), 168–173. <https://doi.org/10.1629/2048-7754.107>
- Gutam, S., Mishra, A. K., Pandey, P. S., Hariharan, C., Chandrasekaran, & Guttikonda, A. (2010). *Status of open access repositories in India* [Unpublished manuscript]. [http://works.bepress.com/sridhar\\_gutam/54/](http://works.bepress.com/sridhar_gutam/54/)
- Hoeyer, K., Svendsen, M. N., & Koch, L. (2008). OECD guidelines on open access: commercialization in disguise? *Trends in Biotechnology*, 26(9), 479–482. <https://doi.org/10.1016/j.tibtech.2008.05.006>
- Huang, C., Neylon, C., Montgomery, L., Hosking, R., Diprose, J. P., Handcock, R. N., & Wilson, K. (2024). Open access research outputs receive more diverse citations. *Scientometrics*, 129(2), 825–845. <https://doi.org/10.1007/s11192-023-04894-0>
- International Federation of Library Associations and Institutions (IFLA). (2004). *IFLA statement on open access to scholarly literature and research documentation*. <https://repository.ifla.org/items/9723652d-6d90-47d6-b3cc-4323e2785f4a>
- Jayakanth, F., Minj, F., Silva, U., & Jagirdar, S. (2008). ePrints@IISc: India's first and fastest growing institutional repository. *OCLC Systems & Services*, 24(1), 59–70. <https://doi.org/10.1108/10650750810847260>
- Kington, R. S., Arnesen, S., Chou, W. S., Curry, S. J., Lazer, D., & Villarruel, A. M. (2021). Identifying Credible Sources of Health Information in Social Media: Principles and Attributes. *NAM Perspectives*. <https://doi.org/10.31478/202107a>
- Kulkarni, A. M., Muthumari P. and Nemade, N. D. (2020) Scholarly Communication in India, *International Journal of Management* 11(11), 781-789. [10.34218/IJM.11.11.2020.073](https://doi.org/10.34218/IJM.11.11.2020.073)
- Laakso, M., & Björk, B. (2013). Delayed open access: An overlooked high-impact category of openly available scientific literature. *Journal of the American Society for Information Science and Technology*, 64(7), 1323–1329. <https://doi.org/10.1002/asi.22856>
- Laakso, M., Welling, P., Bukvova, H., Nyman, L., Björk, B. C., & Hedlund, T. (2011). The development of open access journal publishing from 1993 to 2009. *PloS one*, 6(6), e20961. <https://doi.org/10.1371/journal.pone.0020961>

- Lederberg, J. (1993). Communication as the root of scientific progress. *Current Contents I*(5-11).
- Ling, T. C., Yaacob. M. H & Phang, K.K. (1996). An overview of electronic publishing. *Malaysian Journal of Library & Information Science*, 1(2), 1-11.
- Loan, F. A. & Mushtaq, R. (2018) Open access digital repositories in India and China: a comparative study. *Journal of Indian library association*, 54(4), 195-205.
- Mahesh, V. M., & Kumar, R. A. (2022, February). *Open access institutional repositories in India: A status report*. In *Transformation of the library ecosystem: Terrains and trajectories* (Calicut).
- Margoni, T., & Peters, D. (2016). Creative Commons Licenses: Empowering Open Access. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2746044>
- Mashroofa, M. M. (2016). Open Access Revolution: Is it a paradigm shift of scholarly publishing practices? A literature review of global scenario. *Journal of the University Librarians Association of Sri Lanka*, 19(1), 115–135. <https://doi.org/10.4038/jula.v19i1.7878>
- MDPI. (2025). *6 benefits of open access*. <https://blog.mdpi.com/2024/08/13/6-benefits-of-open-access/>
- MSSRF. (2004). *Open access and institutional repository workshop, Chennai*. <https://www.utsc.utoronto.ca/~chan/oaindia/index.html>
- Mukherjee, B. (2009) Scholarly Communication: A Journey from Print to Web, *Library Philosophy and Practice*.
- National Knowledge Commission (NKC). (2009). *National Knowledge Commission report to the nation 2006–2009*. Government of India. <https://www.aicteindia.org/downloads/nkc.pdf>
- Nazim, M. (2021). Analysing Open Access Uptake by Academic and Research Institutions in India. *DESIDOC Journal of Library & Information Technology*, 41(2) 108-115. 10.14429/djlit.41.2.16324
- ONOS. (2025). *About*. <https://www.onos.gov.in/about>
- Suber, P., Brown, P. O., Cabell, D., et al. (2003). *Bethesda Statement on Open Access Publishing*. [https://www.researchgate.net/deref/https%3A%2F%2Fdash.harvard.edu%2Fbitstream%2Fhandle%2F1%2F4725199%2Fsuber\\_bethesda.htm](https://www.researchgate.net/deref/https%3A%2F%2Fdash.harvard.edu%2Fbitstream%2Fhandle%2F1%2F4725199%2Fsuber_bethesda.htm)
- Open Access India. (2018). *Delhi Declaration on Open Access*. <http://openaccessindia.org/delhi-declaration-on-open-access/>
- Openaccess.nl. (2025). *What is open access?* <https://www.openaccess.nl/en/what-is-open-access>

- Oppenheim, C. (2008). Electronic scholarly publishing and open access. *Journal of Information Science*, 34(4) 577 – 590. [10.1177/0165551508092268](https://doi.org/10.1177/0165551508092268)
- Parray, U. Y., Khan, A. M., Mir, A. A., & Mir, S. M. (2023). Unveiling the present status of open access repositories: a comparative analysis of India and China. *Library Management*, 44(1/2), 120–132. <https://doi.org/10.1108/lm-09-2022-0084>
- Piwowar, H., Priem, J., Larivière, V., Alperin, J. P., Matthias, L., Norlander, B., Farley, A., West, J., & Haustein, S. (2018). The state of OA: a large-scale analysis of the prevalence and impact of Open Access articles. *PeerJ*, 6, e4375. <https://doi.org/10.7717/peerj.4375>
- Puala, S., Singh, K. & Maharana, B. (2023). A New Era in Scholarly Communication: Open Access Publishing. *Indian Journal of Library and Information Science* 17(3), 231-235. <http://dx.doi.org/10.21088/ijlis.0973.9548.17323.6>
- Rao, S. S., & Rao, N. L. (2018). *Open access policies and mandates: A study of their implementation in academic institutions in India*. In *IFLA World Library and Information Congress (WLIC), 24–30 August 2018, Kuala Lumpur, Malaysia*.
- Sathyanarayana, N. (2008b). Open access and open J-Gate. *DESIDOC Journal of Library & Information Technology*, 28(1), 57–60. <https://doi.org/10.14429/djlit.28.1.153>
- Sawant, S. (2012). Past and present scenario of open access movement in India. *The Journal of Academic Librarianship*, 39(1), 108–109. <https://doi.org/10.1016/j.acalib.2012.11.007>
- Shuttleworth, S., & Charnley, B. (2016). Science periodicals in the nineteenth and twenty-first centuries. *Notes and Records the Royal Society Journal of the History of Science*, 70(4), 297–304. <https://doi.org/10.1098/rsnr.2016.0026>
- Singh, P. (2016). Open access repositories in India. *IFLA Journal*, 42(1), 16–24. <https://doi.org/10.1177/0340035215610131>
- Springer Nature. (2025). *Green or gold routes to open access*. <https://www.springernature.com/gp/open-science/about/green-or-gold-routes-to-oa>
- Springer Nature. (2025). *The fundamentals of open access and open research*. <https://www.springernature.com/gp/open-science/about/the-fundamentals-of-open-access-and-open-research>
- Suber, P. (2004). *A very brief introduction to open access*. <http://www.earlham.edu/~peters/hometoc.htm>
- Suber, P., Brown, P. O., Cabell, D., et al. (2003). *The Bethesda Statement on Open Access Publishing*. [https://www.researchgate.net/publication/48547523\\_The\\_Bethesda\\_Statement\\_on\\_Open-Access\\_Publishing](https://www.researchgate.net/publication/48547523_The_Bethesda_Statement_on_Open-Access_Publishing)

- To, W., & Yu, B. T. (2020). Rise in higher education researchers and academic publications. *Emerald Open Research*, 1(3). <https://doi.org/10.1108/eor-03-2023-0008>
- UNESCO. (2025). *Open access policy concerning UNESCO publications*. <https://unesdoc.unesco.org/ark:/48223/pf0000220872>
- UNESCO. (2012). *UNESCO open access strategy*. <https://www.unesco.org>
- World Health Organization (WHO). (2025). *WHO policy on open access*. <https://www.who.int/about/policies/publishing/open-access>
- Xia, J. (2011). An anthropological emic-etic perspective on open access practices. *Journal of Documentation*, 67(1), 75–94. <https://doi.org/10.1108/00220411111105461>

# **CHAPTER 4**

## **Data Carpentry: Conceptual Approach**

#### 4.1. Introduction

Today, data is one of the most powerful assets in the world, growing rapidly and evolving fundamentally over time. In research, the vast amount of data is transforming traditional methodologies and reshaping the way studies are conducted. The concept of big data refers to the emergence of large and complex datasets that require advanced techniques for processing and analysis. Big data enables researchers to uncover patterns, trends, and insights that were previously impossible to detect with conventional data analysis methods (Medida & Kumar, 2024). Research data exists in various forms and is generated through systematic investigation, including observation, experimentation, and hypothesis testing (Pryor, 2012). While the abundance of data presents numerous opportunities, it also brings challenges related to its organization, storage, and accessibility. Ensuring that data remains structured, secure, and reusable requires effective Research Data Management (RDM), which involves strategies for collecting, processing, preserving, and sharing data responsibly. A key component of RDM is adherence to the FAIR principles (Findability, Accessibility, Interoperability, and Reusability), which ensure that research data is well-documented, easily located, and structured for long-term reuse (Barker et al., 2022). These principles not only support Open Science by making data more transparent and accessible but also enhance research reproducibility by ensuring that datasets can be validated and built upon by other researchers (Cai & Zhu, 2015). Additionally, researchers face complexities in data analysis and documentation, making it essential to develop skills in handling data efficiently. As data continues to expand, its value is realized only when individuals are data literate, equipped with the skills to locate, analyze, interpret, and critically apply it (Ridsdale et al., 2015). In simple terms, the ability to read, understand, and effectively use data is called Data Literacy (Nwagwu, 2024). With the growing need for skilled and well-trained researchers to handle data in a reproducible way, Data Carpentry has emerged as a specialized approach to teaching fundamental data skills. It operates under 'The Carpentries', an organization that also includes Software Carpentry and Library Carpentry, contributing to a global movement

aimed at strengthening research computing and data management skills. Explained briefly:

#### 4.2. The Carpentries

The Carpentries is a registered 501(c)(3) non-profit organization based in Delaware, USA, that teaches basic data science and coding skills to researchers worldwide. The Carpentries emerged to address the lack of proper training for researchers in handling computational data across various disciplines. Their mission is to educate and foster an inclusive, diverse, and engaged community of learners and instructors, emphasizing the significance of software and data in research. Through collaboration, they create openly accessible lessons and deliver them using evidence-based teaching methods. Their primary focus is on individuals involved in conducting and supporting research. Its global community works together to offer (The Carpentries, 2025):

- A suite of open source, collaboratively-built, community-developed lessons.
- Evidence-based, proven pedagogical training.
- Workshops based on a learn-by-doing, ‘code with me’ approach.
- A supportive learning culture.
- A global community which subscribes to an inclusive code of conduct.



**Figure 4.1: Homepage of The Carpentries**

(source: <https://carpentries.org/>)

**4.2.1. Software Carpentry:** Software Carpentry was founded in 1998 by Greg Wilson with the goal of teaching programming and computational skills to scientists (Wilson, 2010). It is a training program that teaches basic computing and data skills to researchers, helping them write better code, manage data efficiently, and use tools like Python, R, Git, and the command line. Additionally, it equips researchers with best practices for reproducible and efficient research workflows.

**4.2.2. Library Carpentry:** Library Carpentry, a branch of Data Carpentry, specializes in domain-specific data skills such as data curation, managing textual data, bibliographic content handling, regular expressions (regex), named entity recognition (NER), and data reconciliation (Baker et al., 2016). It came in 2014 by James Baker which helps library professionals enhance their existing services and adapt to the evolving demands of data management and digital tools. The lessons are designed to enhance digital literacy and computational thinking among academic library staff, helping them streamline workflows and eliminate repetitive tasks in their daily operations (Seidlmayer et al., 2020).

**4.2.3. Data Carpentry:**

Data Carpentry is a community-driven initiative that trains researchers to enhance their fundamental data skills in organizing, cleaning, analyzing, and visualizing data. The aim is to help researchers across disciplines develop computational and data-handling skills to improve the reproducibility, transparency, and efficiency of their research work. The primary goal of Data Carpentry is to increase data literacy among researchers and enable them to work confidently with data. The training is delivered through interactive, hands-on workshops that emphasize practical learning rather than theoretical instruction. Participants work with real-world datasets relevant to their fields, ensuring that the skills learned are directly applicable to their research. The workshops focus on best practices for data management, encouraging researchers to adopt structured and reproducible workflows. Data Carpentry workshops use spreadsheets and open-source tools such as OpenRefine, Python, R, and SQL for data cleaning, organization, analysis, and visualization. They are designed specifically for those with little to no prior experience in programming or

data management, making them accessible to beginners while still being valuable for more experienced researchers. The instruction is customized for different research fields, including life sciences, physical sciences, social sciences, and geospatial sciences. The targeted participants of Data Carpentry workshops are researchers who handle large volumes of data in their projects. The workshops cover topics such as data organization in spreadsheets, data cleaning with OpenRefine, data analysis using R, Python, or SQL, and various data visualization techniques. Participants also learn about data documentation, reproducibility, and ethical data practices, which are crucial for ensuring the integrity and accessibility of research.

The importance of Data Carpentry lies in bridging the skill gap for researchers who struggle with data management. Many researchers, despite their expertise in their fields, lack formal training in data handling and computational tools. This gap can lead to inefficiencies, errors, and difficulties in reproducing results. By equipping researchers with the necessary skills, Data Carpentry helps reduce errors, save time, and improve research workflows. Participants come from diverse backgrounds, including scientists, librarians, students, data professionals, and policymakers. Through Data Carpentry, they gain confidence in handling data, improve their research efficiency, and contribute to open science initiatives. The program fosters a collaborative learning environment, encouraging participants to engage with peers and develop long-term skills that can be applied in their careers.

Since 2014, Data Carpentry has expanded globally, collaborating with universities, research institutions, and libraries to provide training to thousands of researchers. By promoting open, reproducible, and transparent research practices, Data Carpentry plays a crucial role in modern scientific research, ensuring that researchers can efficiently handle data and make meaningful contributions to their fields.



**Figure 4.2: Homepage of Data Carpentry**

(source: <https://datacarpentry.org/>)

### 4.3. Origin of Data Carpentry

Data Carpentry operates under "The Carpentries," an organization that also includes Software Carpentry and Library Carpentry, making it part of a larger movement to enhance research computing and data skills worldwide. Data Carpentry started as part of Software Carpentry, which was founded by Greg Wilson in 1998. Software Carpentry aimed to teach researchers basic computer programming and data management skills. As the focus on data-driven research grew, it became clear that specific training in data management and analysis was needed for researchers who weren't necessarily programmers.

In 2014, Data Carpentry was created to address this need. Its goal is to teach researchers with little to no programming experience essential data skills, such as cleaning, organizing, and analyzing data.

In 2013, members of the Software Carpentry community recognized the need for training aimed at computational beginners, focusing on helping researchers manage their data. Consequently, Data Carpentry was established in 2014 under the leadership of Tracy Teal and her colleagues to address the growing need for data management skills among researchers. Both Software and Data Carpentry are fiscally sponsored projects of NumFOCUS, a 501(c) (3) non-profit organization based in the United States (Jordan, 2016). Dr. Tracy Teal, a bioinformatics researcher, identified

that many scientists lacked formal training in data organization, cleaning, and analysis. In 2018, Data Carpentry and Software Carpentry merged to form The Carpentries, a global community dedicated to teaching foundational coding and data skills to researchers. This merger strengthened the reach and impact of Data Carpentry, enabling it to develop a larger network of instructors, improve curricula, and implement a more structured approach to training (Baker et al., 2016).

The first two-day workshop on Data Carpentry was held at the National Evolutionary Synthesis Center (NESCent) on May 8-9, 2014, following the successful model of Software Carpentry bootcamps (Teal et al., 2015). Data Carpentry is a project supported by NumFOCUS, a 501(c)(3) non-profit organization that backs high-quality, innovative open-source projects in scientific computing. The workshop report indicates that the 30-seat capacity was filled in less than 24 hours, with many people placed on a waiting list, highlighting the demand for such courses. The workshop received significant support through social media, discussions, and widespread interest, along with numerous requests for additional workshops to be held in the future. Data Carpentry's establishment was driven by the increasing demand for data management training, providing researchers with the skills necessary to handle and analyze data effectively. Its continued growth and the support it has garnered underscore the importance of fostering data literacy in research communities and further solidify its role in empowering researchers across disciplines.

#### **4.4. Number of Workshops Held Across Countries**

In India, various workshops on Data Carpentry have been conducted, including initiatives aimed at empowering researchers, academics, and professionals with essential data skills to enhance their work in fields such as ecology, genomics, social sciences, and more. These workshops have been organized in collaboration with academic institutions, research organizations, and community groups, fostering a culture of data-driven research and open science. By focusing on foundational computational and data skills, these workshops have helped participants streamline their workflows, improve data management practices, and gain proficiency in tools

like R, Python, OpenRefine, and SQL. The growing popularity of Data Carpentry in India reflects the increasing recognition of the importance of data literacy in addressing complex research challenges and advancing scientific discovery. The following number workshops have been listed below (The Carpentries, 2024):

1. The first workshop in India took place at the Indian Statistical Institute from March 10–13, 2015, instructed by Clare Sloggett and Harriet Dashnow.
2. Another workshop was held at CEPT University on October 6–7, 2018, instructed by Shaily Gandhi and Bindi Dave.
3. The third workshop on Data Carpentry (Ecology with R) was conducted online by the Marie Curie Alumni Association - India Chapter on May 14–15, 2022, instructed by Kishore Kumar Jagadeesan, Annajiat Alim Rasel, Joel Nitta, and Pradeep Eranti.
4. The most recent workshop was held at Charutar Vidya Mandal (CVM) University from October 12–17, 2023, instructed by Parthasarathy Mukhopadhyay, Aditya Tripathi, and Raina Gaharwar.

## References

- Baker, J., Moore, C., Priego, E., Alegre, R., Cope, J., Price, L., Stephens, O., Van Strien, D., & Wilson, G. (2016). Library Carpentry: Software skills training for library professionals. *LIBER Quarterly the Journal of the Association of European Research Libraries*, 26(3), 141–162. <https://doi.org/10.18352/lq.10176>
- Barker, M., Hong, N. P. C., Katz, D. S., Lamprecht, A., Martinez-Ortiz, C., Psomopoulos, F., Harrow, J., Castro, L. J., Gruenpeter, M., Martinez, P. A., & Honeyman, T. (2022). Introducing the FAIR Principles for research software. *Scientific Data*, 9(1). <https://doi.org/10.1038/s41597-022-01710-x>
- Birkbeck, G., Nagle, T., & Sammon, D. (2022). Challenges in research data management practices: a literature analysis. *Journal of Decision System*, 31(1), 153–167. <https://doi.org/10.1080/12460125.2022.2074653>
- Cai, L., & Zhu, Y. (2015). The Challenges of Data Quality and Data Quality Assessment in the Big Data Era. *Data Science Journal*, 14(0), 2. <https://doi.org/10.5334/dsj-2015-002>
- Medida, L. H., & Kumar, N. (2024). Addressing challenges in data analytics. In *Advances in computer and electrical engineering* (pp. 16–33). <https://doi.org/10.4018/979-8-3693-2260-4.ch002>
- Nwagwu, W. E. (2024). Mapping the field of global research on data literacy: Key and emerging issues and the library connection. *IFLA Journal*, 50(3), 491–510. <https://doi.org/10.1177/03400352241257669>
- Pryor, G. (2012). Why manage research data? In G. Pryor (Ed.), *Managing research data* (pp. 1–16). Facet.
- Ridsdale, C., Rothwell, J., Smit, M., Ali-Hassan, H., Bliemel, M., Irvine, D., & Wuetherick, B. (2015). *Strategies and best practices for data literacy education: Knowledge synthesis report*. Dalhousie University. [https://www.researchgate.net/publication/284029915\\_Strategies\\_and\\_Best\\_Practices\\_for\\_Data\\_Literacy\\_Education\\_Knowledge\\_Synthesis\\_Report](https://www.researchgate.net/publication/284029915_Strategies_and_Best_Practices_for_Data_Literacy_Education_Knowledge_Synthesis_Report)
- Seidlmayer, E., Müller, R., & Förstner, K. U. (2020). Data Literacy for Libraries – A Local Perspective on Library Carpentry. *BIBLIOTHEK Forschung Und Praxis*, 44(3), 485–489. <https://doi.org/10.1515/bfp-2020-2038>
- Teal, T. K., Cranston, K., Lapp, H., White, E., Wilson, G. V., Ram, K., & Pawlik, A. (2015). Data Carpentry: Workshops to Increase data Literacy for Researchers. *International Journal of Digital Curation*, 10(1), 135–143. <https://doi.org/10.2218/ijdc.v10i1.351>
- The Carpentries. (2024). *Past workshops*. <https://carpentries.org/workshops/past-workshops/>
- The Carpentries. (2025). *About us*. <https://carpentries.org/about-us/>

Wilson, G. (2010). *Software Carpentry: Teaching basic lab skills for research computing*. <http://software-carpentry.org/>

**CHAPTER 5**

**Profile of Selected Central  
Universities**

### **5.1. Introduction**

The word education derived from the Latin '*e-ducare*' which means "to lead forth" or "bring out" something that already exists in potential (Bass & Good, 2004). Its main purpose is to help a child develop the ability to solve problems related to their own needs. Education plays a vital role in a person's life, throughout the growth from childhood to adulthood. In early learning phase, it builds foundational skills such as reading, writing, and critical thinking, while nurturing curiosity, creativity, and moral values. At higher levels, it encourages independent inquiry and research, enabling individuals to explore new ideas, solve complex problems, and contribute to the advancement of knowledge.

In India, education has undergone significant transformations over time, shaped by changing social, economic, and technological demands. The Ministry of Education (MoE), through bodies such as the University Grants Commission (UGC) and other statutory agencies, oversees all education-related activities, including higher education initiatives, infrastructure development, and funding allocation.

### **5.2. Evolution of Higher Education in India**

India has always been a hub of learning since the ancient times for universities like Taxila, Nalanda, Vikramshila (Maity & Maity, 2016). The education system in India has undergone many significant changes over the past decades from different periods like ancient, medieval colonial period, post-independence and so on. The concept 'higher education' refers to the education provided beyond secondary level acquired specially in colleges, institutions and universities. After the independence, the higher education bodies in India have been seen growing by emphasizing improved infrastructure, technology in teaching learning, quality education and increasing number of state or central universities and institutions in different parts of the country. (Nigavekar, 2003). By the time of Independence there were only 20 universities and 500 colleges but now it has increased upto 659 universities and 33023 colleges till the year 2012 (Sheikh, 2017).

### **5.2.1. Importance of Higher Education Institutions**

Higher education institutions play a crucial role for holistic development of an individual in a nation for several reasons like:

- i. **Developing Skills:** It facilitates specialized knowledge and professional training courses contributing to economic growth and development.
- ii. **Research and Innovation:** Universities and Institutions are centre of research and developments, driving new ideas and advancements in different subject fields.
- iii. **Development of Human Capital:** The higher education institutions produces skilled professionals and academicians driving productivity and dynamic competitiveness in a society.
- iv. **Social Mobility:** Education has always been a life changing opportunity for transforming an individual's socioeconomic status in a better way and higher education institution being the channel.
- v. **Cultural and Intellectual Development:** academic institutions act as a hub for cultural exchange, intellectual and critical thinking, respecting the differences.
- vi. **Policy Formulation:** Higher education institutions always strengthen the decision-making ability in various fields including education, healthcare, and governance.

### **5.3. Indian Higher Education Governing Bodies**

In India education system, there are several higher education governing bodies that are looking after the various sections like funding, infrastructure, education and research as listed below:

#### **5.3.1. Ministry of Education, Government of India (GoI):**

The Ministry of Education is an apex body responsible for formulating administrative policies and regulating the primary to higher educational system of India. MoE is established in September 26, 1985, formerly known as Ministry of Ministry of Human Resource Management (MHRD) which was changed in the year 2020. The main function is developing national education policies, designing national curriculum frameworks for quality education, implementing

training programs for teaching learning, supporting research and innovation, international collaboration to exchange educational resources. One of its prime aims to facilitate equal education to all the segments of society, regardless of any socio-economic background. Bridging the gap between urban and rural areas, promoting gender equality, and delivering inclusive education to all. The MoE associated with state governments, educational institutions, and various stakeholders to design and implement schemes that addresses holistic development of learners (MoE, 2024). Presently, MoE works under two departments i.e, Department of School Education & Literacy and Department of Higher Education.



**Figure 5.1: Homepage of MoE's Website**

(Source: <https://www.education.gov.in/>)

**5.3.2. Department of School Education & Literacy (SE&L):** Department of School Education & Literacy looks after the school education and literacy of the country. The main objective of the department is 'universalization of education' and formulates policies to enhance the quality of education, improving access to schooling, and promoting literacy across all age groups. The department introduces various new schemes and initiatives which have begun resulting in positive results in the increasing enrollment rates in schools. Department of School Education and Literacy have its autonomous/Statutory bodies, i.e., CBSE, KVS, JNV, NIOS, and NCTE. Its other centrally sponsored schemes like Samagra Shiksha, PM Poshan,

Padhna Likhna Abhiyan and central sector scheme of National Means cum Merit Scholarships is dedicated to create a quality education system, with specialized focus on historically marginalized, disadvantaged, and underrepresented groups that acts as a great level and is the best tool for achieving economic and social mobility, inclusion, and equality (MoE, 2024).

**5.3.3. Department of Higher Education (DHE):** Department of Higher Education is looking after the largest Higher Education systems in the world after countries like United states and China. It is responsible for the overall development and formulating policies and planning of the higher education sector. DHE has offers the best opportunities in higher education and research to its citizen of the country so that the students don't leave behind to compete in an international platform. The government has taken various initiatives by launching joint ventures and signing MoUs with well-known institutions for the benefit of the Indian students.

- **Vision of DHE:** To understand India's human resource potential in the Higher Education sector, with equity and inclusion.
- **Mission of DHE:**
  - a) Provide greater opportunities for access to Higher Education with equity to all eligible persons and in particular to the vulnerable sections.
  - b) Increase access by supporting existing institutions, establishing new institutions, and supporting State Governments and Non-Government Organizations/civil society to supplement public efforts aimed at removing regional or other imbalances that exist at present.
  - c) Formulate policies and programmes for strengthening research and innovations and encourage institutions - public or private to engage in expanding the frontiers of knowledge.
  - d) Promote the quality of Higher Education by investing in infrastructure and faculty, promoting academic reforms, improving governance and institutional restructuring toward the inclusion of the hitherto deprived communities.



**Figure 5.2: Homepage of DHE Website**

(Source: [https://www.education.gov.in/higher\\_education\\_hi](https://www.education.gov.in/higher_education_hi))

**5.3.4. University Grant Commission (UGC):** UGC is an important pillar which is responsible to oversee the prospects of higher education in the country. It came into existence on 28th December, 1953 and became a statutory body of the Government of India by an Act of Parliament in 1956 to coordinate and maintain the quality of teaching, examination and research in higher education. The main function of UGC is to look after different components of university education including, accreditation, curriculum development, funding aspects and academic standards. It formulates policies and guidelines for universities and colleges, administers grants and scholarships, and conducts evaluation to monitor the performance of academic institutions. Moreover, it promotes research and innovation in various disciplines and facilitates academic collaboration, industry, and government agencies. Over the years, the UGC has planned its strategies to address emerging challenges and opportunities in the education sector, including advancements in technology, changing employment landscapes, and the increasing demand for skilled professionals. Through its programs and initiatives, the UGC continues to contribute specifically for the growth and development of higher education in India, striving to uphold academic excellence and inclusivity across the nation. Currently, the UGC have total affiliation of 460 state universities, 128 deemed to be universities, 430 private universities and 56 central universities (UGC,2024).



**Figure 5.3: Homepage of UGC Website**

(Source: <https://www.ugc.gov.in/>)

- i. **State University:** A state university is a public higher education institution funded and administered by the state government. The purpose of a state university is to serve the residents of their respective state by providing accessible and affordable education to a wide range of students.
- ii. **State Private Universities:** State private university is a type of university established under a State/Central Act by a sponsoring body viz. A Society registered under the Societies Registration Act 1860, or any other corresponding law for the time being in force in a state or a Public trust or a company registered under section 25 of the Companies Act, 1956 (DHE, (2016). State private universities typically have more autonomy and independence than the public universities in terms of governance, curriculum development, and decision-making aspects.
- iii. **Deemed to be university:** A Deemed to be university is granted by UGC under section 3 of the UGC Act, 1956 to the higher education institutions of India. This type of universities maintains higher standard in academic excellence and infrastructure, they have their own syllabus, courses and curriculum.

- iv. **Private University:** Private University is a higher education institution administered and funded by private organization or self-supported institution. They have their own set of standards, curriculum, degrees and fields of study.
- v. **Central University:** A Central University is a type of institution of higher education in India, established by an act of The Central Universities Act, 2009, under Department of Higher Education in the Ministry of Education, Government of India. These universities are fully funded and operated by central government. The prime aim of these universities is to excel in academics and research activities in different parts of a country.

#### 5.3.4.1 Importance of Central Universities

Central universities play a significant role in imparting quality education to its citizens across the nation. The importance of central universities are as follows:

- a) **Quality Education:** Central universities are known for providing advanced education, better infrastructure, well-trained faculties with advanced teaching-learning methods (Gupta, 2021)
- b) **Research and Innovation:** Central universities develop a strong focus on research and innovation aspects. They have well-equipped laboratories and collaborate with national and international institutions, publish wide range of research papers in their respective fields (Panneerselvam, 2017).
- c) **Promotion of Diversity:** Central universities offer a great provision of promoting diversity by attracting students from different parts of the country which helps to learn and respect different culture, language and tradition (Marisha et al., 2017).
- d) **International Collaboration:** Central universities have increasingly engaged in collaborations with prestigious foreign universities across the world and promote academic exchange, research projects, and faculty/student exchange programs.

**Table 5.1: List of Central Universities of India**

| Sl. No. | State             | University                                            | Estd. | Specialization           |
|---------|-------------------|-------------------------------------------------------|-------|--------------------------|
| 1       | Andhra Pradesh    | Central Tribal University of Andhra Pradesh           | 2019  | Tribal General           |
| 2       |                   | Central University of Andhra Pradesh                  | 2019  | General                  |
| 3       |                   | National Sanskrit University                          | 1956  | Sanskrit                 |
| 4       | Arunachal Pradesh | Rajiv Gandhi University                               | 1985  | General                  |
| 5       | Assam             | Assam University                                      | 1994  | General                  |
| 6       |                   | Tezpur University                                     | 1994  | General                  |
| 7       | Bihar             | Central University of South Bihar                     | 2009  | General                  |
| 8       |                   | Mahatma Gandhi Central University                     | 2016  | General                  |
| 9       |                   | Nalanda University                                    | 2010  | International University |
| 10      |                   | Dr. Rajendra Prasad Central Agriculture University    | 1905  | Agriculture              |
| 11      | Chhattisgarh      | Guru Ghasidas Vishwavidyalaya                         | 1983  | General                  |
| 12      | Delhi             | Central Sanskrit University                           | 1970  | Sanskrit                 |
| 13      |                   | Indira Gandhi National Open University                | 1985  | Distance education       |
| 14      |                   | Jamia Millia Islamia                                  | 1920  | General                  |
| 15      |                   | Jawaharlal Nehru University                           | 1969  | General                  |
| 16      |                   | Shri Lal Bahadur Shastri National Sanskrit University | 1962  | Sanskrit                 |
| 17      |                   | South Asian University                                | 2010  | International University |
| 18      |                   | University of Delhi                                   | 1922  | General                  |
| 19      | Gujarat           | Central University of Gujarat                         | 2009  | General                  |
| 20      |                   | Gati Shakti Vishwavidyalaya                           | 2022  | Transport                |
| 21      | Haryana           | Central University of Haryana                         | 2009  | General                  |

|    |                  |                                                     |      |                               |
|----|------------------|-----------------------------------------------------|------|-------------------------------|
| 22 | Himachal Pradesh | Central University of Himachal Pradesh              | 2009 | General                       |
| 23 | Jammu and        | Central University of Jammu                         | 2011 | General                       |
| 24 | Kashmir          | Central University of Kashmir                       | 2009 | General                       |
| 25 | Jharkhand        | Central University of Jharkhand                     | 2009 | General                       |
| 26 | Karnataka        | Central University of Karnataka                     | 2009 | General                       |
| 27 | Kerala           | Central University of Kerala                        | 2009 | General                       |
| 28 | Ladakh           | Sindhu Central University                           | 2021 | General                       |
| 29 | Madhya           | Dr. Hari Singh Gour University                      | 1946 | General                       |
| 30 | Pradesh          | Indira Gandhi National Tribal University            | 2007 | General                       |
| 31 | Maharashtra      | Mahatma Gandhi Antarrashtriya Hindi Vishwavidyalaya | 1997 | Hindi Language                |
| 32 | Manipur          | Central Agricultural University                     | 1993 | Agriculture                   |
| 33 |                  | Manipur University                                  | 1980 | General                       |
| 34 |                  | National Sports University                          | 2018 | Sports                        |
| 35 | Meghalaya        | North Eastern Hill University                       | 1973 | General                       |
| 36 | Mizoram          | Mizoram University                                  | 2000 | General                       |
| 37 | Nagaland         | Nagaland University                                 | 1994 | General                       |
| 38 | Odisha           | Central University of Odisha                        | 2009 | General                       |
| 39 | Puducherry       | Pondicherry University                              | 1985 | General                       |
| 40 | Punjab           | Central University of Punjab                        | 2009 | General                       |
| 41 | Rajasthan        | Central University of Rajasthan                     | 2009 | General                       |
| 42 | Sikkim           | Sikkim University                                   | 2007 | General                       |
| 43 | Tamil Nadu       | Central University of Tamil Nadu                    | 2009 | General                       |
| 44 |                  | Indian Maritime University                          | 2008 | Marine Science                |
| 45 | Telangana        | English and Foreign Languages University            | 1958 | English and Foreign languages |
| 46 |                  | Maulana Azad National Urdu University               | 1998 | Urdu Language                 |
| 47 |                  | University of Hyderabad                             | 1974 | General                       |
| 48 | Tripura          | Tripura University                                  | 1987 | General                       |

|    |               |                                                  |      |                  |
|----|---------------|--------------------------------------------------|------|------------------|
| 49 | Uttar Pradesh | Aligarh Muslim University                        | 1920 | General          |
| 50 |               | University of Allahabad                          | 1887 | General          |
| 51 |               | Babasaheb Bhimrao Ambedkar University            | 1996 | General          |
| 52 |               | Banaras Hindu University                         | 1916 | General          |
| 53 |               | Rajiv Gandhi National Aviation University        | 2013 | Aviation Science |
| 54 |               | Rani Lakshmi Bai Central Agricultural University | 2014 | Agriculture      |
| 55 | Uttarakhand   | Hemwati Nandan Bahuguna Garhwal University       | 1973 | General          |
| 56 | West Bengal   | Visva-Bharati University                         | 1921 | General          |

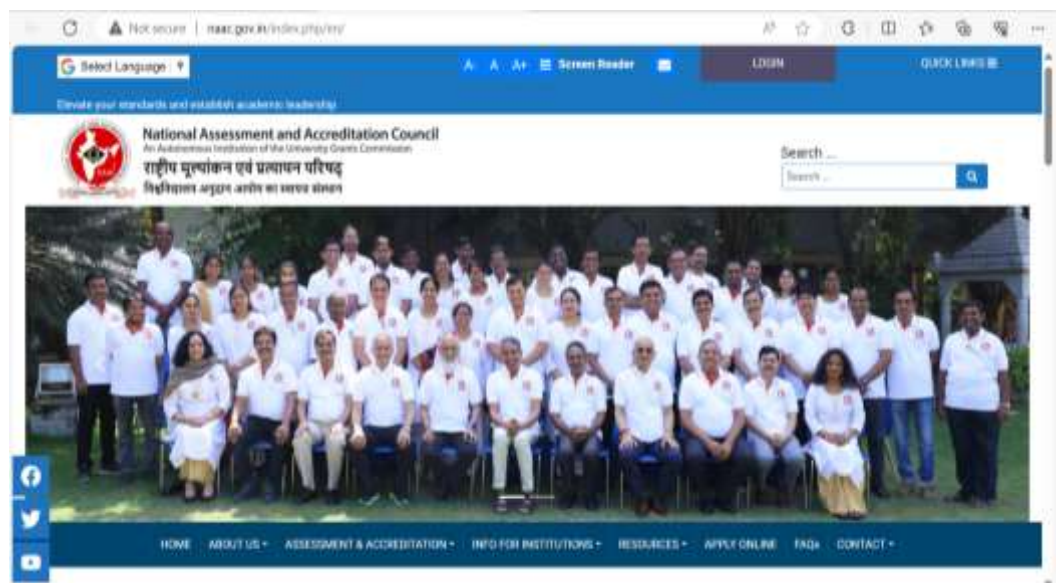
(Source: UGC)

#### 5.4. Ranking and Evaluation of Higher Education Institutions

Evaluation and ranking of higher education institutions are part of important component for assuring its quality and credibility in the academic milieu. Accreditation bodies like NIRF and NAAC plays an important role in assessing and accrediting the academic institutions of India based on valuable comparative perspective. <http://naac.gov.in/index.php/en/>

**a. National Assessment and Accreditation Council (NAAC):** The Indian higher education landscape has undergone dynamic variations, which brings the need for accounting the excellence and quality assurance. By considering the concerns, the National Assessment and Accreditation Council (NAAC) was established in the year 1994 as an autonomous institution of UGC under recommendation of the National Policy on Education (NPE, 1986) and the Programme of Action (PoA, 1992). The headquarter of NAAC is situated in Bengaluru. The vision of NAAC is to assure quality and accredit the Higher Education Institutions (HEIs) like universities, colleges, etc., in India. Currently, NAAC accredited total of 10,282 higher education institutions out which 458 are universities and 9,824 are colleges. The NAAC evaluation functions based on its General Council (GC) and

Executive Committee (EC) which comprises of eminent like policy makers, academic administrators and senior academicians of the Indian higher education system (NAAC, 2024). NAAC evaluation focuses on the factors like curriculum design, teaching-learning methods, research output, infrastructure, governance, and student support services. Accreditation by NAAC validates an institution's overall educational excellence by meeting its predefined standards.



**Figure 5.4: Homepage of NAAC Website**

(Source: <http://naac.gov.in/index.php/en/>)

- **Advantages of NAAC Accreditation:**

NAAC accreditation presents various advantages to the educational institutions, students, faculty, and other stakeholders (NAAC, 2024):

- a) It enables the institutions to recognize their strength, weakness, opportunities through an informed review process.
- b) Identifies the internal areas of planning and resource allocation.
- c) Collegiality on the campus.
- d) Funding agencies look for objective data for performance funding.
- e) Institutions to initiate innovative and modern methods of pedagogy.

- f) New sense of direction and identity for institutions.
- g) The society look for reliable information on quality education offered.
- h) Employers look for reliable information on the quality of education offered to the prospective recruits.
- i) Intra and inter-institutional interactions.

**b. National Institutional Ranking Framework (NIRF):** The National Institutional Ranking Framework (NIRF) was introduced on 29th September 2015 by Ministry of Education (MoE), India, to rank higher education institutions of the country. It acts as an important tool for assessing the overall performance and quality of the institutions based on five predefined parameters. The evaluation of ranking is performed annually which helps the member of an institution to make informed decisions about their status in different aspects. The ranking built a competitive environment among the institutions which fosters continued improvement with context to education and research contributing to the overall enhancement of the institutions.

The five parameters for ranking higher education institutions are as follows (NIRF,2024):

**i. *Teaching, Learning & Resources (TLR)***

- Student Strength including Doctoral Students (SS)
- Faculty-student ratio with emphasis on permanent faculty (FSR)
- Combined metric for Faculty with PhD (or equivalent) and Experience (FQE)
- Financial Resources and their Utilisation (FRU)

**ii. *Research and Professional Practice (RP)***

- Combined metric for Publications (PU)
- Combined metric for Quality of Publications (QP)
- IPR and Patents: Published and Granted (IPR)
- Footprint of Projects and Professional Practice (FPPP)

**iii. *Graduation Outcomes (GO)***

- Metric for University Examinations (GUE)

- Metric for Number of Ph.D. Students Graduated (GPHD)

**iv. Outreach and Inclusivity (OI)**

- Percentage of Students from Other States/Countries (Region Diversity RD)
- Percentage of Women (Women Diversity WD)
- Economically and Socially Challenged Students (ESCS)
- Facilities for Physically Challenged Students (PCS)
- Perception (PR) Ranking

**v. Peer Perception**

- Academic Peers and Employers (PR)



**Figure 5.5: Homepage of NIRF Website**

(Source: <https://www.nirfindia.org/Home>)

## **5.5. Profile of Selected Central Universities of India**

The present study is confined to the nineteen central universities of India based on NIRF ranking 2022.

### **5.5.1. Jawaharlal Nehru University**

The Jawaharlal Nehru University (JNU) is a well-known public university situated in New Delhi, established in the year 1969. JNU ranked 2<sup>nd</sup> position in National Institutional Ranking Framework (NIRF) 2023 in university category consistently for the past five years and bagged 10<sup>th</sup> position in overall category which has

succeeded in delivering quality education in India. The university has total 13 schools, 38 centres and 8 special centres with state-of-the-art labs. It facilitates different courses on disciplines like Languages and Cultural Studies, Humanities and Social Sciences, Science, Management and Engineering from bachelor's degree to M.Phil./Ph.D. programs including Diplomas. The university consist of more than 9000 students with leading faculties and is a great hub for research and education.



**Figure 5.6: Homepage of Jawaharlal Nehru University Official Website**

(Source: <https://www.jnu.ac.in/main/>)

### **5.5.2. Jamia Millia Islamia**

Jamia Millia Islamia is a prestigious central university located in New Delhi. Originally founded in the year 1920 at Aligarh in United Provinces and turn into a central university in 1988 under act of Parliament and moved to Delhi. The university is known for providing advanced and quality education to students from all community from national and international background. The university succeeded to bag 3<sup>rd</sup> rank in NIRF 2023 among all universities in India. Various courses are facilitated by the university in hybrid method in regular and distance mode of education ranging from UG to Ph. D programmes in disciplines like Arts& humanities, social sciences, natural sciences, Engineering, IT, etc. The university is equipped with standard departments, offices, hostels and library with wide-network campus for fulfilling the prime motto of the university.



**Figure 5.7: Homepage of Jamia Millia Islamia Official Website**

(Source: <https://jmi.ac.in/>)

### 5.5.3. Banaras Hindu University

Banaras Hindu University is a worldwide reputed knowledge hub situated in the city of Varanasi, Uttar Pradesh. The university was founded in the year 1916 by Madan Mohan Malaviya formerly known as 'Central Hindu College'. BHU is considered as the largest residential university in the entire Asia, also the Indian government as declared it as Institute of eminence. By Consisting of 6 Institutes, 14 Faculties 144 Departments, 4 Interdisciplinary centres, a constituent college for women's and 3 Constituents Schools, covering wide range of subjects including Humanities, fine arts, social science, medicine, science etc. Equipped with standard amenities of playgrounds, auditoriums, printing press, publication cell, canteens, Employment and Information Bureau and many more. More than 15,000 students are part of the university belonging to different parts of the country as well as foreign countries like USA, Europe, Africa, Middle East, etc. with the motto of serving knowledge and promoting new ideas.



**Figure 5.8: Homepage of Banaras Hindu University Official Website**

(Source: [https://www.bhu.ac.in/Site/Home/1\\_2\\_16\\_Main-Site](https://www.bhu.ac.in/Site/Home/1_2_16_Main-Site))

#### 5.5.4. University of Hyderabad

University of Hyderabad is one of the top central universities situated in Hyderabad, Telangana known as best multidisciplinary university in India. Established in 1974 accredited with 'A' grade by NAAC which offers UG courses to doctorate programmes in different disciplines like science, social science, management, education, computer applications etc with 12 schools and 41 departments. The university is known to be a central hub of good quality research, teaching and learning centres for betterment of the society at global level. Considered as 'Institute of Eminence' by UGC, Government of India. The campus is surrounded by greenery with different species of flower, birds and animal and rich in infrastructure with a library with large collection of resources.



**Figure 5.9: Homepage of University of Hyderabad Official Website**

(Source: <https://uohyd.ac.in/>)

#### **5.5.5. Aligarh Muslim University**

Aligarh Muslim University is a well-known public central university with ‘A<sub>+</sub>’ grade accredited by NAAC which is located in Aligarh, Uttar Pradesh, India. The university serves a large number of students from different parts of the country including foreign countries like West Asia, Southeast Asia and Africa. Comprising of different departments including agricultural Sciences, Arts, Commerce, Engineering & Technology, Law, Life Sciences, Medicine, Management Studies & Research, Science, Social Sciences, etc. with 13 faculties. The university also facilitates Centre for Distance and Online Education with undergraduate courses to doctorate programmes. It aims to build an integrated modern system of education complying with the new education policy fostering teaching, learning, research and innovation for making a better future of all.



**Figure 5.10: Homepage of Aligarh Muslim University Official Website**

(Source: <https://www.amu.ac.in/>)

#### 5.5.6. University of Delhi

University of Delhi is one of the largest and prestigious university in the world located in Delhi, India which is established in the year 1922 under the Act of Central Legislative Assembly. The university facilitates different educational programmes, well trained faculties with advanced infrastructure which is considered as 'Institute of eminence' by government of India. Over 80 departments with 16 faculties, more than 7 lakh students over the world, offering 209 programmes in diverse disciplines with 91 constituent colleges makes the university a notable one amongst all. The university have other facilities like good library, bank, post office, proper health centre, administrative and examination blocks. University of Delhi is a great place for attaining advanced knowledge and production of large number of quality research outputs and has ranked 11<sup>th</sup> in NIRF 2023.



**Figure 5.11: Homepage of University of Delhi Official Website**

(Source: <https://www.du.ac.in/>)

### 5.5.7. Central University of Kashmir

Central University of Kashmir is established in March 2009 under an Act 'The central universities Act 2009' by Ministry of Human Resource development (MHRD) situated in Ganderbal district of Jammu and Kashmir. The university offers 40+ education courses like diploma, Undergraduate, postgraduate, doctorate and vocational programmes to more than 3,000 students across the country. Comprising total of 9 schools, 19 departments in different disciplines like Arts and Humanities, Science Social science and Technology by maintaining higher standards in academics and research. The prime motto of the university is to disseminate advance knowledge with new ideas and innovation by contributing cultural, economic, educational and social advancement to the society. Within a short period of time, the university has abled to positively grow both in terms of human resource and good infrastructural facilities.



**Figure 5.12: Homepage of Central University of Kashmir Official Website**

(Source: <https://web.cukashmir.in/#/publiczone>)

### 5.5.8. Central University of Jammu

The central university of Jammu is established in the year 2011 under central universities Act, 2009 with its administrative office at Bagla, Rahya-Suchani in Samba district which is 25kms away from Jammu. The university is considered as one of the leading higher education institutions by implementing modern and advanced technology which offers courses from undergraduate to M.Phil./Ph.D. programmes. With total of 9 schools and 23 departments in different disciplines like Business studies, Engineering, Basic and Applied sciences, Education, Humanities and Social services, Language, Life Science, National Security studies and Management. The university aims to impart education to develop talent for sustainability in everything, inculcate self-confidence and also bringing up collaborative research with well-known institutions. The university facilitates well equipped library with good resources, auditorium, hostels, medical facilities, Digital learning cell, IT facilities etc. The university has MoUs in different departments with other leading institutes for joint collaborative research, academic exchange of students and resources for promoting cooperation in academia. The university has also established Dr. Ambedkar Centre of Excellence (DACE) under

Ministry of Social Justice and Empowerment, Government of India to provide free coaching to 100 Schedule Caste students for Civil Services examination conducted by UPSC.



**Figure 5.13: Homepage of Central University of Jammu Official Website**

(Source: <https://www.cujammu.ac.in/>)

### 5.5.9. Tezpur University

Tezpur University is one of the top central universities of the country which is established in the year 1994 situated in Tezpur district of Assam, India by an Act of Parliament. The university comprises of more than 1500 students and 130 faculties. It is one of the premier higher education institutions of the North East region known for its leadership in academics and quality research outputs. The university offers courses like UG, PG, diploma and M.Phil./Ph.D. programs in four schools of Humanities & Social science, Science, Management and Engineering with 27 academic departments and also special cells and centres. It has also been accredited 'A+' by NAAC peer committee and ranks 90<sup>th</sup> in 2022 and 69<sup>th</sup> in the year 2023 in overall category. The prime motto of the university is to work excellently into the field of Science and Technology for bringing excellence to the region as well as the country. The university is also taking sustainable campus initiatives, providing

facilities like library, computer centre, hostels, health centre, food quality control laboratory, guest house, yoga centre, AdaptNET, horticulture section etc.



**Figure 5.14: Homepage of Tezpur University Official Website**

(Source: <http://www.tezu.ernet.in/>)

#### **5.5.10. North Eastern Hill University**

The North-Eastern Hill University is established in the year 1973 under Act of Parliament situated in Meghalaya, India with a green campus. It has two campuses Shillong and in Tura with the aim to provide best research and academic facilities for social and economic development of the people of hilly areas in North Eastern regions. Initially, it used to be a regional university for the NE states like Arunachal university, Nagaland and Mizoram which is later on separated in 1994 and 2001. Currently there are fifty-three undergraduate colleges and eight professional colleges are affiliated under NEHU. The university has total seven schools and forty-six departments in different disciplines like Humanities, Science, Arts, Social Science, Management etc. comprising more than 4,500 students, 300 academic staff and 937 doctoral students. The faculty and students of the university has received many projects under DST, DBT, UGC, ICSSR, DAE, CSIR etc and some faculties have also received honorary academic awards of the country. UGC has conferred NEHU as 'Potential for Excellence' in the year 2006. The university facilitates

library with a large number of collections, laboratories, residential quarter for faculty and students, ICT facilities etc. Moreover, NEHU ranked 59<sup>th</sup> in NIRF ranking in the year 2021 under ‘universities’ category.

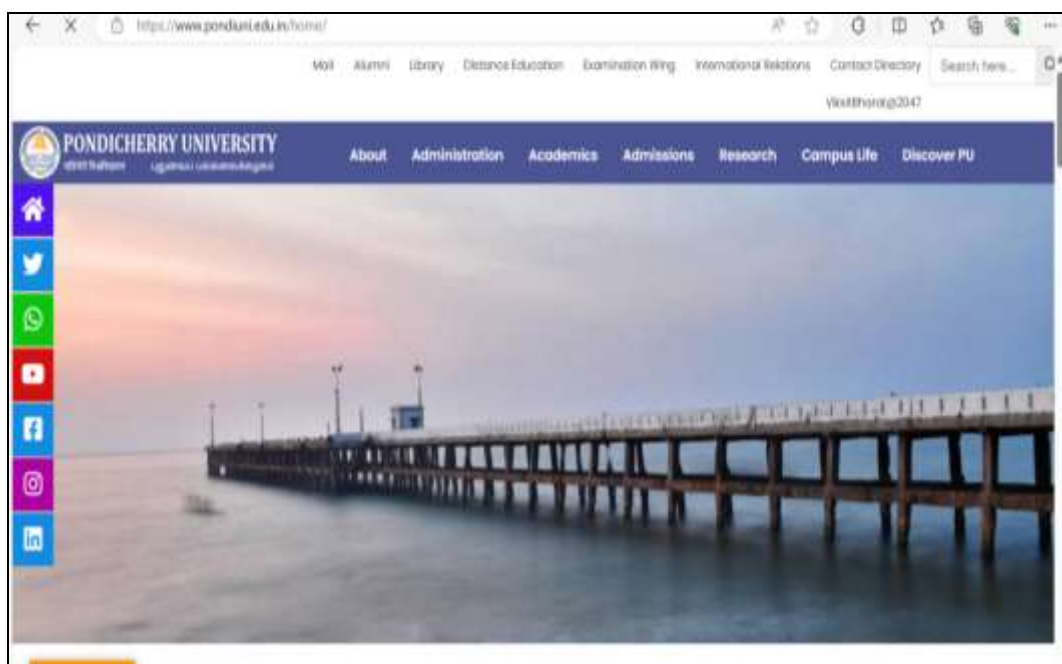


**Figure 5.15: Homepage of North-Eastern Hill University Official Website**

(Source: <https://www.nehu.ac.in/>)

#### **5.5.11. Pondicherry University**

Pondicherry University is a well-known central university established in the year 1985 under the Act of Parliament Department of Higher Education, Ministry of Education, GOI, which is situated in Kalapet in Union Territory of India. The offers courses from UG, PG, Diploma to doctorate programmes in 14 schools like Engineering, Applied science, Life science, Mathematics, Humanities, Social science etc, with 52 departments. The university has more than 4,804 students from different parts of the world and has 200 affiliated colleges. The university aims to creating a benchmark by endorsing excellence in the learning process maintaining standard teaching, education and research environment. The university's prime vision is to add value to the human society enriched with better infrastructure and technological facility. Comprising facilities like a library with advanced infrastructure, Wi-Fi, remote access, RFID facilities with more than 4.97 lakh resources. The university has achieved to rank 68<sup>th</sup> in NIRF ranking 2022 under 'university' category and also accredited 'A' grade by NAAC.



**Figure 5.16: Homepage of Pondicherry University Official Website**

(Source: <https://www.pondiuni.edu.in/>)

#### **5.5.12. Mizoram University**

Mizoram University is a prestigious central university established in July, 2001 under the Act of Parliament which is located in the capital city of Mizoram, India. It is one of the first university to be based on eco-friendly environment which runs on Solar Power system. Mizoram university succeeded to bag 1<sup>st</sup> rank in the North-East region according to Times Higher Education Impact Rankings 2022, 76<sup>th</sup> position in NIRF 2023 under ‘universities’ category and received ‘A’ grade by NAAC in 2014 & 2019. The Mizoram university has also been awarded ‘A’ grade in the year 2013 by the Mizoram State Pollution Control Board while Green Audit conduction of the University campus. The university various courses offered from vocational, UG, PG to doctorate programmes along with facilities for students with disabled and Visually Challenged, also have their own academic journals from different departments. The university have total nine schools like Social Sciences, Fine Arts, Planning & Architecture, Medical & Paramedical Sciences, Education, Engineering & Technology, Humanities & languages, SEMIS, and Earth Sciences & Natural Resources Management with forty departments. Provides dynamic facilities like Wi-Fi, central library, e-journals, natural history museum, hostels,

advanced laboratories, DBT BioNEST Incubator, DRDO industry academia- centre of Excellence, Guest House, etc. The university consist of total 40 affiliated institutes in different parts of the state.



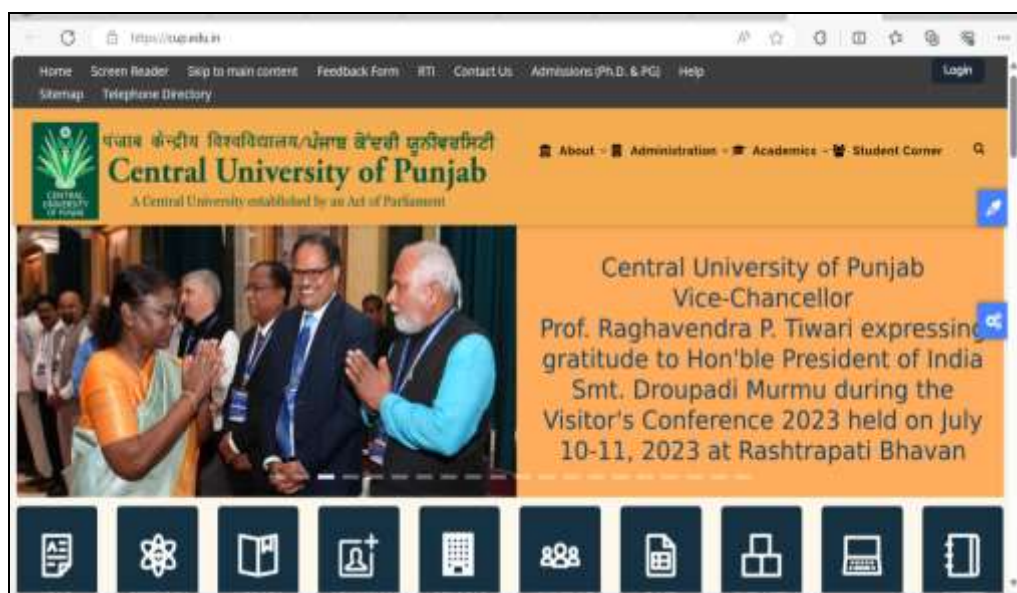
**Figure 5.17: Homepage of Mizoram University Official Website**

(Source: <https://mzu.edu.in/>)

### 5.5.13. Central University of Punjab

Central University of Punjab is a central university established in the year 2009 under the Act of Parliament situated in Bathinda, Punjab, India. The university have a very eco-friendly campus and aims to provide advance research facilities, innovative teaching and learning in the academia in order to fulfil the needs of regional, national and global community. The university also received ‘A+’ by NAAC in the year 2003 and has secured 81<sup>th</sup> rank in 2022 under ‘university’ category in the NIRF 2023. The university offers courses like PG and doctorate programmes in 11 schools of Science, Technology, Humanities, Social Sciences, Education and Law with 31 departments. Students and staffs from different parts of the world are also engaging with the university with a curriculum specifical focusing on skill development entrepreneurship and quality research. The university is also engaged with different big projects and publications with other new central universities. The university is equipped with multi facilities like a central library with large number of resources, sufficient hostels, Sports complex for different

indoor & outdoor games, technology-based laboratories for multipurpose, WiFi, health care, expansive cafeteria and Gym.



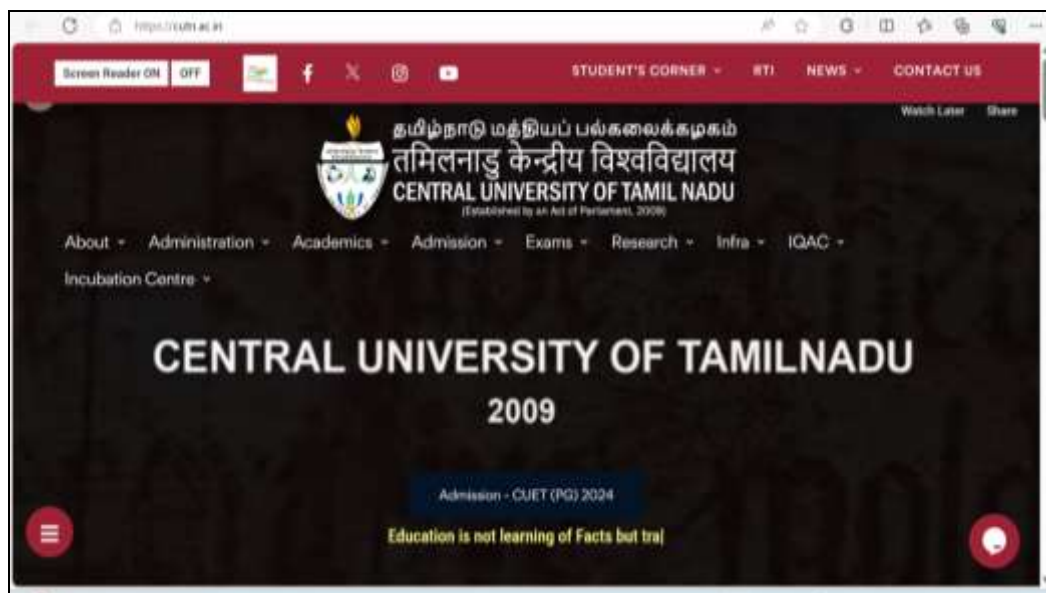
**Figure 5.18: Homepage of Central University of Punjab Official Website**

(Source: <https://cup.edu.in/>)

#### **5.5.14. Central University of Tamil Nadu**

Central University of Tamil Nadu (CUTN) which is considered as a hub of academic excellence established in the year 2009 under the Act of Parliament situated in Thiruvavur, Tamil Nadu, India. The prime aim of CUTN is to enhance the people of knowledge society for bringing prosperity among individuals, regional, national and global by promoting knowledge, innovation and education. The university offers 64 academic courses with 29 research courses, 22 specialized programmes, different PG diploma programmes, 6 integrated courses and two UG courses in 13 schools and 28 functioning departments. The university is engaged with some excellent collaboration with other well-known institutions for global visibility in research and academics. The university facilitates a central library with large number of resources, guest house, health care centre, hostels for students, Quarters for its staff members, Gym, well infrastructure-based conference hall, multipurpose hall, media studio, theatre. Wifi, Yoga centre, Sports complex for various games. The University is surrounded with green environment and functioning of Drip Irrigation system, integrated farming, children's park, mini

forest, recharge ponds, tree plantation, Sewage water treatment plant with immense tree plantation. CUTN has succeeded to rank 85<sup>th</sup> in 2022 and 89<sup>th</sup> position in NIRF 2023.

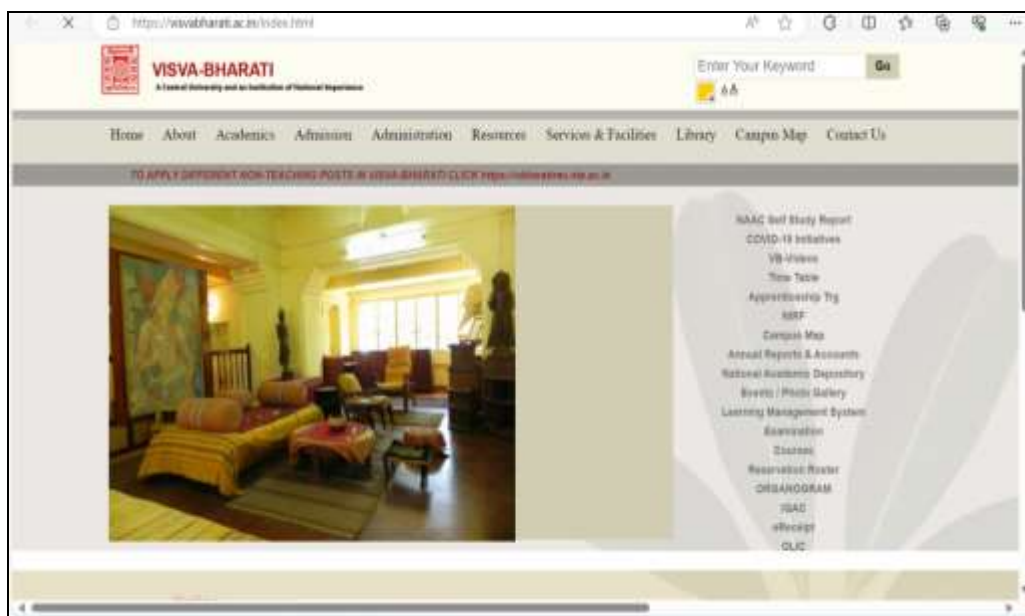


**Figure 5.19: Homepage of Central University of Tamil Nadu Official Website**  
(Source: <https://cutn.ac.in/>)

#### 5.5.15. Visva Bharati University

Visva Bharati University is a public central university founded by Rabindranath Tagore in 1921 and declared as an institution of national importance in 1951 by an Act of Parliament. The name visva-bharati means unity of the world with India as addressed by Rabindranath Tagore. The university is 102 years older located in Shantiniketan, West Bengal, India, which have more than 9,600 students with 466 staff members around the world. The university have multiple centres, department and schools which are divided into institutes of Fine arts, Dance, drama & music, Chinese language and culture, rural reconstruction, Tagore studies & research, Science, Humanities etc. The university offers courses like undergraduate, post graduates, certificate courses and diploma programmes. The programmes are based on its vibrant cultural heritage of arts and dance education which is funded by Department of Science and Technology (DST). The university has secured 69<sup>th</sup> position in ‘overall’ and 98<sup>th</sup> among ‘universities’ category in NIRF 2022. The university facilitates a central library with large collections and e-journal,

computing and learning centre, transportation, placement cell, sports board, cafeteria, information for students, student welfare, guest house and museums.



**Figure 5.20: Homepage of Visva Bharati University Official Website**

(Source: <https://www.visvabharati.ac.in/>)

#### **5.5.16. Assam University**

Assam University is a central university established in the year 1994 situated in Silchar, Assam while the other campus is in Diphu in the district of Karbi Anglong, Assam, India. The university offers different courses from Undergraduate, Postgraduate to Doctorate programmes in sixteen schools different disciplines like Physical Sciences, Science, Language, Humanities, Environmental Sciences, Management etc with 42 departments. There are 73 affiliated undergraduate colleges under Assam university. The university facilitates several i-apps of File monitoring system, electronic billing system and Grievance redressal system. The university have different cells and centres on computer centre, career counselling facility, health care centre, incubation centre, sports, NSS cell, remedial and NET coaching centre, skill hub and Bioinformatics centre. Assam University has more than 4,364 students from different parts of the world which has ranked 93<sup>rd</sup> and 101 position in NIRF 2021 and 2023 under 'university' category. The prime aim of the university is to increase the Gross Enrolment Ratio (GER) and provide equal

opportunity to its students despite any bias or discrimination based on race, gender, caste or linguistic barrier. The university provides amenities like a central library with more than 147000 physical resources and 12000 e-resources with fully functional Wi-Fi, hostels for its students, playground for sports, specialised laboratories and transportation services.



**Figure 5.21: Homepage of Assam University Official Website**

(Source: <http://www.aus.ac.in/>)

#### **5.5.17. Central University of Kerala**

Central University of Kerala is established in the year 2009 under the Central universities Act situated in Kasaragod, Kerala, India. The mission of the university is expanding the boundaries of knowledge through creativity and encourage the students in critical thinking to understand real life situations. The university offers undergraduate, postgraduate courses and doctorate programmes with 12 schools like Science, Social science, Business studies, cultural studies, education, economics, legal studies, Medicine etc and 29 departments. The university provides facilities like scholarships, hostel, library with a huge collection of resources, transportation, ICT wings, health care, Creche, student cell, museum, guest house and National Academic Depository (NAD). The university ranked 151 positions in NIRF 2022 in 'overall category'. Campus of the university is filled with vibrant

clubs and societies. The university has made MOU with some well-known academic and specialized institutes like Central Institute of Brackishwater Aquaculture, Aquaculture Development Cooperative Society, Indian Institute of Public Health, Gandhi Nagar, Institute of Applied Mathematical Research, Karelian Research Centre of Russian Academy of Sciences (IAMR), MiklensBio Pvt Limited, The North Malabar Chamber of Commerce, National Institute of Disaster Management (NIDM) etc. The university is engaging with many projects funded by ICSSR, CSIR, UGC, BRNS etc.



**Figure 5.22: Homepage of Central University of Kerala Official Website**

(Source: <https://www.cukerala.ac.in/>)

#### **5.5.18. English & Foreign Languages University**

English & Foreign Languages University (EFLU) is a well-known central university located in Hyderabad specially dedicated to South Asian languages established in the year 1958. EFLU was formerly known as Central Institute of English and Foreign Language. It has three campuses; the main campus is in Hyderabad and the regional campuses are in Shillong and Lucknow. The prime aim of the university is to offering advance knowledge and research through skill-based training, education and research in its specialized disciplines. IFLU offers its programmes in have total 7 schools and 26 departments. The university offers higher studies in different foreign languages such as Russian, Japanese,

Korean, Persian, Turkish, Arabic, Chinese, French, German, Spanish, Italian, English, Education, Literature, Linguistics, Interdisciplinary and Cultural Studies. EFLU offers courses from Undergraduate, post-graduate, B.Ed. and doctorate programmes. Provides various facilities like health care, counselling centre, guest house, cultural cell, equal opportunities cell, student welfare, placement cell, library etc. For more collaborative projects and opportunities the university have made MOUs with some well-known institutions across the world like Royal University of Bhutan, University of Paul-Valery Montpellier-3, France, University of Vechta, Germany, University for Foreigners of Perugia, Italy, University of Delgi Studi Di Torino, Italy, Universidad Autonoma de Sinaloa, Mexico Slavik University, Kishinev/Chisinau, Republic of Moldova, etc.



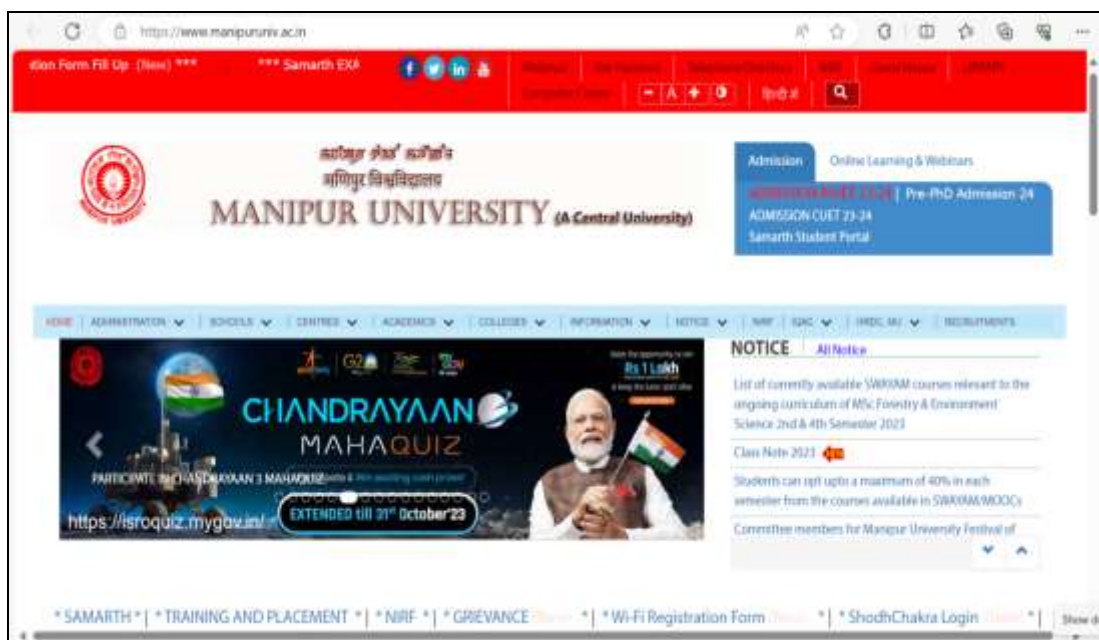
**Figure 5.23: Homepage of English & Foreign Languages University Official Website**

(Source: <https://www.efluniversity.ac.in/>)

### 5.5.19. Manipur University

Manipur University is a prestigious central university established in the year 1980 by Manipur University Act which is located in Imphal, Manipur, India. The prime

aim of the university is to promote innovation in teaching and learning process and to encourage people for the well-being of the own region as well as the country. The university consist more than 5, 265 students and 370 academic staffs with 119 affiliated colleges including 2 medical colleges. The university offers various UG, Pg and doctorate courses in 9 schools, 44 departments and 8 centres in different subjects like Humanities, Education, Life Science, Physical science, Engineering, Social Science etc. Centres like Educational Multimedia Research Centre, Centre for development studies Centre for Manipur Studies, etc. The university has made MOUs with different prestigious institutions across the globe for better collaboration opportunities. The university is in the top 200 universities in the country and accredited ‘A’ grade by NAAC. The facilities in the university includes Earthquake detecting system, Landslide monitoring in the North Eastern states, a central library with more than 1,90,463 physical collections and more than 6,161 e resources with subscription to many peer reviewed journals, a computer centre, university museum, language and phonetics laboratory, banks, healthcare, guest house, hostels for students, transportation, special cell for Scheduled Castes, Scheduled Tribes and Other Backward Classes students etc.



**Figure 5.24: Homepage of Manipur University Official Website**

(Source: <https://www.manipuruniv.ac.in/>)

## References

- Aligarh Muslim University. (2024). <https://www.amu.ac.in/>
- Assam University. (2024). <http://www.aus.ac.in/>
- Banaras Hindu University. (2024). [https://www.bhu.ac.in/Site/Home/1\\_2\\_16\\_Main-Site](https://www.bhu.ac.in/Site/Home/1_2_16_Main-Site)
- Bass, R. V., & Good, J. W. (2004). Educare and Educere: Is a Balance Possible in the Educational System? *The Educational Forum*, 68(2), 161–168. <https://doi.org/10.1080/00131720408984623>
- Central University of Jammu. (2024). <https://www.cujammu.ac.in/>
- Central University of Kashmir. (2024). <https://web.cukashmir.in/#/publiczone>
- Central University of Kerala. (2024). <https://www.cukerala.ac.in/>
- Central University of Punjab. (2024). <https://cup.edu.in/>
- Central University of Tamil Nadu. (2024). <https://cutn.ac.in/>
- Department of Higher Education (DHE). (2016). *State private universities*. Government of India, Ministry of Education. <https://www.education.gov.in/>
- English & Foreign Languages University. (2024). <https://www.efluniversity.ac.in/>
- Gupta, A. (2021). Focus on quality in higher education in India. *Indian Journal of Public Administration*, 67(1), 54-70. <https://doi.org/10.1177/00195561211007224>
- Jamia Millia Islamia. (2024). <https://jmi.ac.in/>
- Jawaharlal Nehru University. (2024). <https://www.jnu.ac.in/main/>
- Maity, A. K. & Maity, S., (2016) Evolution of higher education in India, *International Journal of Advanced Education and Research*, 1(10) 56-59.
- Manipur University. (2024). <https://www.manipuruniv.ac.in/>
- Marisha, N., Banshal, S. K., & Singh, V. K. (2017). Research performance of central universities in India. *Current Science*, 112(11), 2198. <https://doi.org/10.18520/cs/v112/i11/2198-2207>
- Ministry of Education (MoE). (2024). *Ministry of Education*. <https://www.education.gov.in/>
- Mizoram University. (2024). <https://mzu.edu.in/>
- NAAC (2024). National Assessment and Accreditation Council (NAAC) <http://naac.gov.in/index.php/en/>
- National Institutional Ranking Framework (NIRF). (2024). *National Institutional Ranking Framework: Parameters*. Ministry of Education. <https://www.nirfindia.org/>
- Nigavekar, A. (2003). *Higher education in India: Issues, concerns and new directions*. University Grants Commission. <https://www.ugc.ac.in/oldpdf/pub/he/heindia.pdf>
- North-Eastern Hill University. (2024). <https://www.nehu.ac.in/>

Panneerselvam, P. (2017). Scholarly Publications of Central Universities: Study based on Indian Citation Index. *Journal of Library & Information Science*, 7(3).

Pondicherry University. (2024). <https://www.pondiuni.edu.in/>

Sheikh, Y. A., (2017) Higher Education in India: Challenges and Opportunities. *Journal of Education and Practice*, 8(1), 39-42

Tezpur University. (2024). <http://www.tezu.ernet.in/>

University Grants Commission. (2024). *Consolidated list of all universities*. <https://www.ugc.ac.in/>

University of Delhi. (2024). <https://www.du.ac.in/>

University of Hyderabad. (2024). <https://uohyd.ac.in/>

Visva Bharati University. (2024). <https://www.visvabharati.ac.in/>

# **CHAPTER 6**

## **Data Analysis and Interpretation**

## **6.1. Introduction**

The word Data can be in various forms such as characters, numbers, images, or other formats, and can be analyzed to make decisions regarding a specific action (Alem, 2020). Moreover, data analysis is simply a process of making the complex or unstructured data into meaningful information (Taherdoost, 2020). It is the most important part of a research study, as it validates the findings and ensures the reliability of the results. Data analysis involves transforming a large set of raw data into a simpler, more understandable form through various statistical methods and tools. Its primary purpose is to scrutinize the raw data and draw conclusions from it (Bhatia, 2017). Therefore, it is essential to organize data prior to analysis. This process involves breaking down existing complexities into simpler components and then reassembling them for meaningful interpretation. Data analysis and interpretation involve illustrating the investigation carried out with the aim of obtaining answers to the research questions. According to Ibrahim (2015), the process of data analysis involves several key steps, including classification and tabulation, graphical representation, measures of central tendency and variability, analysis of relationships, estimation of unknown values, and hypothesis testing.

## **6.2. Data Analysis and Interpretation**

This chapter outlines the process of data collection, comprehensive assessment, and application of various analytical tools to examine, analyze, and interpret the results with reference to the stated objectives and hypotheses. The present study has unveiled several meaningful insights that will contribute to a deeper understanding of Open Access within the context of scholarly communication in India. The data has been collected using Scopus database as shown in table 6.1. This chapter will show the growth trend, prolific sources, collaboration, citation, and different dimensions of open access by the leading central universities of India.

**Table 6.1: Framework of Data Analysis**

| <b>Objectives</b>                                                                                                                                                                                                                         | <b>Parameter</b>                                                                                                                                                                                     | <b>Tools used</b>                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| <b><i>Objective 1</i></b><br>To assess the year-wise growth of open access (OA) publications between 2005 to 2024 and forecast the future growth of research of the selected central universities of India.                               | -Growth of Open Access publications and forecast for the next two years.                                                                                                                             | -MS Excel                                         |
| <b><i>Objective 2</i></b><br>To analyze the subject-wise distribution, social, intellectual and conceptual structures of OA publications trends by collaboration of authors and countries, citation impact, and key words analysis.       | -Subject-wise distribution of OA publications.<br>-Growth pattern of citation count.<br>-Top ten influential papers<br>-Collaboration of authors<br>-Collaboration of countries<br>-Keyword analysis | -MS Excel<br>-<br>VOSviewer<br>-Tableau<br>-Gephi |
| <b><i>Objective 3</i></b><br>To measure the open access friendliness of the publications of central universities based on OA compatibility parameters (Designed & Developed by Mukhopadhyay, 2022) and open access collaboration pattern. | -Distribution of OA routes<br>-Yearwise growth of respective OA routes<br>-Distribution of OA licences<br>-Open Access Friendliness framework                                                        | -MS Excel<br>-Unpaywall<br>-<br>OpenRefine        |
| <b><i>Objective 4</i></b><br>To compare the open access publications trends in sciences, Social Sciences and Arts & Humanities                                                                                                            | -Distribution of OA publication based on in sciences, Social                                                                                                                                         | -MS Excel<br>-Tableau                             |

|                                                                                                                                  |                                                 |                                  |
|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------------------|
| Domain.                                                                                                                          | Sciences and Arts & Humanities Domain.          |                                  |
| <b>Objective 5</b><br>To find out the gender ratio of the Open Access publications of the selected central universities of India | - Gender identification of authors.             | -MS Excel<br>-Tableau<br>-Namsor |
| <b>Objective 6</b><br>To rank the central universities based on the number of Open Access publications.                          | - Top universities with maximum OA publications | -MS Excel<br>-Tableau            |

### 6.3. Research Growth and Science Mapping

The first two objectives (*Objective 1 and Objective 2*) will be dealing with the tracing of research growth and science mapping of the Open Access publications by the selected Indian central universities. Research Growth Analysis refers to the quantitative assessment of the growth in the number of research publications over a specific period of time. It involves tracing the year-wise distribution of publications to understand growth patterns, and often includes forecasting future publication trends using statistical tools. Science Mapping also known as scientographs which generates network visualizations exploring the structural and dynamic aspects of scientific research. Science mapping is widely used in bibliometrics and Scientometrics for quantitative studies of science (Chen, 2017). It involves analyzing subject distributions, collaboration networks, citation patterns, and conceptual frameworks to understand the existing intellectual and social interconnections. To measure the impact of OA research publications, citation counts have been considered to understand the influence and significance of it. It evaluates how widely research publications are recognized, cited, or discussed within the scholarly community. Social Structure Analysis examines the collaborative relationships among authors, institutions, and countries involved in research. It maps how researchers are connected through co-authorships indicating the patterns of collaboration in the field. Intellectual Structure Analysis identifies the foundational and influential works, authors, and journals within a field based on citation patterns

(Simao et al., 2020). It examines and reveals how knowledge is constructed and key ideas evolve over time. Conceptual Structure Analysis assess the major emerging themes, topics, and concepts in a particular research domain. It often uses keyword co-occurrences and clustering techniques to present the thematic organization to provide a deeper insight into the scientific landscape (Aria et al., 2024).

### **6.3.1. Overall Year-wise Growth of OA Publications**

Assessing year-wise growth helps in understanding the evolving significance of a subject area. Figure 6.1 and table 6.2 illustrates the growth trend of open access (OA) publications across selected Indian central universities over two decades (2005–2024), along with a forecast for 2025 and 2026. The number of OA publications has risen significantly from 326 in 2005 to 3,418 in 2024. During the early years of the OA movement, it is observed that the number of OA publications were gradually growing where only 326 publications were recorded in 2004, increasing to 1,669 by 2013. From 2014, however, a slight decline has been occurred with dropping to 1,663 and then 1,421 papers in 2015. This was followed by a sharp recovery in 2016 (2,069 publications) and a steady upward trend through 2022, peaking at 4,885 publications. A significant growth in OA publications over the past two decades was observed, with accelerated growth between 2019 and 2022, likely due to the pandemic surge and the emerging importance of OA research dissemination. However, the post-pandemic period witnessed a decline in OA research, with the number of publications dropping to 4,771 in 2023 and 3,418 in 2024. The forecast for the years 2025 and 2026 shows a steady rise in publication numbers, with 3,654 and 3,891 expected, respectively. Despite recent fluctuations, the blue bars in the graph suggest continued growth though at a more moderate pace compared to the sharp surge witnessed between 2019 and 2022. This ongoing upward trend highlights the growing commitment of Indian central universities to open access research and the broader goal of knowledge sharing. Several factors may have contributed to the slight fluctuations in the growth pattern of OA publications. These include inconsistent funding, limited institutional policies supporting OA, low researcher awareness, and a preference for high-impact subscription-based journals. Additional challenges such as article processing charges (APCs), inadequate incentives, and

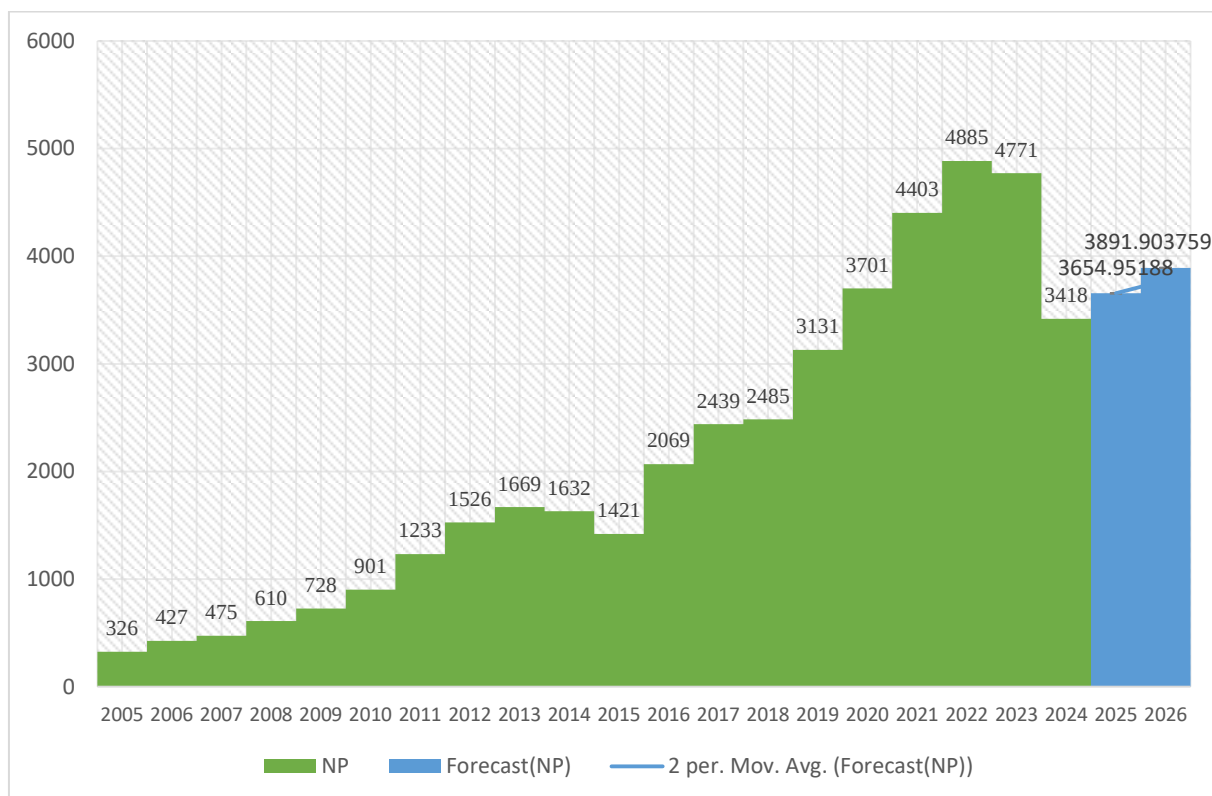
variability in national and institutional OA mandates have likely influenced these trends. Moreover, shifts in global publishing practices and research funding priorities may have further impacted the trajectory of OA publication growth in India.

**Table 6.2: Overall Yearwise Growth of OA publications all the Selected Universities and Forecast the Growth**

| Year | NP   | Forecast(NP) |
|------|------|--------------|
| 2005 | 326  |              |
| 2006 | 427  |              |
| 2007 | 475  |              |
| 2008 | 610  |              |
| 2009 | 728  |              |
| 2010 | 901  |              |
| 2011 | 1233 |              |
| 2012 | 1526 |              |
| 2013 | 1669 |              |
| 2014 | 1632 |              |
| 2015 | 1421 |              |
| 2016 | 2069 |              |
| 2017 | 2439 |              |
| 2018 | 2485 |              |
| 2019 | 3131 |              |
| 2020 | 3701 |              |
| 2021 | 4403 |              |
| 2022 | 4885 |              |
| 2023 | 4771 |              |
| 2024 | 3418 |              |
| 2025 |      | 3654.95188   |
| 2026 |      | 3891.903759  |

*Note.* NP= Number of Publications

(Source: Table by Researcher)



Note. NP= Number of Publications

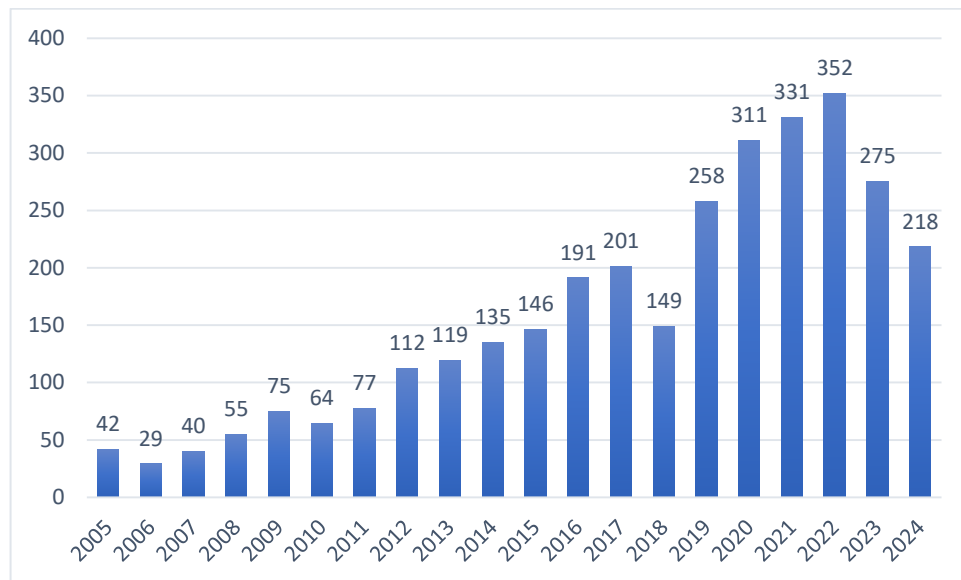
**Figure 6.1: Overall Yearwise Growth of OA Publications and Forecast the Growth**

(Source: Figure by Researcher)

### 6.3.2. Year-wise Growth of Jawaharlal Nehru University

Jawaharlal Nehru University (JNU), the top-ranked university among the 19 central universities under study, has recorded a total of 3,180 open access (OA) publications between 2005 and 2024. As illustrated in Figure 6.2, the year-wise growth of OA publications reveals a fluctuating yet overall upward trend until 2022. The number of publications increased from 42 papers in 2005 to 218 papers in 2024. Initially, the growth was slow, reaching 201 papers in 2017, but it decreased to 149 papers in 2018. A significant rise is observed from 2019 onwards, with a notable increase in output from 258 publications in 2019 to 352 in 2022. This growth aligns with the global momentum toward open access, particularly during the COVID-19 pandemic years when the need for rapid dissemination of research was paramount. However, a

declining trend is noted in the most recent years, with 275 publications in 2023 and 218 in 2024, possibly indicating shifts in publishing practices, funding constraints, or post-pandemic changes in research output. Overall, the data reflect JNU's strong engagement with open access publishing, despite some fluctuations in recent years.

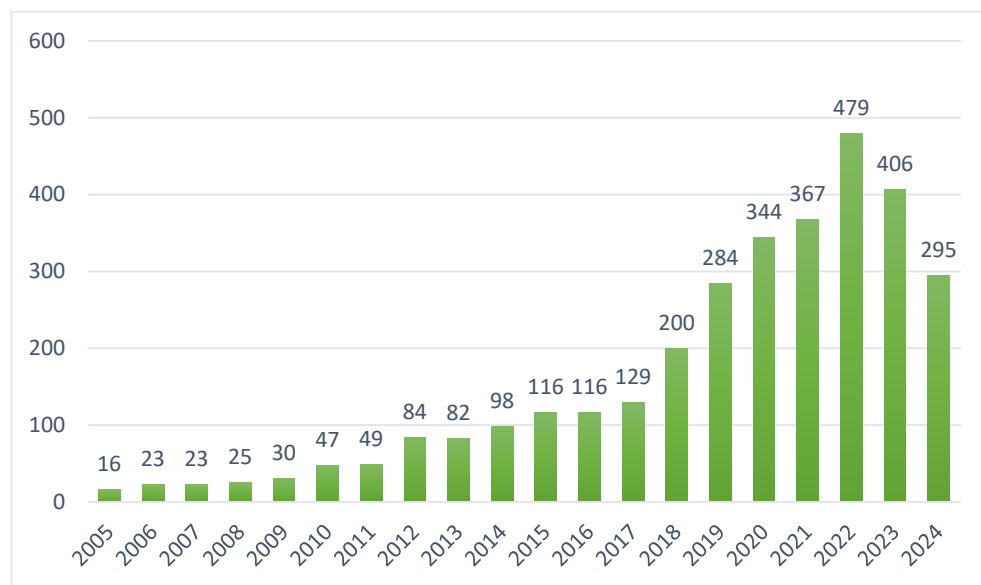


**Figure 6.2: Year-wise Growth of OA Publications of Jawaharlal Nehru University**

(Source: Figure by Researcher)

### 6.3.3. Year-wise growth of Jamia Milia Islamia

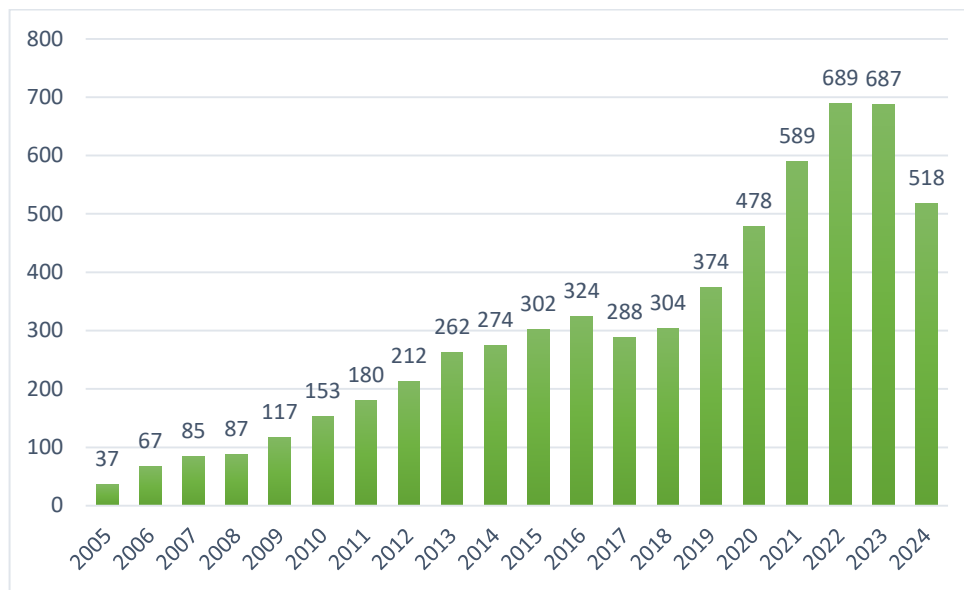
Figure 6.3 shows the year-wise growth of Open Access (OA) publications of Jamia Millia Islamia from 2005 to 2024. The graph indicates a gradual overall rise, followed by a decline in recent years. The university started with 16 publications in 2005, reaching a peak of 479 in 2022, before declining to 406 in 2023 and 295 in 2024. A significant flow is observed between 2019 and 2022, reaching at 479 publications in 2022, likely due to the increased demand for open dissemination of research during the pandemic years. This trend may reflect growing awareness and institutional support for open access. However, a decline in publication numbers is seen in 2023 (406) and 2024 (295), possibly representing a normalization after the peak period. Overall, the trend demonstrates strong growth in OA publishing, especially over the past decade.



**Figure 6.3: Year-wise Growth of OA Publications of Jamia Milia Islamia**  
(Source: Figure by Researcher)

#### 6.3.4. Year-wise Growth of Banaras Hindu University

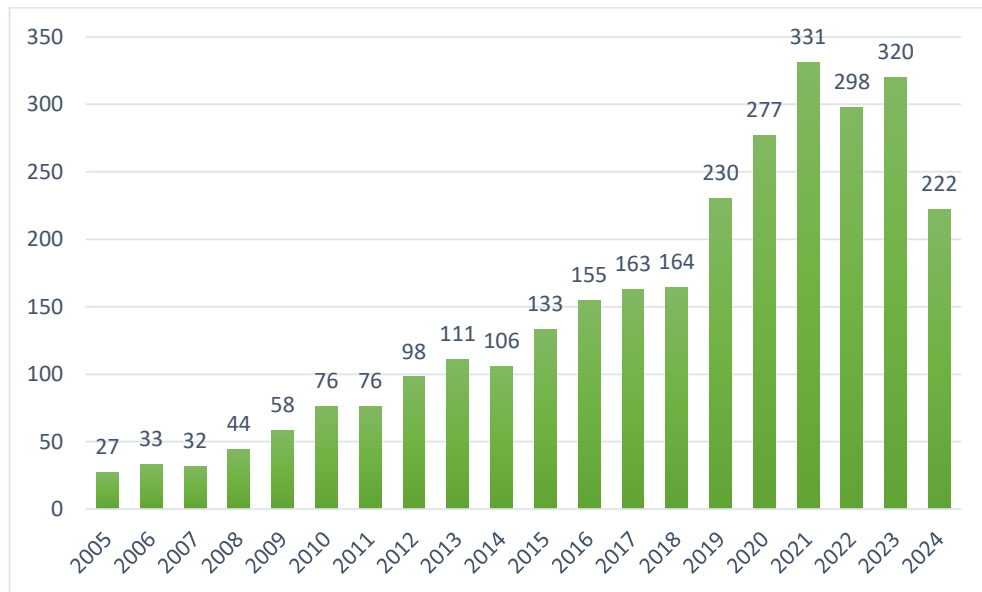
Figure 6.4 depicts the year-wise growth of Open Access (OA) publications from Banaras Hindu University (BHU), the oldest university among the 19 central universities selected for this study, between 2005 and 2024. The graph indicates an overall gradual increase in OA output throughout this period, with minimal decline in recent years. Starting with 37 papers in 2005, the number rose to 324 in 2016, reflecting a slow but steady adoption of open access. However, a slight decline was observed in the following year, with publications dropping to 288. A significant surge occurred between 2018 and 2022, reaching a peak of 689 publications in 2022, reflecting an increased emphasis on OA research. A minor decline followed in 2023 (687) and 2024 (518). Overall, the trend demonstrates substantial growth, particularly from 2018 onward, highlighting the university's expanding engagement with OA publishing. The fluctuations in the later years may suggest evolving institutional strategies or external factors affecting research output. The graph underscores a positive shift toward open-access research over the past decade.



**Figure 6.4: Year-wise Growth of OA Publications of Banaras Hindu University**  
(Source: Figure by Researcher)

### 6.3.5. Year-wise Growth of University of Hyderabad

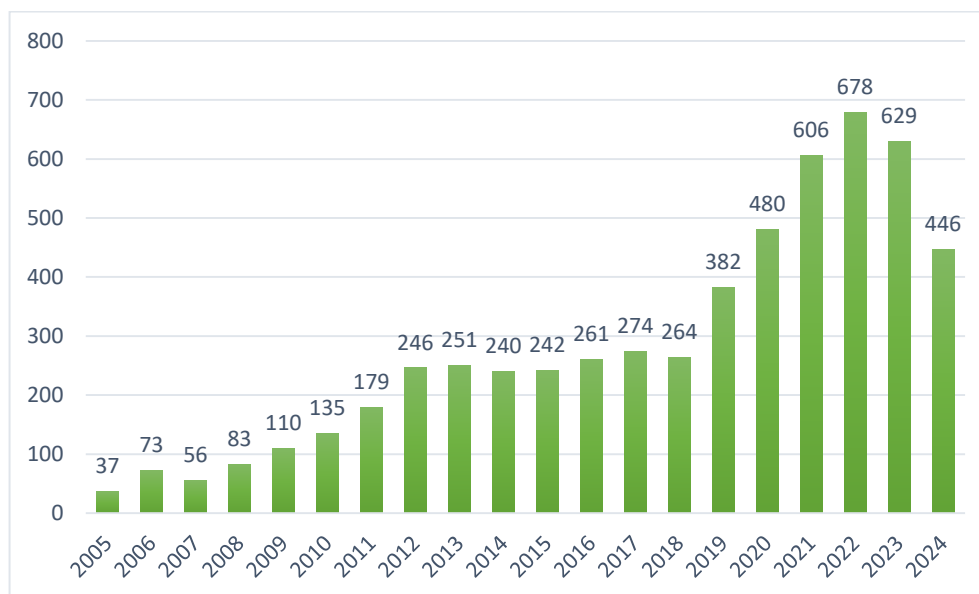
Figure 6.5 illustrates the year-wise growth of Open Access (OA) publications from the University of Hyderabad during 2005–2024. The graph shows growth with consistent fluctuations throughout the period, starting with 27 publications in 2005 and 222 in 2024. The number of publications increased steadily until 2018, reaching 164 papers. A significant rise is observed from 2019 to 2021, likely due to the pandemic surge, indicating a growing emphasis on OA dissemination. However, a noticeable decline occurs after 2022, with publication output falling to 222 in 2024. This downturn may be attributed to post-pandemic normalization of research activities, reduced external funding or collaborations, shifting institutional priorities, or delays in publication processes. Despite the recent decline, the overall trend reflects a strong and sustained commitment to Open Access publishing, with relatively moderate fluctuations over the past two decades.



**Figure 6.5: Year-wise Growth of OA Publications of University of Hyderabad**  
(Source: Figure by Researcher)

#### 6.3.6. Year-wise Growth of Aligarh Muslim University

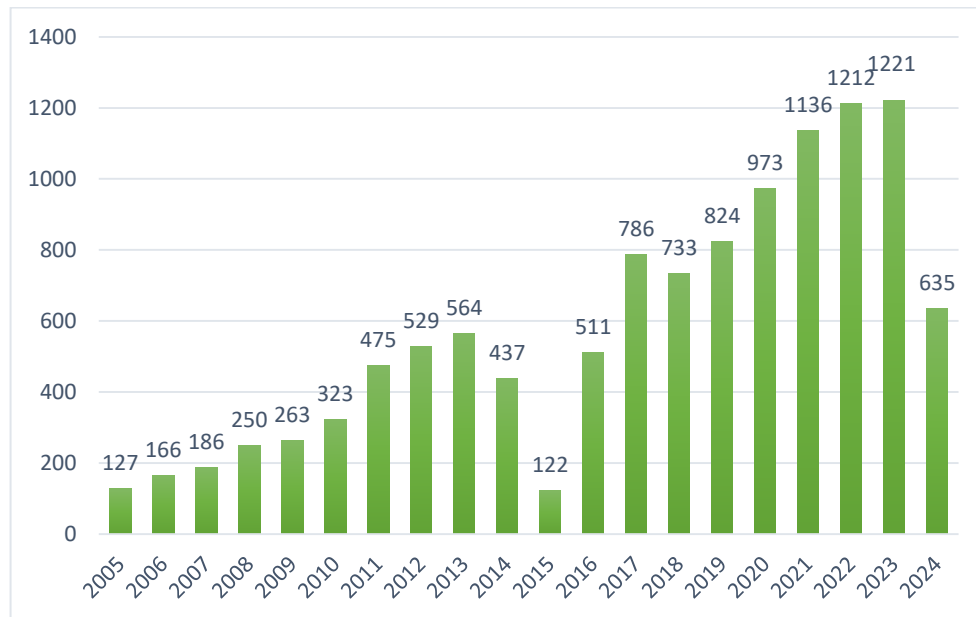
Figure 6.6 illustrates the year-wise growth of Open Access (OA) publications from Aligarh Muslim University (AMU), one of the oldest and most prestigious universities in India. The data show a steady increase from 2005 to 2010, starting with 37 publications in 2005 and reaching 179 by 2012. From 2013 onwards, the number of publications continued to rise gradually, reaching 364 papers by 2018. A notable surge is observed from 2019 onward, peaking at 678 publications in 2022 likely driven by the increased demand for rapid research dissemination during the COVID-19 pandemic. However, a decline is noted in the subsequent years, with 653 publications in 2023 and 462 in 2024, possibly indicating a post-pandemic normalization in research output. Despite recent fluctuations, the overall trend reflects AMU's growing engagement with Open Access publishing, consistent with its long-standing academic legacy.



**Figure 6.6: Year-wise Growth of OA Publications of Aligarh Muslim University**  
(Source: Figure by Researcher)

### 6.3.7. Year-wise Growth of University of Delhi

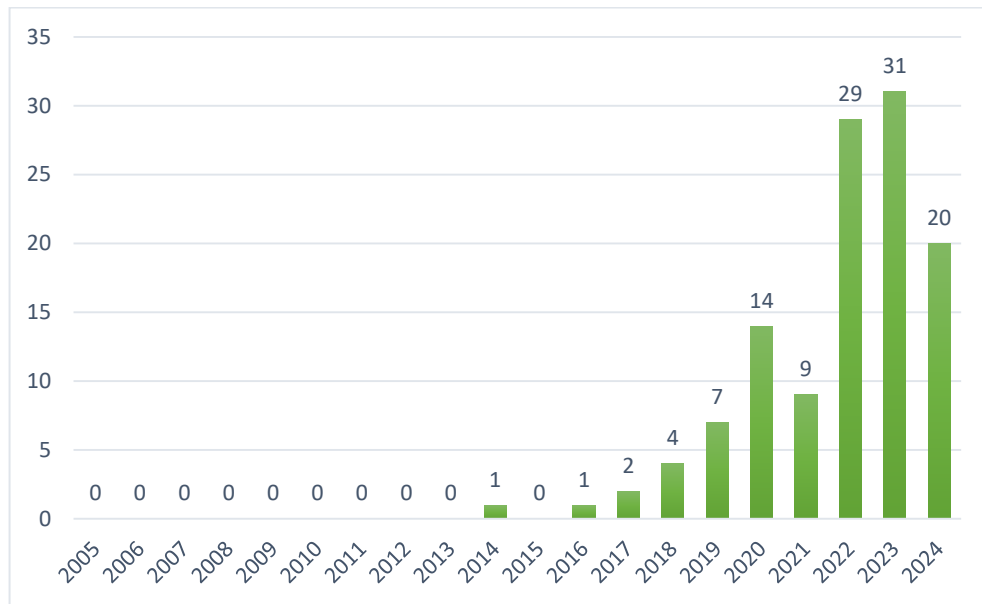
Figure 6.7 shows the year-wise growth of Open Access (OA) publications by the University of Delhi, which is one of the prestigious universities of India with highest number of OA publications (11,351) amongst all. The graph reflects a steadily growing trend in OA output over the two decades, though marked by several fluctuations. In the early phase (2005–2013), the university's OA publications increased slowly and gradually from 127 in 2005 to 564 in 2013. However, a noticeable decline has been observed in the year 2015 with the lowest number of OA papers (122). It significantly increased again with 511 papers in 2016 and gradually progressing till 2023. Moreover, the year 2024 witnessed a slight decline to 635 publications. Overall, the graph highlights a remarkable and consistent upward trend in the University of Delhi's open access publishing activities, especially post-2016, indicating a strategic shift toward greater openness and visibility in scholarly communication.



**Figure 6.7: Year-wise Growth of OA Publications of University of Delhi**  
(Source: Figure by Researcher)

### 6.3.8. Year-wise Growth of Central University of Kashmir

Figure 6.8 presents the year-wise growth of Open Access (OA) publications of the central university of Kashmir from 2005 to 2024. Although the university was established in the year 2009, so no OA publications were published until 2014. The period between 2009 and 2013 remained inactive in terms of OA output. The first and the only OA paper published was in 2014 followed by another single paper in 2016, indicating a slow initial adoption of the OA publishing model. A gradual rise began thereafter till 2020 with 14 publications, marking the beginning of significant OA practices. There was a slight dip in 2021 with 9 publications, possibly due to post-pandemic research delays, but this was followed by a remarkable surge in 2022 and 2023 with 29 and 31 publications respectively, the highest during the observed period. The slight decline to 20 in 2024 may be attributed to incomplete data for the year. Overall, the figure reflects the university's steadily growing commitment to open science and greater visibility of research, particularly in the post-2018 period, showing a clear trend toward embracing OA dissemination practices.

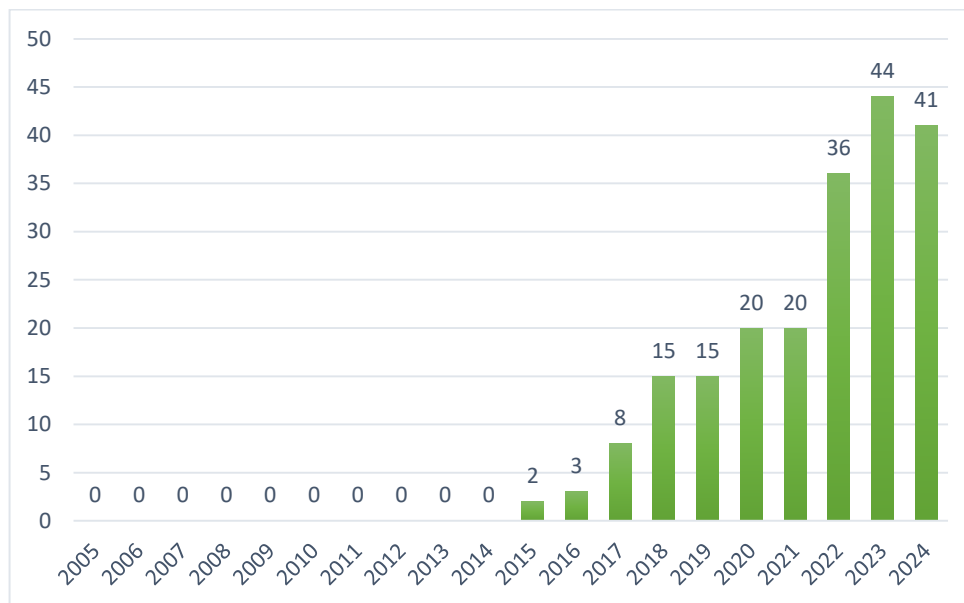


**Figure 6.8: Year-wise Growth of OA Publications of Central University of Kashmir**

(Source: Figure by Researcher)

### 6.3.9. Year-wise Growth of Central University of Jammu

Figure 6.9 illustrates the year-wise growth of Open Access (OA) publications of the Central University of Jammu from 2005 to 2024. Although the university was newly established in 2011, no OA publications were recorded in the initial years up to 2013. The university published its first two OA papers in 2015, followed by three in 2016, indicating a slow start in scholarly publishing. A noticeable gradual rise began in 2022 and 2023, with 36 and 44 publications respectively, showing growing research engagement. This upward momentum slightly declined to 41 publications in 2024. Overall, the trend clearly indicates the university's increasing focus on research visibility and open knowledge dissemination, particularly from 2017 onwards.

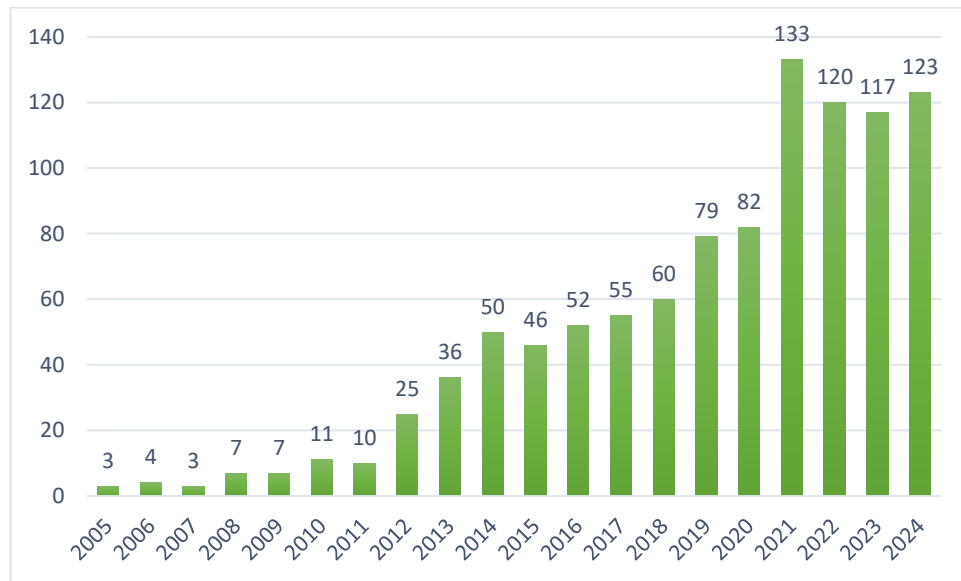


**Figure 6.9: Year-wise Growth of OA Publications of Central University of Jammu**

(Source: Figure by Researcher)

#### 6.3.10. Year-wise Growth of Tezpur University

Figure 6.10 illustrates the year-wise growth of Open Access (OA) publications of Tezpur University from 2005 to 2024. The university has demonstrated balanced growth in OA output over the years. With just 3 publications in 2005, the growth remained gradual until 2010, which recorded 11 publications followed by a slight drop to 10 papers in 2011. A noticeable rise in OA publications began in 2012 with 25 papers, increasing to 50 in 2014 before slightly declining to 46 in 2015. Subsequently, the output grew gradually, reaching a peak of 133 publications in 2021 reflecting heightened emphasis on research dissemination during the COVID-19 period. However, the following years 2022, 2023, and 2024 exhibited some fluctuation, with 120, 117, and 123 publications respectively. Despite these variations, the overall trend suggests a growing institutional focus on open science and enhanced accessibility of scholarly work.

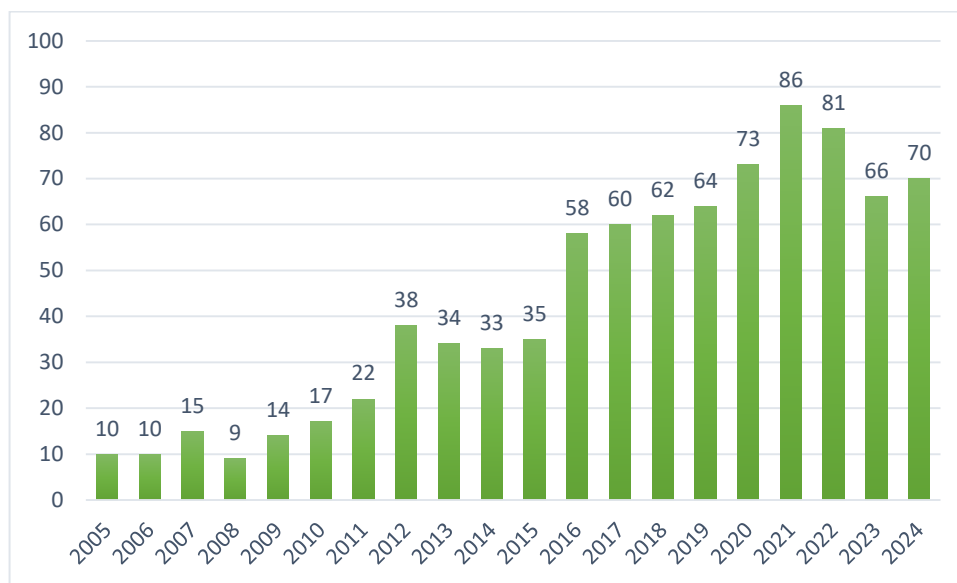


**Figure 6.10: Year-wise Growth of OA Publications of Tezpur University**

(Source: Figure by Researcher)

#### 6.3.11. Year-wise Growth of North Eastern Hill University

Figure 6.11 illustrates the year-wise growth of OA publications at North Eastern Hill University (NEHU) from 2005 to 2024. Over this 20-year period, NEHU's OA output exhibited a fluctuating growth pattern. The trend began with 10 OA publications in 2005. During the first decade, the highest number was recorded in 2012 with 38 publications, followed by a decline in subsequent years. In the second decade, a gradual rise resumed from 2015 onward, culminating in a peak of 86 OA publications in 2021 likely influenced by the COVID-19 pandemic. However, in the following years, the growth remained inconsistent, potentially due to various factors such as limited funding, fluctuating institutional priorities, or varying levels of researcher awareness.

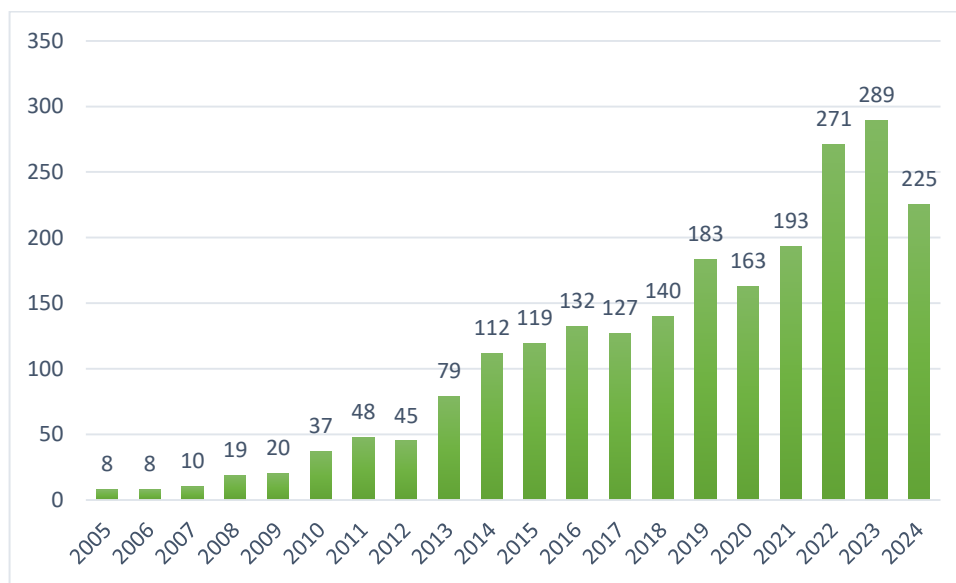


**Figure 6.11: Year-wise Growth of OA Publications of North Eastern Hill University**

(Source: Figure by Researcher)

### 6.3.12. Year-wise Growth of Pondicherry University

Figure 6.12 shows the year-wise growth of OA publications of Pondicherry University from 2005 to 2024. The university started with a modest number of 12 OA publications in 2005. A gradual increase is observed over the years, with a notable rise beginning in 2011. Significant growth occurred between 2014 and 2023, peaking in 2023 with 302 OA publications. The highest publication output during this period is likely influenced by the academic shift during and after the COVID-19 pandemic. However, in 2024, a decline is noted, with the total dropping to 240 publications. Overall, the trend indicates a steady and substantial increase in OA publication output over the two decades, despite some fluctuations.

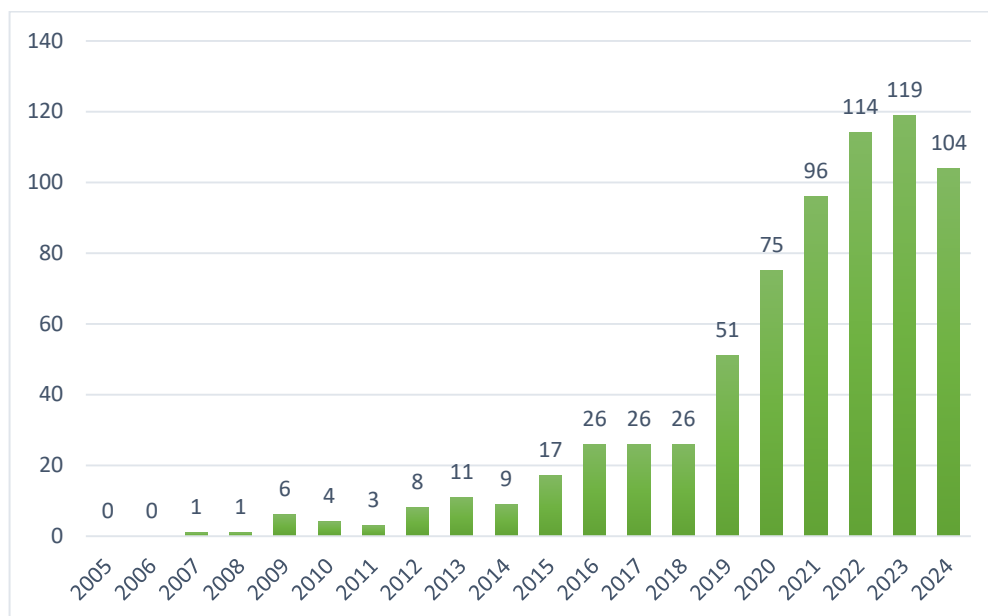


**Figure 6.12: Year-wise Growth of OA Publications of Pondicherry University**

(Source: Figure by Researcher)

### 6.3.13. Year-wise Growth of Mizoram University

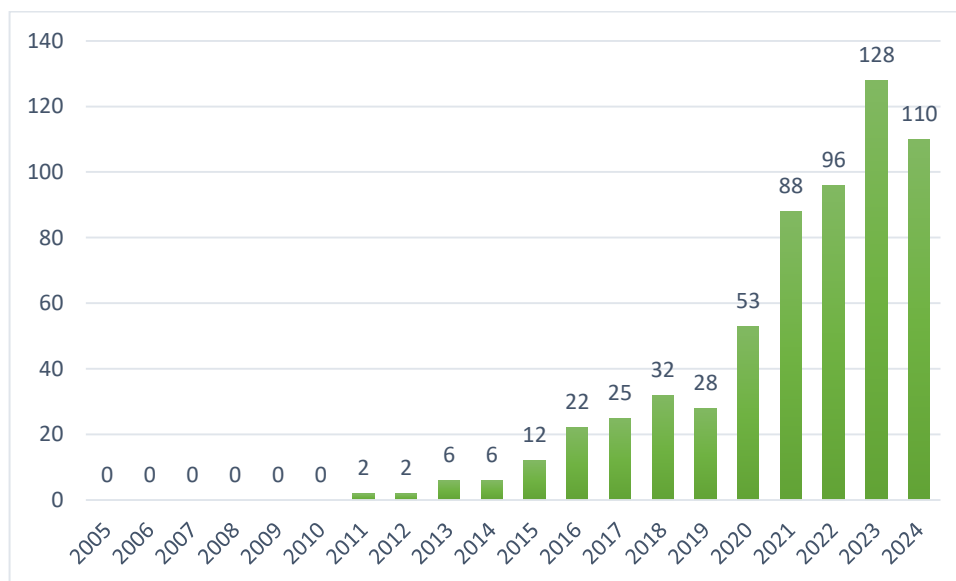
Figure 6.13 illustrates the year-wise growth of Open Access (OA) publications from Mizoram University between 2005 and 2024. Overall, the graph indicates a slow yet steady growth over the two decades, despite the university being relatively newly established in 2001. The university recorded its first OA publication in 2007, followed by gradual progress with slight fluctuations until 2016. From 2018 onwards, the number of OA publications began to rise significantly from 26 publications in 2018 to 119 OA papers in 2022, indicating the implementation of OA initiatives, possibly driven by policy changes or increased researcher participation. However, in the recent year, 2024, a decline in growth was observed. Despite periodic challenges, the graph underscores Mizoram University's increasing engagement with OA publishing.



**Figure 6.13: Year-wise Growth of OA Publications of Mizoram University**  
(Source: Figure by Researcher)

#### 6.3.14. Year-wise Growth of Central University of Punjab

Figure 6.14 shows the year-wise growth of open access (OA) publications of the Central University of Punjab from 2005 to 2024. Although the university was established in 2009, the first two OA papers were published in 2011, and the number gradually increased until 2018 with 32 papers. However, there was a decline in publications in 2019, followed by a significant rise in OA research, peaking in 2023 with 128 publications, the highest since its inception. In 2024, the number of OA contributions dropped to 110 publications. Overall, the growth of OA publications at this university is satisfactory, reflecting a steady initiative toward Open Access.

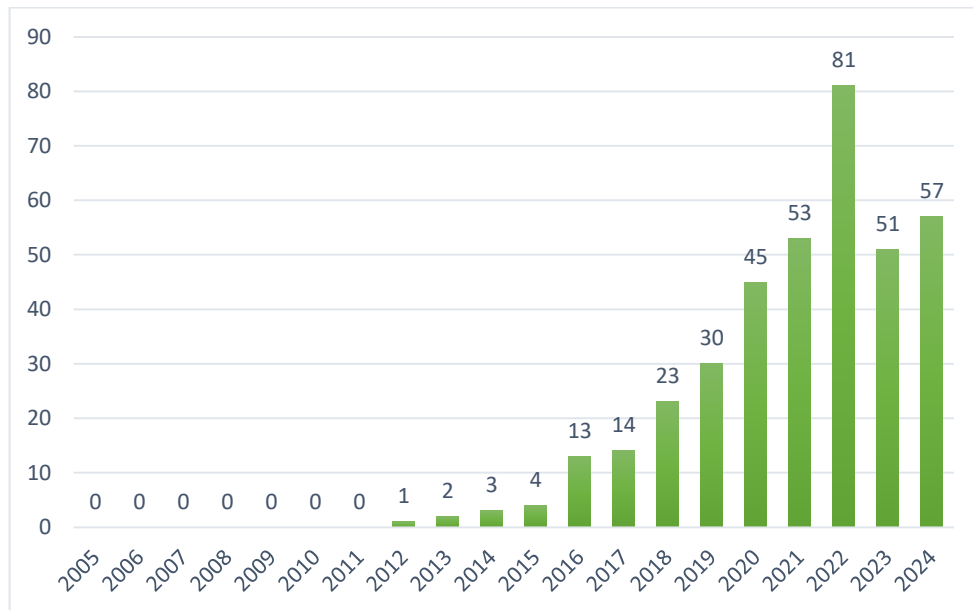


**Figure 6.14: Year-wise Growth of OA Publications of Central University of Punjab**

(Source: Figure by Researcher)

### 6.3.15. Year-wise Growth of Central University of Tamil Nadu

Figure 6.15 illustrates the year-wise growth of Open Access (OA) publications of the Central University of Tamil Nadu from 2005 to 2024. As the university was established in 2009, the first OA paper was published in 2012. Since then, a gradual increase was observed, with highest OA papers (81) in 2022. However, the number of OA publications dropped to 51 papers in 2023, before rising again to 57 papers in 2024. Overall, the growth of OA publications at the Central University of Tamil Nadu is quite remarkable, demonstrating consistent participation in OA research despite slight fluctuations in the final two years.

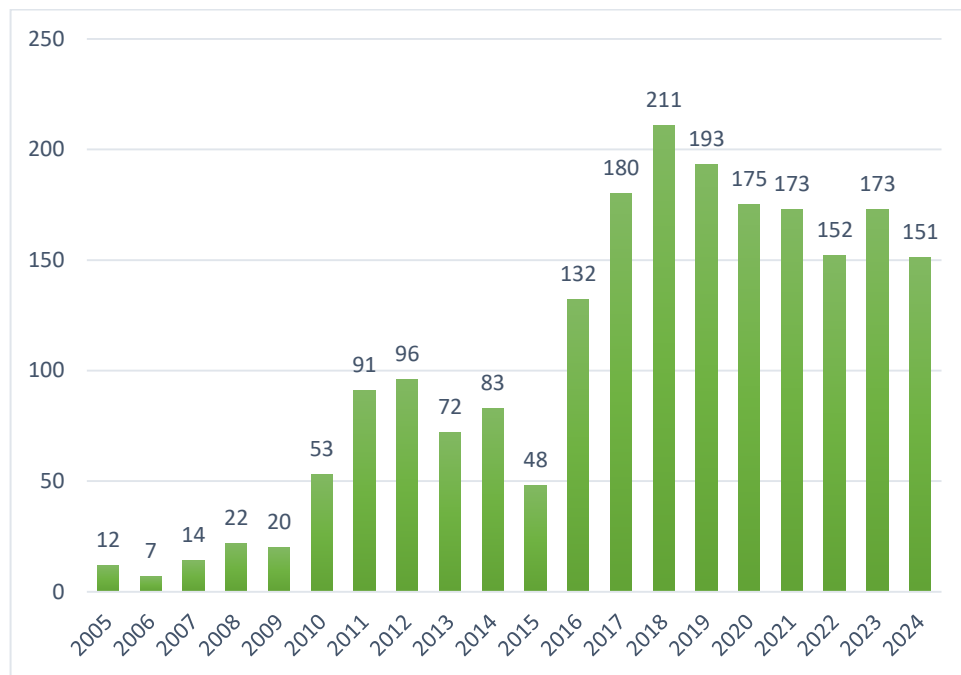


**Figure 6.15: Year-wise Growth of OA Publications of Central University of Tamil Nadu**

(Source: Figure by Researcher)

#### 6.3.16. Year-wise Growth of Visva-Bharati University

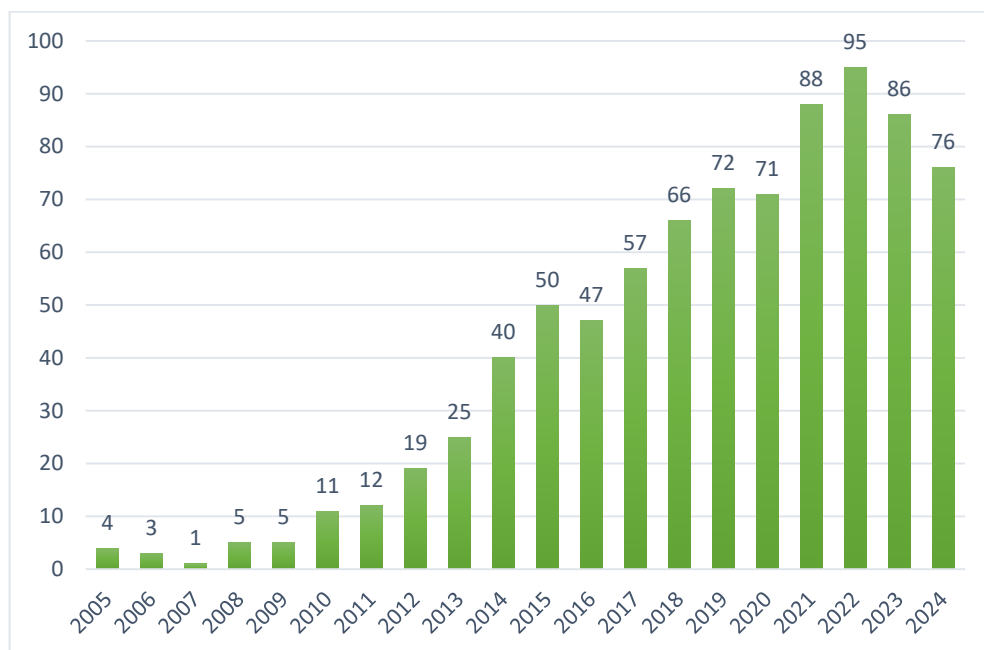
Figure 6.16 presents the year-wise growth of Open Access (OA) publications from Visva-Bharati University between 2005 and 2024. As one of the oldest central universities in the study, Visva-Bharati exhibits a fluctuating trend in OA publishing. The lowest number of OA publications was recorded in 2006, with 7 papers, while the highest was in 2018, with 211 publications. Between 2005 and 2009, OA output remained low, followed by a significant rise from 2010 to 2012, and then a decline up to 2015. Despite the drop in 2015, the numbers surged again in 2016 and remained relatively high until 2018, reaching the peak of 211 publications. However, from 2019 to 2024, the university experienced a noticeable decline in OA output. This pattern indicates inconsistent growth in Open Access publishing, reflecting both the university's strong engagement in scholarly communication and the challenges it may face in sustaining OA momentum. Overall, the OA growth at Visva-Bharati University appears progressive, despite year-to-year fluctuations.



**Figure 6.16: Year-wise Growth of OA Publications of Visva-Bharati University**  
(Source: Figure by Researcher)

### 6.3.17. Year-wise Growth of Assam University

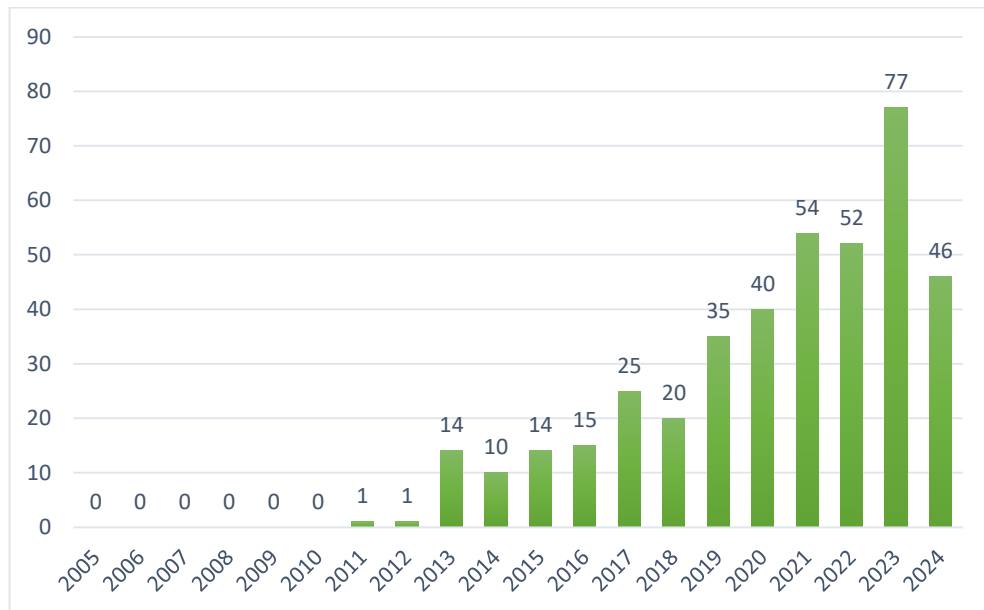
Figure 6.17 illustrates the year-wise growth of Open Access (OA) publications from Assam University between 2005 and 2024. The data reveal a significant upward trend, starting with very few papers in the early years. From 2005 to 2009, OA output remained low, with fewer than six publications annually. A steady rise began in 2010, with notable increases in 2013 (25 papers) and 2014 (40 papers). The university experienced consistent growth from 2016 to 2019, reaching 72 publications, followed by a slight drop to 71 in 2020. Output rose again in 2021 (88 papers) and peaked in 2022 with 95 publications, reflecting growing awareness and institutional support for OA dissemination. However, recent years have seen a decline, with 86 publications in 2023 and 76 in 2024. Overall, the trend indicates a progressive adoption of OA publishing practices by Assam University, in line with global shifts towards open science and scholarly transparency.



**Figure 6.17: Year-wise Growth of OA Publications of Assam University**  
(Source: Figure by Researcher)

### 6.3.18. Year-wise Growth of Central University of Kerala

Figure 6.18 shows the year-wise growth of Open Access (OA) publications from the Central University of Kerala, established in 2009, over the period 2005 to 2024. As expected, there were no OA publications from 2009 to 2011, which likely reflects the early phase of institutional development. The first recorded OA output appeared in 2011 with one publication, followed by a good rise in the subsequent years with minimal fluctuations. A noticeable increase is observed in 2013 with 14 publications, suggesting a growing research engagement. Between 2014 and 2017, the publication count remained steady, ranging between 10 and 25. A sharp rise occurred in 2017 (25 papers), indicating increased research productivity and awareness of OA practices. The period from 2019 onward shows consistent growth to 2021 and the year 2023 has the highest publications with 77. Although 2024 drop to 46 publications, the overall trend reflects a strong institutional adoption of OA publishing and a maturing research environment.

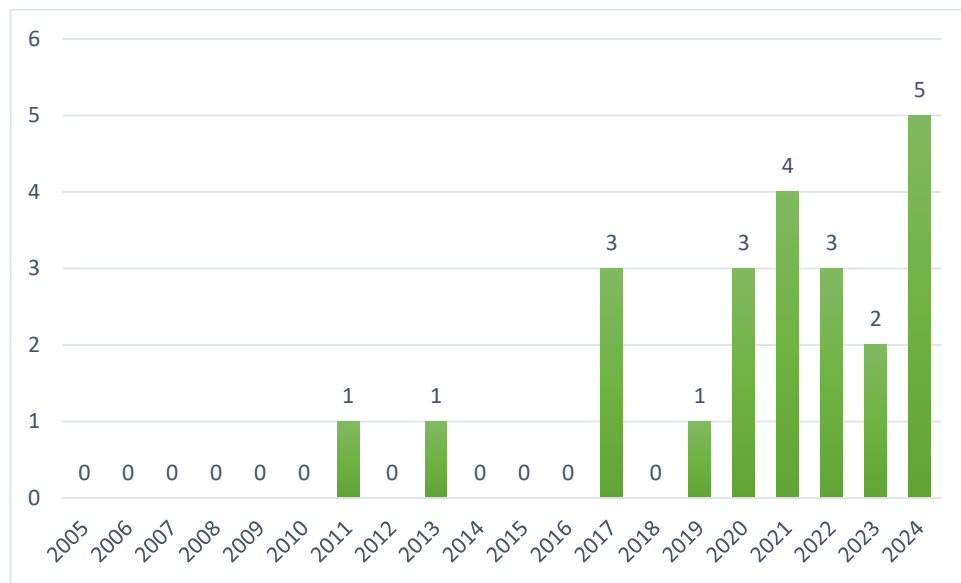


**Figure 6.18: Year-wise Growth of OA Publications of Central University of Kerala**

(Source: Figure by Researcher)

### 6.3.19. Year-wise Growth of English & Foreign Languages University

Figure 6.19 displays the year-wise growth of Open Access (OA) publications from the English and Foreign Languages University (EFLU) between 2005 and 2024. Although EFLU is one of the oldest universities among the selected institutions in the present study, its overall research performance is quite low, with an even lower contribution to open access over the past two decades. The university has published only 23 OA papers during this period as per the Scopus database. Growth in OA publications remained stagnant in the initial years, with zero to one paper published annually until 2019. A gradual increase began in 2019 to 2021, with 1 to 4 OA papers published. The highest number of OA publications was recorded in 2024, with 5 papers, indicating a recent upward trend.

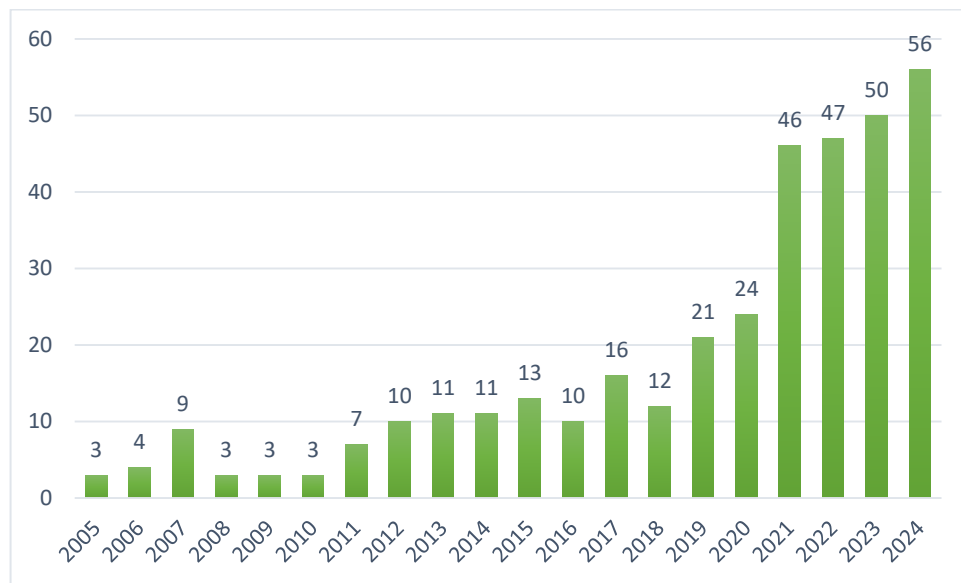


**Fig. 6.19: Year-wise Growth of OA Publications of English & Foreign Languages University**

(Source: Figure by Researcher)

### 6.3.20. Year-wise Growth of Manipur University

Figure 6.20 shows the year-wise growth trend of Open Access (OA) publications from Manipur University between 2005 and 2024. The number of OA publications increased from 3 in 2005 to 56 in 2024, with some fluctuations throughout the period. The initial years, up to 2018, witnessed minimal growth and slight fluctuations. However, from 2019 onward, the number of OA publications began to rise significantly from 24 papers in 2019 to 56 papers in 2024 reflecting a clear upward trend in OA publishing. This steady rise in recent years indicates a growing awareness and adoption of open access practices among researchers at the university.



**Figure 6.20: Year-wise Growth of OA Publications of Manipur University**

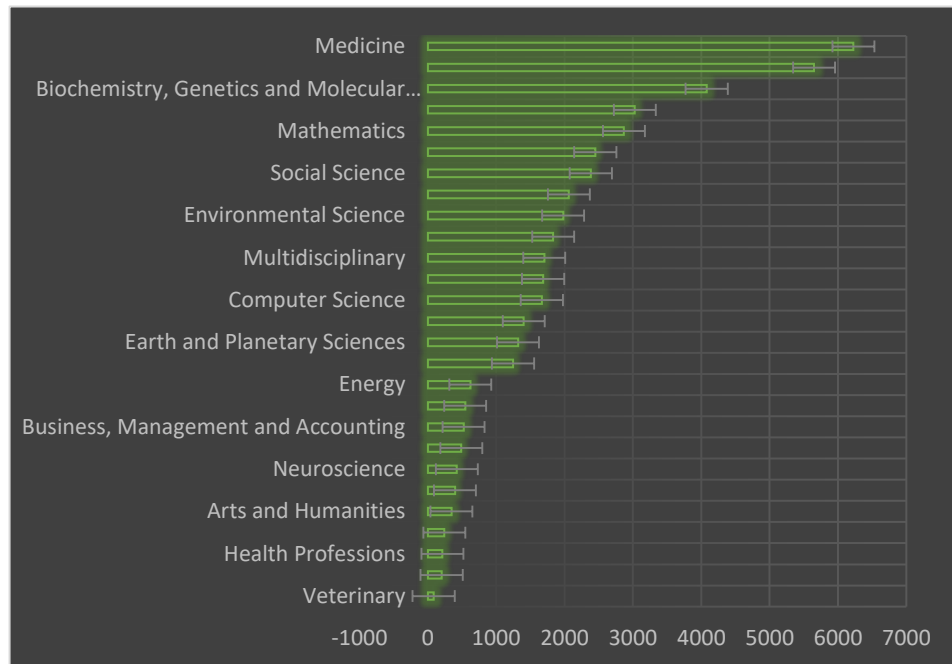
(Source: Figure by Researcher)

#### 6.4. Subject Trends, Impact, and Publishing Influence in OA Research

The subject-wise distribution of Open Access (OA) publications uncovers clear disciplinary patterns, offering insights into which fields are prominent in terms of openness and where new interdisciplinary collaborations are emerging. This not only reflects the strength of research areas but also shows how OA supports the dissemination of knowledge across subject boundaries. The growth of citations demonstrates how OA works are gaining visibility, recognition, and scholarly impact, making them more discoverable to a global audience. Identifying influential publications highlights those studies that have shaped a subject domain within and beyond their fields, serving as guiding references for future research. Likewise, examining prolific journals and publishers reveals the key platforms that consistently support OA dissemination, ensuring that high-quality knowledge reaches wider communities without barriers. Therefore, these dimensions provide a broader view of how OA has transformed the academic landscape by enhancing research productivity, strengthening visibility, fostering collaboration, and making knowledge more equitable and accessible for all.

#### 6.4.1. Subject wise Distribution of OA Publications

The subject-wise classification of Open Access (OA) publications from the selected central universities of India demonstrates a clear dominance of science and medical disciplines in embracing open dissemination of research. As illustrated in Figure 6.21, *Medicine* leads significantly with the highest number of OA publications, reflecting a global trend toward making health-related research more accessible, especially in light of public health priorities. It is closely followed by *Biochemistry, Genetics and Molecular Biology*, further emphasizing the strong presence of life sciences in the OA movement. *Mathematics* ranks third, which indicates an active culture of openness in theoretical and quantitative research, likely supported by the use of preprint servers and collaborative networks. Interestingly, *Social Science* holds the fourth position, suggesting a growing but still moderate participation in OA, as this field often intersects with public policy, education, and social development, where open accessibility can have real-world implications. Mid-ranking fields such as *Environmental Science, Multidisciplinary*, and *Computer Science* point to an increasing awareness about the importance of OA in addressing global environmental challenges, fostering interdisciplinary research, and promoting open-source digital innovations. On the other hand, lower representation is observed in domains like *Business, Management and Accounting, Neuroscience, Arts and Humanities, Health Professions*, and *Veterinary Science*. These fields may face more traditional publishing models, lack of OA infrastructure, or limited incentives for open publishing. Nevertheless, their presence indicates a gradual shift towards inclusivity in OA across disciplines. Overall, the analysis reflects that while scientific disciplines continue to dominate OA publishing, there is a positive trend of diversification, with contributions from both STEM and non-STEM fields, indicating a broader cultural shift toward open knowledge practices in Indian higher education and research.



**Figure 6.21: Subject-wise Classification of OA Publications from the Selected Central Universities**

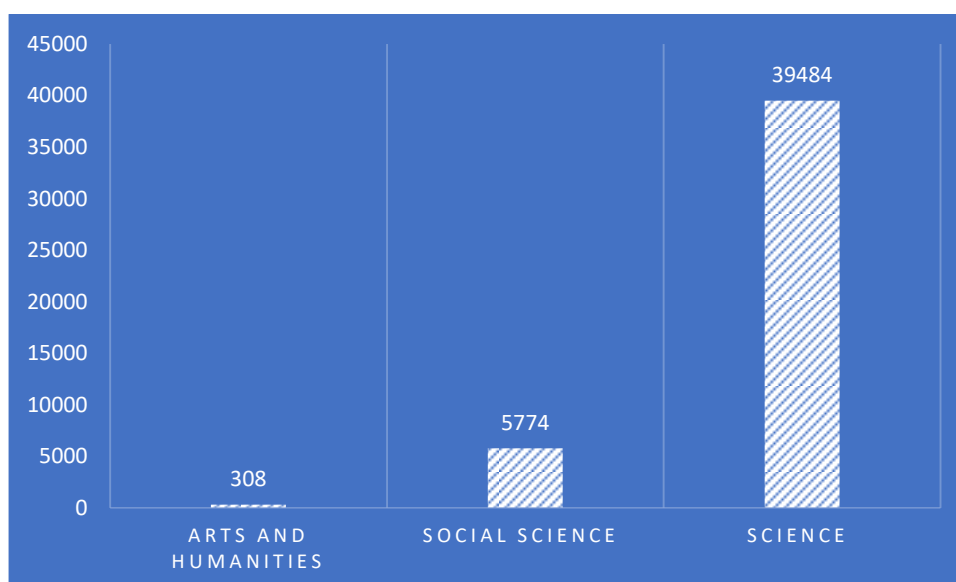
(Source: Figure by Researcher)

#### **6.4.2. OA publications Trend in the Domain of Sciences, Social Sciences, and Arts and Humanities**

Figure 6.22 displays the number of Open Access (OA) publications of the selected Central Universities in the domains of Sciences, Social Sciences, and Arts and Humanities. The analysis clearly reveals a disciplinary skew in OA publishing: the highest number of publications are from the Science domain (39,484), followed by Social Sciences (5,774), and the Arts and Humanities contributing the least with only 308 OA publications. These findings are consistent with previous studies. For instance, Piwowar et al. (2018) conducted a large-scale study on OA prevalence and impact, revealing that disciplines such as medicine, biology, and physical sciences have significantly higher OA uptake compared to the humanities and social sciences. Similarly, Larivière et al. (2015), in their analysis of disciplinary differences in scholarly publishing, found that STEM fields exhibit stronger OA tendencies due to higher funding levels, journal availability, and funder mandates.

The dominance of Sciences in OA publishing can be driven by various factors, such as the greater availability of external research funding, mandatory OA policies by scientific funding agencies, a strong culture of preprint usage, and the presence of well-established subject-specific repositories (e.g., arXiv, PubMed Central). In Science departments, researchers are more likely to engage in collaborative, grant-funded projects with international linkages, making them more exposed to OA mandates and better resourced to publish in OA journals. In contrast, Arts and Humanities, as well as Social Sciences, typically rely more on book-based outputs, face limited research funding opportunities, and often publish in subscription-based or regionally focused journals that are not indexed in major international databases like Scopus, resulting in reduced OA visibility. Moreover, departments in these disciplines often operate with limited budgets, encounter infrastructural gaps, and tend to prioritize traditional print publishing formats, further constraining their OA participation.

This analysis underscores not only the disciplinary imbalance in OA publishing but also the structural and institutional challenges that contribute to this disparity across academic domains within Indian Central Universities.

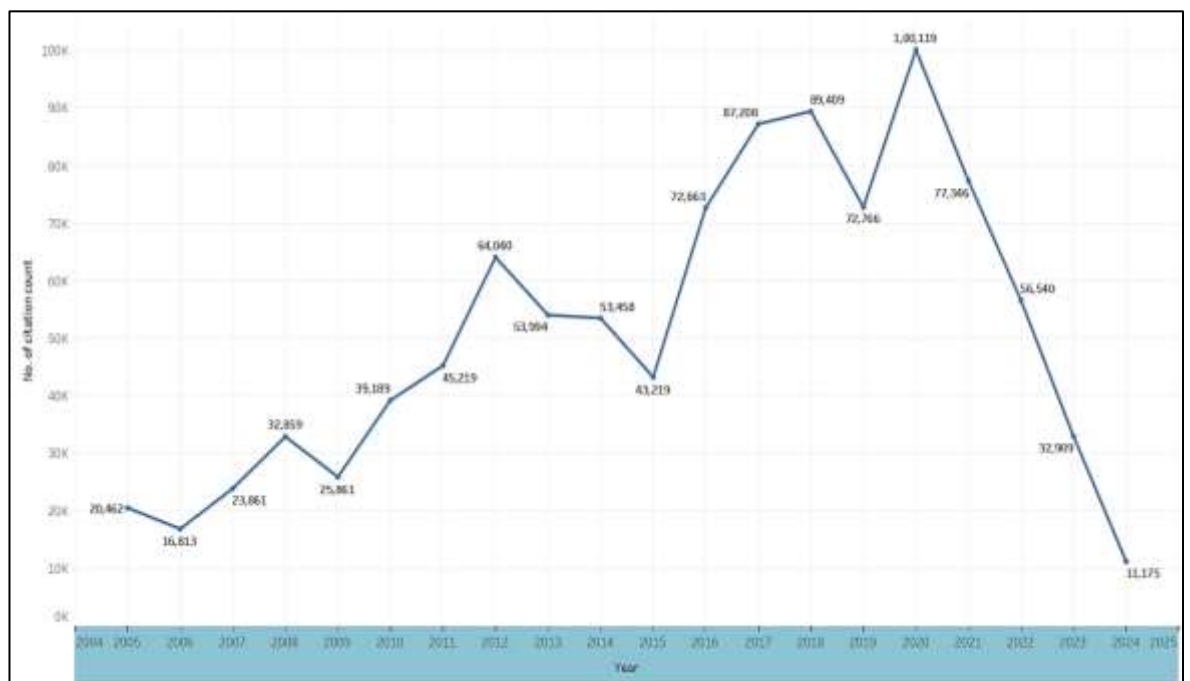


**Figure 6.22: Distribution of OA Publications Trends in Sciences, Social Sciences and Arts and Humanities Domain**

(Source: Table by Researcher)

### 6.4.3. Yearly Growth of Citation Counts of the OA Publications

Figure 6.23 illustrates the yearly growth of citation counts of Open Access (OA) publications from 2004 to 2025. The citation trend indicates a fluctuating yet evolving route of scholarly influence over time. In the early phase (2004–2010), citation counts were relatively modest and inconsistent, beginning with 20,462 citations in 2004 and reaching 25,861 in 2009. A notable dip occurred in 2005 (16,813 citations), followed by moderate growth, peaking at 32,859 in 2007. This period indicates the gradual acceptance and limited visibility of OA literature during its developmental years. A significant surge is observed in 2011, when citations jumped to 64,040, marking the beginning of OA's increasing academic influence. Between 2012 and 2015, the pattern fluctuated again, reflecting transitional phases in research output and access dynamics. From 2016 onwards, citation counts rose steadily, reaching a peak of 1,00,119 in 2019, highlighting the mainstreaming of OA in scholarly communication. However, a decline is evident from 2020 onwards, dropping to 11,175 citations in 2025. This recent decrease is most likely due to citation lag, as newer publications require time to be cited.



**Figure 6.23: Yearly Growth of Citation Counts of the OA Publications**

(Source: Figure by Researcher)

#### **6.4.4. Highly Influential Publications Based on Citation Counts**

Identifying the highly cited documents makes it possible to recognize the areas of research that are receiving the most scholarly attention and shaping academic discourse. Table 6.3 presents the top ten most influential papers based on citation counts, with a remarkable dominance of the Global Burden of Disease (GBD) studies. Eight of these belong to the GBD series, reflecting their supreme significance in global health research and their role in guiding evidence-based health policy across the world. The predominance of *The Lancet* and its associated journals as the main publishing source for these works highlights the journal's credibility and its vital role in disseminating high-impact medical knowledge. Remarkably, all ten papers are available through Green Open Access, a factor that likely enhanced their discoverability, broadened readership, and contributed to their impressive citation performance.

Published mainly by Elsevier and its affiliates between 2005 and 2021, the documents span a wide array of subjects, including global disease burden, mortality, neurological disorders, alcohol use, antibiotic resistance, and even nuclear physics. This diversity illustrates the multidisciplinary impact of Open Access literature, showing how freely accessible research can reach diverse audiences and catalyze scholarly discussions well beyond the immediate field. The results indicates that the combination of highly relevant topics, prestigious publishing outlets, and open accessibility has been instrumental in amplifying the influence of these papers, making them benchmarks in their respective domains

**Table 6.3: Top ten Influential Publications Based on Citation Counts**

| Rank | Title                                                                                                                                                                                                                               | Citation | Year | Journal                        | DOI                             | Publisher               | ISSN     | OA status |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|--------------------------------|---------------------------------|-------------------------|----------|-----------|
| 1    | Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019                                                                           | 11229    | 2020 | The Lancet                     | 10.1016/S0140-6736(20)30925-9   | Elsevier B.V.           | 1406736  | Green     |
| 2    | Global, regional, and national incidence, prevalence, and years lived with disability for 354 Diseases and Injuries for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017 | 9956     | 2018 | The Lancet                     | 10.1016/S0140-6736(18)32279-7   | Lancet Publishing Group | 1406736  | Green     |
| 3    | Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015                                   | 5834     | 2016 | The Lancet                     | 10.1016/S0140-6736(16)31678-6   | Elsevier B.V.           | 1406736  | Green     |
| 4    | Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017                                    | 5747     | 2018 | The Lancet                     | 10.1016/S0140-6736(18)32203-7   | Lancet Publishing Group | 1406736  | Green     |
| 5    | Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015                             | 5171     | 2016 | The Lancet                     | 10.1016/S0140-6736(16)31012-1   | Lancet Publishing Group | 1406736  | Green     |
| 6    | Global, regional, and national burden of stroke and its risk factors, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019                                                                                  | 3321     | 2021 | The Lancet Neurology           | 10.1016/S1474-4422(21)00252-0   | Elsevier Ltd            | 14744422 | Green     |
| 7    | Global, regional, and national burden of neurological disorders, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016                                                                                       | 3266     | 2019 | The Lancet Neurology           | 10.1016/S1474-4422(18)30499-X   | Lancet Publishing Group | 14744422 | Green     |
| 8    | Formation of dense partonic matter in relativistic nucleus-nucleus collisions at RHIC: Experimental evaluation by the PHENIX Collaboration                                                                                          | 2910     | 2005 | Nuclear Physics A              | 10.1016/j.nuclphysa.2005.03.086 | Elsevier                | 3759474  | Green     |
| 9    | Emergence of a new antibiotic resistance mechanism in India, Pakistan, and the UK: A molecular, biological, and epidemiological study                                                                                               | 2465     | 2010 | The Lancet Infectious Diseases | 10.1016/S1473-3099(10)70143-2   |                         | 14733099 | Green     |
| 10   | Alcohol use and burden for 195 countries and territories, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016                                                                                              | 2399     | 2018 | The Lancet                     | 10.1016/S0140-6736(18)31310-2   | Lancet Publishing Group | 1406736  | Green     |

*Note.* DOI= Digital Object Identifier

(Source: Table by Researcher)

#### 6.4.5. Highly Prolific Journals Based on Number of OA Publications

Table 6.4 presents the top ten most prolific journals based on the number of Open Access (OA) publications contributed by selected Indian central universities. The table also includes each journal's ISSN, publisher, CiteScore, OA status, and whether it is indexed in the Directory of Open Access Journals (DOAJ). The journal *Scientific Reports* leads with the highest number of OA publications (991), followed by *PLoS ONE* with 846 articles and the *Journal of High Energy Physics* with 592 articles. Remarkably, most of these journals are fully open access and are indexed in DOAJ, demonstrating their commitment to accessibility and visibility in global research. Only two journals i.e., *Physical Review Letters* and *Physical Review D* are subscription-based and not listed in DOAJ. Springer Nature emerges as the most significant publisher in this context, contributing three journals to the list. This indicates its major role in supporting and disseminating OA research from Indian central universities. Furthermore, it is observed that the majority of the journals belong to the field of physical sciences, highlighting the strong research output and publication trends in physics and related disciplines. This trend also reflects the dominant areas of research collaboration and funding focus within the central universities studied.

**Table 6.4: List of Top Ten Prolific Journals Based on Number of OA Publications**

| Journal                                                                          | OA publications | ISSN      | Publisher                 | CiteScore | OA status | in DOAJ |
|----------------------------------------------------------------------------------|-----------------|-----------|---------------------------|-----------|-----------|---------|
| Scientific Reports                                                               | 991             | 2045-2322 | Springer Nature           | 6.7       | OA        | Yes     |
| PLoS ONE                                                                         | 846             | 1932-6203 | Public Library of Science | 5.4       | OA        | Yes     |
| Journal of High Energy Physics                                                   | 592             | 1029-8479 | Springer Nature           | 9.9       | OA        | Yes     |
| Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics | 575             | 0370-2693 | Elsevier                  | 8.3       | OA        | Yes     |
| ACS Omega                                                                        | 479             | 2470-1343 | American Chemical Society | 7.1       | OA        | Yes     |

|                             |     |           |                            |      |                           |     |
|-----------------------------|-----|-----------|----------------------------|------|---------------------------|-----|
| Physical Review Letters     | 463 | 0031-9007 | American Physical Society  | 15.6 | subscription-based access | No  |
| Physical review. D          | 396 | 2470-0010 | American Physical Society  | 9.1  | subscription-based access | No  |
| RSC Advances                | 392 | 2046-2069 | Royal Society of Chemistry | 7.6  | OA                        | Yes |
| European Physical Journal C | 376 | 1434-6052 | Springer Nature            | 7.8  | OA                        | Yes |
| IEEE Access                 | 244 | 2169-3536 | IEEE                       | 9    | OA                        | Yes |

(Source: Table by Researcher)

#### 6.4.6. Prolific Publishers Based on the Number of Open Access Publications

Table 6.5 presents the top ten prolific publishers based on the number of Open Access (OA) publications contributed by the selected Indian Central Universities between 2005 and 2024. Springer Science and Business Media LLC leads the list with 6,197 OA publications, followed closely by Elsevier BV with 5,567, together accounting for a substantial share of the overall output. Other major contributors include Medknow, MDPI AG, Wiley, Frontiers Media SA, Informa UK Limited, Public Library of Science (PLOS), and Oxford University Press (OUP). The dominance of Springer and Elsevier demonstrates the continued reliance of Indian academia on large, internationally recognized publishing houses, reflecting both their reputation and global visibility. At the same time, the significant presence of Medknow an Indian publisher and PLoS highlights the growing recognition of publishers specializing in OA models, suggesting a balanced engagement between traditional and emerging OA-driven platforms. This distribution indicates that central universities in India are increasingly leveraging a combination of global and OA-focused publishers to disseminate their research. Such patterns not only ensure wide accessibility but also enhance citation potential and global visibility of Indian scholarly work. The trend further emphasizes how institutional research strategies are aligning with the global OA movement, embracing sustainable publishing practices that promote equitable access to knowledge and strengthen India's academic footprint worldwide.

**Table 6.5: Top Ten Prolific Publishers Based on the Number of OA Publications**

| <b>Rank</b> | <b>Publisher</b>                        | <b>OA publications</b> |
|-------------|-----------------------------------------|------------------------|
| 1           | Springer Science and Business Media LLC | 6197                   |
| 2           | Elsevier BV                             | 5567                   |
| 3           | Medknow                                 | 2120                   |
| 4           | MDPI AG                                 | 2050                   |
| 5           | American Physical Society (APS)         | 1754                   |
| 6           | Wiley                                   | 1491                   |
| 7           | Frontiers Media SA                      | 1143                   |
| 8           | Informa UK Limited                      | 1041                   |
| 9           | Public Library of Science (PLoS)        | 997                    |
| 10          | Oxford University Press (OUP)           | 882                    |

(Source: Table by Researcher)

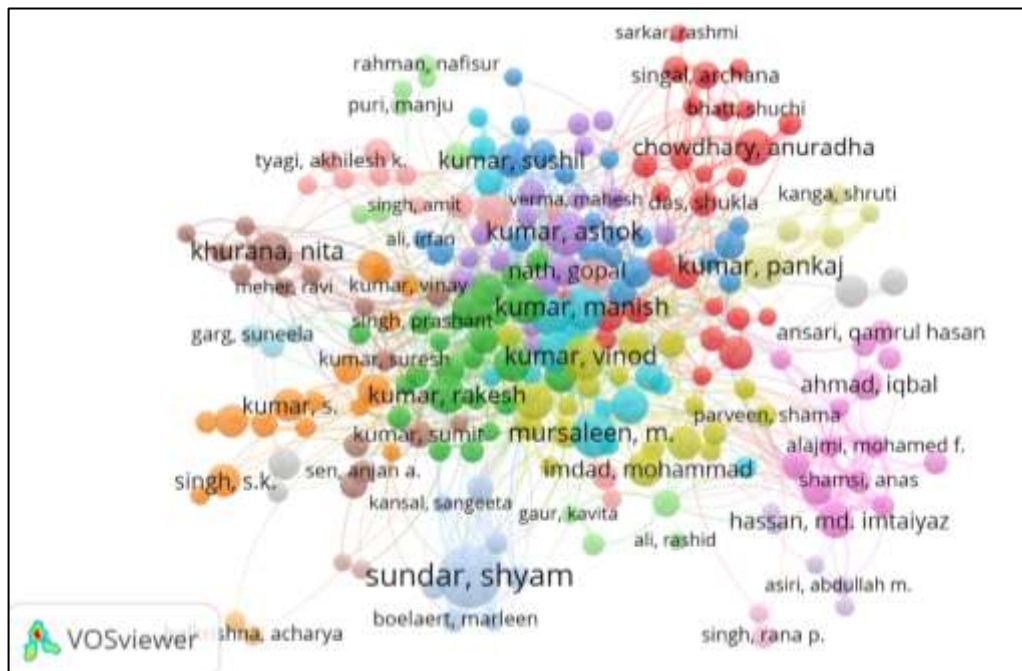
### **6.5. Assessing the Social, Intellectual and Conceptual Structure of OA Publications**

Social structure analysis reveals the underlying patterns of collaboration among authors, offering a deeper understanding of the scholarly networks that shape the evolution of a subject field. It demonstrates how researchers are interconnected through co-authorship, citation practices, or institutional affiliations, thereby revealing the dynamics of knowledge exchange and collaborative communities within the academic domain (Tahamtan et al., 2016). While intellectual structure analysis emphasizes the identification and mapping of influential authors, documents, and sources that have played a pivotal role in advancing the field. This approach highlights the foundational contributions that drive theoretical development, research directions, and the overall intellectual growth of the discipline (Khare & Jain, 2022). On the other hand, conceptual structure analysis explores the underlying themes, ideas, and emerging trends within a subject area by examining the relationships among keywords, terms, and concepts (Dindorf et al., 2022). Altogether, the study analyzed the social, intellectual, and conceptual structure presenting a holistic view of OA publications by mapping collaborative relationships, identifying influential knowledge foundation, and tracing the thematic pattern that

shape the trajectory of academic research. The analysis has been performed using MS Excel and the network visualization has been created using VOSviewer.

### **6.5.1 Co-authorship of Authors**

Figure 6.24 displays the co-authorship of authors to show the collaboration among authors of OA publications from the selected central universities of India. Out of a total of 90,846 authors identified in the dataset, a minimum 30 documents per author was applied to ensure meaningful collaboration analysis. Based on this criterion, 232 authors met the threshold, and considered for the final co-authorship network visualization in VOSviewer. A total of 20 clusters were identified in the co-authorship network, representing different collaborative groups among prolific authors. This filtering allows focus on the most prolific and collaborative contributors, ensuring clarity in the network map where the size of each nodes denotes its frequency. It is found that the authors such as Sundar Shyam, *Manish Kumar*, *M. Mursaleen*, and *Ashok Kumar*, appears significantly having maximum number of collaborations. Of 20 clusters, Clusters 1 and 2, with 27 and 24 authors respectively, represent the most active and densely connected research groups. Clusters 3 to 8, each comprising 15 to 20 authors, indicate moderately strong collaboration. Clusters 9 to 14 include 5 to 14 authors, showing smaller but notable groups. The remaining Clusters 15 to 20, each with only 2 to 3 authors, reflect limited or emerging collaborative efforts. This clustering pattern highlights both well-established research communities and smaller, independent author groups.



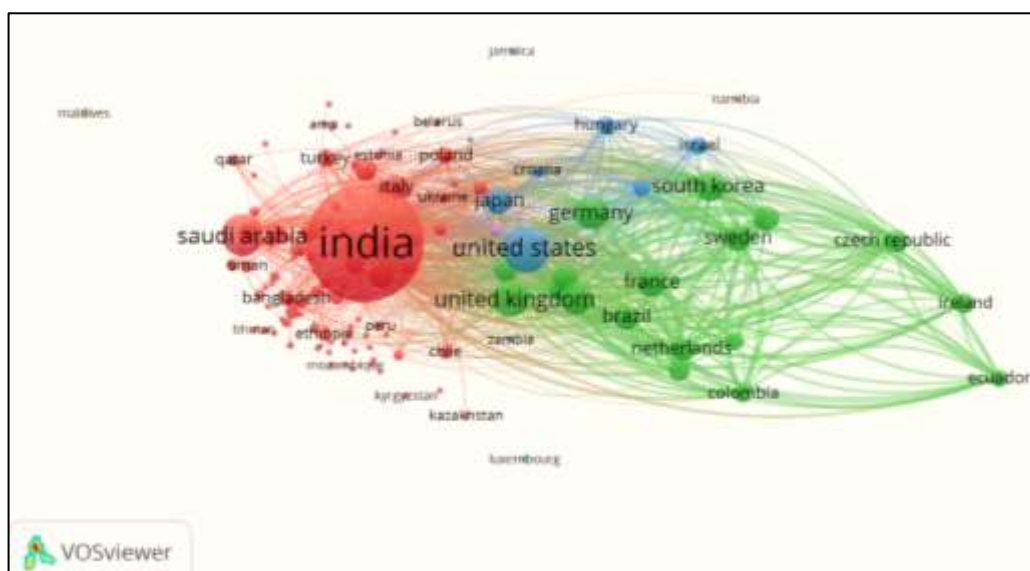
**Figure 6.24: Co-authorship of Authors**

(Source: Figure by Researcher)

### 6.5.2. Co-authorship of Countries of OA Publications

Figure 6.25 shows the collaboration pattern of different countries in OA research by the selected Indian central universities. The analysis is performed using VOSviewer, of total 293 countries, minimum number of 3 documents for each country, where 142 countries meet the threshold. These countries are categorized into seven distinct clusters, each represented by different colors, indicating collaborative groups. The size of each node presents the number of collaborative documents, with larger nodes indicating higher levels of contribution. India appears as the most dominant node, showing extensive collaboration with a wide range of countries, notably Saudi Arabia, the United States, the United Kingdom, and Bangladesh. The edges connecting the countries represent co-authorship links, where the thickness of the lines indicates the strength of collaboration. Cluster 1 mainly includes Asian, Middle Eastern, and African countries with India at the center. Cluster 2 covers European and Latin American countries like the UK, Germany, and Brazil. Cluster 3 includes the US, Japan, and Israel. Clusters 4 to 7 are small, each with a single country showing limited collaboration. Overall, the visualization highlights India's central

role in OA research collaboration and the global nature of partnerships fostered by Indian central universities.



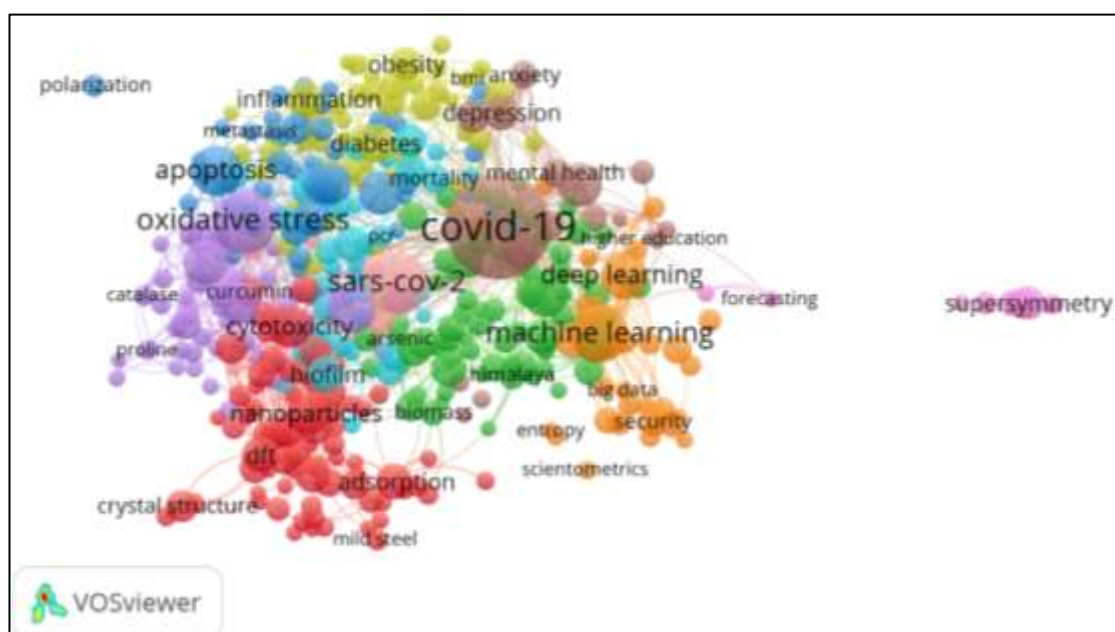
**Figure 6.25: Co-authorship of Countries**

(Source: Figure by Researcher)

### 6.5.3. Keyword analysis of OA Publications

Visualization of keywords based on their occurrences helps in identifying emerging research hotspots. Figure 6.26 illustrates these hotspots through a network visualization of OA publications contributed by the selected Indian central universities. In VOSviewer, out of a total of 84,543 author-indexed keywords, 562 met the minimum threshold of 20 occurrences. These keywords were grouped into 11 distinct clusters, each represented by different colors, where the cluster size reflects the frequency of keyword occurrence. Cluster 1 emphasizes materials science and nanotechnology (e.g., antimicrobial activity, drug delivery), while Cluster 2 focuses on environment and sustainability themes (e.g., climate change, biodiversity, Northeast India). Cluster 3 is centered on cancer and biomedical research, whereas Cluster 4 highlights public health and lifestyle diseases (e.g., diabetes, Ayurveda, yoga). Cluster 5 deals with plant biology and stress physiology (e.g., rice, wheat), and Cluster 6 addresses infectious diseases (e.g., malaria, antimicrobial resistance). Cluster 7 relates to artificial intelligence and data science (e.g., machine learning,

scientometrics), while Cluster 8 emphasizes mental health and pandemic-related research (e.g., COVID-19, online learning). Cluster 9 explores theoretical physics and forecasting (e.g., dark matter, ARIMA), Cluster 10 highlights COVID-19 drug research, and Cluster 11 points to mucormycosis as a niche area. Overall, the distribution of clusters reflects the research priorities of Indian central universities in OA publishing, with clear emphasis on health, environment, agriculture, emerging technologies, and pandemic-related issues such as COVID-19 and mental health, thereby aligning with both national and global research needs.



**Figure 6.26: Network visualization of keyword occurrences**

(Source: Figure by Researcher)

#### 6.5.4. Identification of Highly Occurred Keywords

Table 6.6 presents the top 20 keywords based on their frequency in OA research publications contributed by the selected Indian central universities. The keyword ‘COVID-19’ ranks the highest, occurring 757 times, followed by ‘oxidative stress’ (279) and ‘SARS-CoV-2’ (265), reflecting a clear dominance of pandemic-related research themes and their associated health impacts. Other frequently occurring terms such as ‘diabetes,’ ‘tuberculosis,’ ‘breast cancer,’ and ‘cancer’ emphasize the continued focus on chronic and life-threatening diseases. Alongside health, research also highlights technological and environmental priorities, with keywords like

‘machine learning,’ ‘deep learning,’ ‘nanoparticles,’ ‘climate change,’ ‘rice,’ and ‘remote sensing’, indicating a strong multidisciplinary orientation. A comparative interpretation of these patterns shows that health-related keywords dominate the research landscape, particularly due to the pandemic’s influence, while technology and environment-related terms emerge as complementary but less frequent themes. Therefore, this distribution reveals the universities’ dual commitment to addressing global health crises on an urgent basis while simultaneously engaging with long-term sustainability and technological advancement by underscoring the role of Open Access in fostering broad-based and impactful research.

**Table 6.6: Top Ten Highly Occurred Keywords**

| <b>Rank</b> | <b>Keyword</b>          | <b>Occurrences</b> |
|-------------|-------------------------|--------------------|
| <b>1</b>    | Covid-19                | 757                |
| <b>2</b>    | Oxidative stress        | 279                |
| <b>3</b>    | Sars-cov-2              | 265                |
| <b>4</b>    | Machine learning        | 224                |
| <b>5</b>    | Apoptosis               | 175                |
| <b>6</b>    | Rice                    | 162                |
| <b>7</b>    | Deep learning           | 152                |
| <b>8</b>    | Climate change          | 151                |
| <b>9</b>    | Reactive oxygen species | 141                |
| <b>10</b>   | Tuberculosis            | 134                |
| <b>11</b>   | Pandemic                | 132                |
| <b>12</b>   | Nanoparticles           | 130                |
| <b>13</b>   | Cytotoxicity            | 124                |
| <b>14</b>   | Antioxidants            | 122                |
| <b>15</b>   | Breast cancer           | 121                |
| <b>16</b>   | Cancer                  | 101                |
| <b>17</b>   | Diabetes                | 101                |
| <b>18</b>   | Remote sensing          | 101                |
| <b>19</b>   | Gene expression         | 100                |
| <b>20</b>   | Depression              | 91                 |

(Source: Table by Researcher)

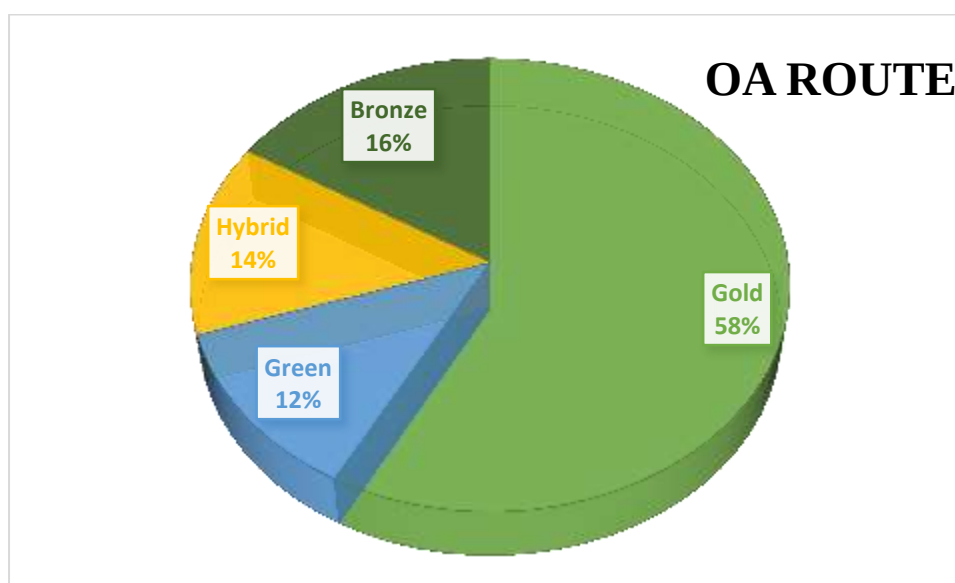
## **6.6 Analysis of OA Publications**

Analysis of Open Access (OA) publications is carried out across multiple scopes including routes, license, and host. The OA route indicates how the work is made available, including Gold OA (fully open access journals), Green OA (self-archiving in repositories), Hybrid OA (open articles in subscription journals), and Bronze OA (free to read but without a license). Similarly, the license governs reuse policies, commonly using Creative Commons types such as CC-BY, CC-BY-SA, CC-BY-NC, and CC-BY-ND, each offering different permissions. While, the host refers to where publications are made accessible whether through repositories or respective publisher's website. Therefore, these scopes provide a comprehensive understanding of how the OA publications of the Indian central universities are distributed, licensed, and sustained within the scholarly communication environment. The analysis has been performed using MS Excel and Tableau Public version 2023.1 software.

### **6.6.1. Distribution of OA Publication Routes**

Figure 6.27 shows the percentage share of different Open Access (OA) publishing routes for the publications authored by the selected central universities of India. The analysis reveals that the majority of the publications have been published via the Gold OA route (50%), followed by Bronze OA (16%), Hybrid OA (14%), and the Green OA route, which accounts for the smallest share of 12%. This trend indicates a strong preference among Indian central universities for Gold OA publishing, likely due to its immediate accessibility and visibility, despite potential article processing charges (APCs) or possibly due to financial support provided by funding agencies, institutional schemes, or collaborative projects that cover such expenses. The comparatively lower share of Green OA suggests that self-archiving practices in repositories are yet to be widely adopted. The preference for Bronze and Hybrid OA reflects the influence of subscription-based journals that offer limited open access. The Bronze OA offers free access on the publisher's website but without a recognisable licence, while Hybrid OA allows paid access to individual articles within subscription journals. Overall, the findings suggest that while Indian

universities are actively participating in OA publishing, there is still scope to promote and strengthen Green OA practices through institutional repositories and national OA mandates.

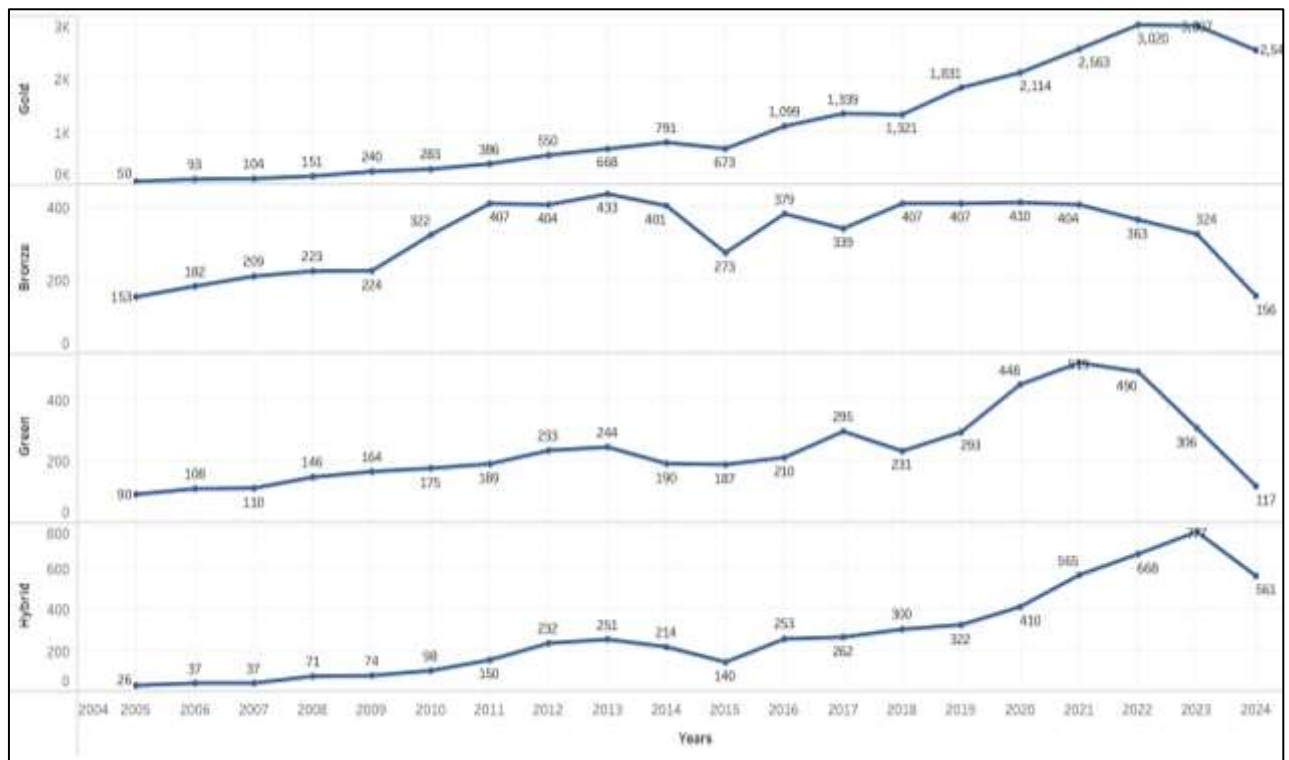


**Figure 6.27: Percentage-wise Distribution of OA Publication Routes**  
(Source: Figure by Researcher)

### 6.6.2. Year-wise Growth Chart of OA publishing Routes

Figure 6.28 displays the year-wise growth pattern of different Open Access (OA) publishing routes over the past 20 years which presents how each route, such as Gold, Bronze, Green, and Hybrid has evolved in popularity among the selected central universities during this period. The Gold OA route shows a straight upward trend, especially after 2015, reflecting a growing shift toward openly accessible, publisher-hosted research. In contrast, the Bronze OA route increased steadily until around 2018 but then began to decline, probably due to changes in publisher policies or reduced temporary free access. The Green OA route, which depends on self-archiving, has remained relatively steady with only slight changes across the years. Interestingly, the Hybrid OA route shows a noticeable rise after 2017, suggesting that more authors have started choosing to make individual articles open in subscription-based journals. Overall, the chart shows that Gold OA has steadily gained popularity over the years, emerging as the most preferred route for researchers to publish their work openly. While the other three routes continue to contribute to the broader OA landscape, their growth has not been as significant. This trend reflects a gradual shift in publishing

preferences, with researchers possibly toward routes that offer greater visibility, broader reach, and more formal recognition.



**Figure 6.28: Year-wise Growth Chart of OA Publishing Routes**

(Source: Figure by Researcher)

### 6.6.3 Distribution of OA Licences

The importance of a license lies in defining the legal terms under which a work can be accessed, reused, shared, or modified, while also ensuring the protection of the author's rights. Table 6.7 displays the various preferred OA Licenses based on the maximum number of adopted by the selected central universities of India. Among the identified license types, the Creative Commons Attribution (CC-BY) license appears as the most commonly used for 15,263 publications. This reflects a strong institutional preference for the most permissive form of licensing, which allows unrestricted reuse, distribution, and adaptation of scholarly content, provided proper attribution is given. The next most preferred license is CC-BY-NC-ND (3,756 publications), which allows sharing with attribution but restricts both commercial use and the creation of derivative works followed by CC-BY-NC (1,616), and CC-BY-NC-SA (917), all of which impose varying levels of restrictions, particularly in terms of

commercial use and derivative works. Other licenses such as publisher-specific OA, public domain, and CC-BY-SA appear less frequently in the dataset. Interestingly, a significant portion of 16,030 items is marked as Blank in Unpaywall, indicating either the absence of license metadata or lack of clarity in terms of reuse rights.

**Table 6.7: List of Various Preferred OA Licenses**

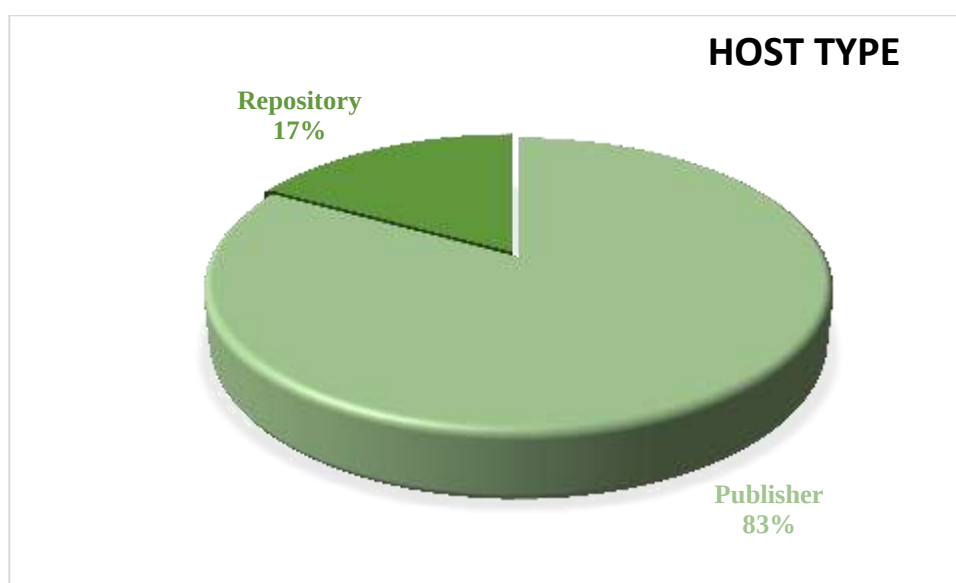
| <b>OA LICENSES</b>           | <b>TOTAL OA<br/>COUNT</b> |
|------------------------------|---------------------------|
| <b>CC-BY</b>                 | 15263                     |
| <b>CC-BY-NC-ND</b>           | 3756                      |
| <b>CC-BY-NC</b>              | 1616                      |
| <b>CC-BY-NC-SA</b>           | 917                       |
| <b>OTHER-OA</b>              | 786                       |
| <b>PUBLISHER-SPECIFIC-OA</b> | 569                       |
| <b>PUBLIC-DOMAIN</b>         | 246                       |
| <b>CC-BY-SA</b>              | 142                       |
| <b>CC-BY-ND</b>              | 40                        |
| <b>UNSPECIFIED</b>           | 34                        |
| <b>FALSE</b>                 | 30                        |
| <b>BLANK</b>                 | 16030                     |

(Source: Table by Researcher)

#### **6.6.4. Proportion of Open Access Articles by Host Type**

Host type refers to the platform where an Open Access (OA) article is stored online and made accessible to readers. Such access may be provided either through the publisher's official website or via a repository. Figure 6.29 presents the proportion of OA publications based on the host type used by Indian central universities. The figure reveals that a significant majority of OA publications (83%) are made freely available through the publisher's official website, while only 17% are stored in repositories. This difference indicates a strong reliance on publisher-hosted platforms for disseminating OA works. This also indicates that gold OA routes are more predominant than Green OA practices among these central universities. The comparatively low repository usage may show limited

institutional self-archiving policies, lack of awareness, or technical infrastructure constraints for maintaining repositories.

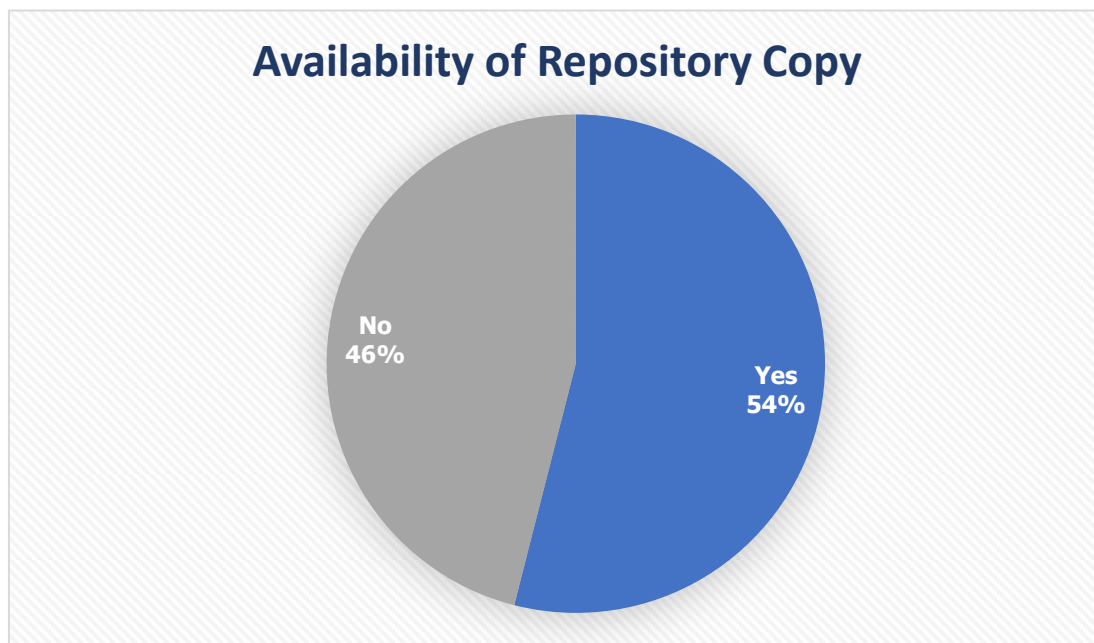


**Figure 6.29: Proportion of Open Access Articles by Host type**

(Source: Figure by Researcher)

#### **6.6.5. Distribution of Articles Based on Availability of Repository Copy**

Figure 6.30 shows the availability of repository copies for Open Access (OA) articles published by selected Indian central universities. The analysis reveals that 54 % of the OA articles have a repository copy, while 46 % do not. This indicates that more than half of the authors are taking the initiative to ensure their work is also available through repositories. Having a copy in a repository not only makes the research easier to find but also helps preserve it for future access. This practice supports wider dissemination and ensures that the research remains accessible to readers, even if publisher access changes over time. While Figure 6.28 earlier showed that only 17 percent of OA publications are primarily hosted in repositories, the present analysis reveals that 54 percent of these articles have an additional copy archived in a repository. This suggests that although publishers remain the dominant host, a substantial number of articles are also being self-archived or deposited in repositories, reflecting growing compliance with Green Open Access practices.

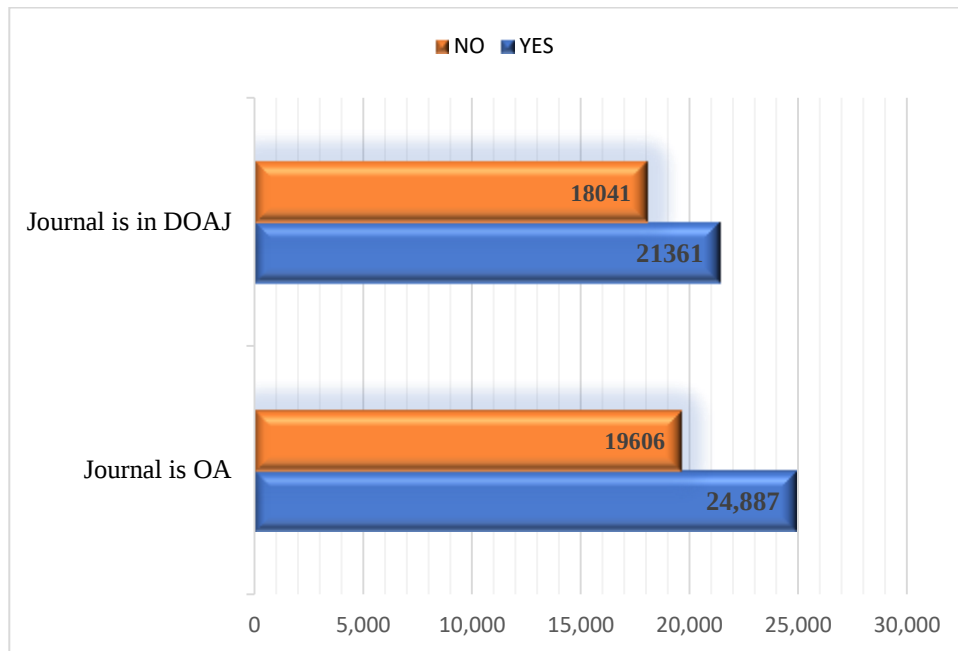


**Figure 6.30: Distribution of Articles Based on Availability of Repository Copy**

(Source: Figure by Researcher)

#### **6.6.6. Distribution of Journals by OA and DOAJ Status**

Figure 6.31 presents a comparison of two key aspects related to the journals where articles from Indian central universities are published: whether the journal is Open Access (OA) and whether it is indexed in the Directory of Open Access Journals (DOAJ). DOAJ is one of the largest online directories which indexes high quality, open access, peer-reviewed journals (Hugar, 2019). The first set of bars shows that 24,887 articles were published in OA journals, while 19,606 appeared in non-OA journals, indicating a strong adoption of the Open Access publishing route. The second set reveals that 21,361 articles were published in journals listed in DOAJ, while 18,041 were not. This shows that a substantial portion of OA content comes from journals not indexed in DOAJ, suggesting differences in quality, visibility, or editorial standards. The two sets of data not show how much research is being published in Open Access journals. Choosing journals that are well-indexed and included in platforms like DOAJ helps ensure that research is not just free to read, but also trusted, easy to find, and more widely used. While Open Access is growing, researchers still need to be thoughtful about selecting quality journals that meet recognized standards. This boosts the visibility, credibility, and long-term impact of work.



**Figure 6.31: Distribution of Journals by OA and DOAJ Status**

(Source: Figure by Researcher)

### 6.7. Measuring of OA friendliness

The adoption of Open Access (OA) in scholarly communication has been gradually and significantly increasing across the globe since its inception. Monitoring and evaluating the growing volume of OA research is essential to identify emerging trends, strengths, and gaps in scholarly publishing. Such an assessment also highlights the level of institutional engagement in advancing Open Science, thereby providing valuable evidence for policymakers, funding agencies, and academicians to design effective strategies that foster equitable access, sustainable publishing practices, and enhanced research dissemination. To assess the Open Access (OA) friendliness of the selected central universities, a framework has been developed based on five parameters, with specific weightages assigned to each. The parameters include: (i) OA share, (ii) OA repository share, (iii) OA license share, (iv) OA citation share, and (v) OA Altmetrics share. These parameters were selected as they collectively demonstrate different dimensions of OA performance such as publication output, institutional repository practices, legal openness through licensing, research impact through citations, and societal impact through altmetrics. Therefore, it provides a comprehensive measure of the extent to which these institutions contribute to and support the Open Access movement.

### 6.7.1 Parameters of OA Friendliness Framework

Table 6.8 presents the five parameters and their Assigned Weightage in the Simplified OA Friendliness Framework. The scope of the parameters is self-explanatory and is partially adapted from the study by Roy and Mukhopadhyay (2022). The Open access friendliness or the adoptability of the Indian central universities has been measured using this framework within these five parameters. The analysis was performed in OpenRefine after retrieving the data from Unpaywall through API.

**OA Share:** In this parameter 30% weightage has been assigned, where the OA share has been the calculated by considering only Gold and Green OA publications out of the total OA output during 2005-2024. Other OA types such as Hybrid, Bronze, and Unspecified OA were deliberately excluded due to their inconsistent licensing, sustainability concerns, or vague reuse rights. This inclusion criteria have been selected to ensure a more accurate and policy-driven assessment of institutional OA practices. The formula used to calculate the OA Share score is-  $(Gold\ OA + Green\ OA) \div Total\ Publications \times 100 \times 0.3$ .

**Repository Share:** The OA repository share is assigned a weightage of 20% and emphasizes the proportion of self-archived publications made available through the Green route. The most appropriate location for archiving a Green OA publication is an Open Access Repository (OAR). This parameter highlights the institutional support provided by Indian central universities in promoting and sustaining their Open Access initiatives. The formula used to calculate the OA repository share score is:  $(Green\ OA\ with\ repository\ copy \div Total\ Green\ OA) \times 100 \times 0.2$

**OA License share:** The OA license share is assigned a weightage of 20% and reflects the proportion of licensing rights held by OA publications made available via the Gold and Green routes. Only those OA publications with recognized licenses primarily Creative Commons licenses are considered. The formula used to calculate the OA license share score is:

$(OA\ Publications\ with\ License \div Total\ OA\ Publications) \times 100 \times 0.2$

**OA Citation Share:** This parameter reflects the citations received by all OA publications made available through various OA routes. It measures the research impact of the OA output

of the selected universities over the past two decades. To ensure comparability across institutions, the citation scores are normalized against the highest average citation observed among the selected universities. The formula used to calculate the OA citation share score is:  $(\text{Average citation of a university} \div \text{Maximum average citation among all universities}) \times 15$

**OA Altmetric Share:** This parameter represents the social impact of Open Access (OA) publications, measured through the Altmetric Attention Score (AAS) received by OA outputs made available via all OA routes. It evaluates the broader influence of research on both academic and non-academic audiences, acknowledging the growing significance of socio-academic platforms. The formula used to calculate the OA Altmetric share score is-  $(\text{Average AAS of a university} \div \text{Maximum average AAS among all universities}) \times 15$

**Table 6.8: Parameters and their Assigned Weightage in the Simplified OA Friendliness Framework**

| SI No | Five Parameters     | Weightage |
|-------|---------------------|-----------|
| I     | OA Share            | 30%       |
| II    | OA Repository share | 20%       |
| III   | OA License share    | 20%       |
| IV    | OA Citation share   | 15%       |
| V     | OA AAS Score        | 15%       |

(Source: Table by Researcher)

### 6.7.2: Breakdown Scores of OA Publications under the OAF Framework

Table 6.9 presents the raw scores of Open Access (OA) publications for each of the five parameters of the OA Friendliness Framework. This breakdown of scores provides a transparent view of how individual parameters OA share, repository share, license share, citation share, and Altmetric Attention Score contribute to the overall assessment. By examining these scores separately, it becomes easier to identify the strengths and weaknesses of each university across different dimensions of OA performance before leveraging the designated weightages. These scores serve as the foundation for calculating the final OA Friendliness Index. In the next table (6.7.3), the allotted weightages are applied

to each parameter, resulting in the composite OA Friendliness score for each central university.

**Table 6.9: Total scores of OA publications for OAF framework**

| University                             | Total OA | Gold OA | Green OA | Repository of Green | With License | Total AAS | Avg. AAS | Total Citations | Avg. Citation |
|----------------------------------------|----------|---------|----------|---------------------|--------------|-----------|----------|-----------------|---------------|
| University of Delhi                    | 11,351   | 6,254   | 1,375    | 1,375               | 4,099        | 16,678    | 1.47     | 3,11,644        | 27.46         |
| BHU                                    | 6027     | 3363    | 752      | 752                 | 2372         | 90,084    | 14.95    | 2,09,528        | 34.77         |
| AMU                                    | 5,672    | 3,139   | 230      | 230                 | 2,401        | 4,167     | 0.73     | 1,28,050        | 22.58         |
| JNU                                    | 3,180    | 1,743   | 509      | 509                 | 1525         | 35,037    | 11.02    | 91,872          | 28.89         |
| Jamia Millia Islamia                   | 3,213    | 1960    | 448      | 448                 | 1,504        | 24,129    | 7.51     | 77,546          | 24.14         |
| University of Hyderabad                | 2,954    | 1,643   | 478      | 478                 | 1,445        | 14,785    | 5.01     | 74,816          | 25.33         |
| Pondicherry University                 | 2,228    | 1,356   | 191      | 191                 | 1,019        | 13,853    | 6.22     | 38,370          | 17.22         |
| Visva-Bharati University               | 2,058    | 1,073   | 227      | 227                 | 823          | 12,314    | 5.98     | 81,895          | 39.79         |
| Tezpur University                      | 1,023    | 542     | 167      | 167                 | 435          | 1,727     | 1.69     | 15,288          | 14.94         |
| North Eastern Hill University          | 857      | 482     | 123      | 123                 | 368          | 1,343     | 1.57     | 13,372          | 15.6          |
| Assam University                       | 833      | 538     | 67       | 67                  | 410          | 2,352     | 2.82     | 12,712          | 15.26         |
| Mizoram University                     | 697      | 502     | 28       | 28                  | 411          | 9,094     | 13.05    | 14,049          | 20.16         |
| Central University of Punjab           | 610      | 364     | 79       | 79                  | 299          | 28,025    | 45.94    | 33,657          | 55.18         |
| Central University of Kerala           | 404      | 270     | 22       | 22                  | 232          | 26,473    | 65.53    | 25,906          | 64.12         |
| Manipur University                     | 359      | 222     | 33       | 33                  | 173          | 716       | 1.99     | 3,056           | 8.51          |
| Central University of Tamil Nadu       | 377      | 258     | 41       | 41                  | 212          | 3,565     | 9.46     | 11,985          | 31.79         |
| Central University of Jammu            | 204      | 144     | 24       | 24                  | 116          | 276       | 1.35     | 2,277           | 11.16         |
| Central University of Kashmir          | 118      | 71      | 15       | 15                  | 57           | 135       | 1.14     | 944             | 8             |
| English & Foreign Languages University | 23       | 18      | 1        | 1                   | 11           | 10        | 0.43     | 51              | 2.22          |

*Note.* OA=Open Access, Avg.- Average, AAs=Altmetric Attention Score, AMU= Aligarh Muslim University, BHU= Banaras Hindu University

(Source: Table by Researcher)

### 6.7.3. OA Friendliness Framework

Table 6.10 presents the Simplified OA Friendliness Framework with the scores received by the selected nineteen central universities of India across five parameters. This table not only shows the scores but also reflects these institutions' OA practices at the ground level. In terms of OA share, over the last two decades, the English & Foreign Languages University (24.78/30) has achieved the highest number of OA share, followed by the Central University of Jammu (24.7/30) and the Central University of Tamil Nadu (23.7/30). It is observed that older universities such as JNU, AMU, and Visva-Bharati University have relatively lower OA share scores, ranging from 17 to 20. In contrast, the newer central universities show

comparatively higher OA share scores, indicating a stronger inclination toward Open Access publishing.

In terms of OA Repository share parameter, all the nineteen Indian central universities received the maximum score of 20/20, indicating that all green OA publications are constantly made available through recognized repositories. This full score advocates a strong institutional support and infrastructure for Green OA practices. It reflects the national-level efforts and policies encouraging the use of Open access repositories, ensuring wider accessibility and preservation of academic outputs for future use.

The OA License Share parameter, carrying a weightage of 20%, indicates how well universities adhere to standard open licensing practices. The results reveals that four Universities including Central University of Punjab, Mizoram University, Central University of Kerala and Central University of Jammu have received the highest score with 11/20. Secondly, nine universities like Jamia Millia Islamia, University of Hyderabad, Jawaharlal Nehru University etc, have received moderate score 9/20. Therefore, rest of the universities have score 7-8/20. Overall, the licensing scores of OA publications do not present a strong outlook in the scholarly communication landscape. This indicates the need for significant improvement in adopting standard open licensing practices to align with global Open Access norms.

The OA citation share parameter, which covers a weightage of 15 % reflecting the research impact of all the OA publications through citation performance. Based on the scores, the Central University of Kerala has achieved the highest citation score of 15, indicating the strongest citation impact among the selected universities. This is followed by the Central University of Punjab with a score of 12.9, Visva-Bharati University with 9.3, and Banaras Hindu University with 8.13 out of 15. Universities demonstrating a moderate level of citation impact include the Central University of Tamil Nadu (7.43), Jawaharlal Nehru University (6.75), and the University of Delhi (6.42), among others. On the other hand, institutions with relatively lower citation scores include the English and Foreign Languages University (0.51) and the Central University of Kashmir (1.87), indicating a comparatively lesser impact of their OA research output in terms of citations.

Altmetric scores presents the amount of online attention that research outputs receive across platforms such as news media, social networks, blogs, policy documents, and other digital outlets. The OA AAS share parameter, which covers a weightage of 15 % reflecting the social research impact of all the OA publications. A higher OA AAS score indicates greater online visibility and engagement with a university's open access publications. The scores reveal that Central University of Kerala received the maximum score of 15, suggesting its OA publications achieved the highest online attention followed by Central University of Punjab (10.51). However, the following universities shows very moderate scores like Banaras Hindu University (3.42), Mizoram University (2.99) Central University of Tamil Nadu (2.16). The remaining universities exhibit very low AAS scores ranging from 0 to 1, reflecting minimal online engagement and limited dissemination of their research outputs.

The Total OAF (Open Access Friendliness) score, calculated on a 100-point scale, represents the overall openness and accessibility of research outputs from each selected central university. Based on five weighted parameters, OA share (30%), repository share (20%), license share (20%), citation share (15%), and Altmetric Attention Score (15%). A higher OAF score indicates a more comprehensive and impactful open access (OA) strategy, combining publication volume, institutional archiving, licensing, citation impact, and online visibility. Based on the table, the Central University of Kerala achieved the highest score of 83, reflecting a strong OA commitment across all parameters due to its higher citation and AAS score. Followed by the Central University of Punjab with a score of 74.91, and the Central University of Tamil Nadu with 64.53, indicating robust open access practices in both quantity and quality. This trend highlights a progressive approach among newer universities, which appear more aligned with open access policies and digital dissemination practices. In contrast, universities like Aligarh Muslim University (51.72) and University of Delhi (54.13) show relatively lower scores, suggesting scope for improvement in certain areas such as online engagement and licensing. The OAF score thus provides a multidimensional outlook on how well institutions are embracing open access in their research dissemination strategies.

**Table 6.10: Distribution of OA Friendliness Scores of Central Universities Using  
a Simplified OAF Framework (Roy & Mukhopadhyay, 2022)**

| University                                | OA share<br>(weightage-<br>30%) | OA<br>Repository<br>share<br>(weightage-<br>20%) | OA<br>License<br>share<br>(weightage-<br>20%) | OA<br>Citation<br>share<br>(weightage-<br>15%) | OA AAS<br>Share<br>(weightage-<br>15%) | Total<br>OAF<br>Score<br>(100) |
|-------------------------------------------|---------------------------------|--------------------------------------------------|-----------------------------------------------|------------------------------------------------|----------------------------------------|--------------------------------|
| University of Delhi                       | 20.16                           | 20                                               | 7.22                                          | 6.42                                           | 0.33                                   | 54.13                          |
| Banaras Hindu University                  | 20.48                           | 20                                               | 7.87                                          | 8.13                                           | 3.42                                   | 59.9                           |
| Aligarh Muslim University                 | 17.81                           | 20                                               | 8.47                                          | 5.28                                           | 0.16                                   | 51.72                          |
| Jawaharlal Nehru<br>University            | 21.24                           | 20                                               | 9.58                                          | 6.75                                           | 2.52                                   | 60.09                          |
| Jamia Millia Islamia                      | 22.48                           | 20                                               | 9.36                                          | 5.64                                           | 1.71                                   | 59.19                          |
| University of Hyderabad                   | 21.54                           | 20                                               | 9.7                                           | 5.92                                           | 1.14                                   | 58.3                           |
| Pondicherry University                    | 20.83                           | 20                                               | 9.14                                          | 4.02                                           | 1.42                                   | 55.41                          |
| Visva-Bharati University                  | 18.9                            | 20                                               | 7.99                                          | 9.3                                            | 1.36                                   | 57.55                          |
| Tezpur University                         | 20.79                           | 20                                               | 8.5                                           | 3.49                                           | 0.38                                   | 53.16                          |
| North Eastern Hill<br>University          | 21.17                           | 20                                               | 8.58                                          | 3.64                                           | 0.35                                   | 53.74                          |
| Assam University                          | 21.7                            | 20                                               | 9.84                                          | 3.56                                           | 0.64                                   | 55.74                          |
| Mizoram University                        | 22.8                            | 20                                               | 11.7                                          | 4.71                                           | 2.99                                   | 62.2                           |
| Central University of<br>Punjab           | 21.7                            | 20                                               | 9.8                                           | 12.9                                           | 10.51                                  | 74.91                          |
| Central University of Kerala              | 21.6                            | 20                                               | 11.4                                          | 15                                             | 15                                     | 83                             |
| Manipur University                        | 21.3                            | 20                                               | 9.63                                          | 1.99                                           | 0.45                                   | 53.37                          |
| Central University of Tamil<br>Nadu       | 23.7                            | 20                                               | 11.24                                         | 7.43                                           | 2.16                                   | 64.53                          |
| Central University of<br>Jammu            | 24.7                            | 20                                               | 11.37                                         | 2.61                                           | 0.3                                    | 58.98                          |
| Central University of<br>Kashmir          | 21.8                            | 20                                               | 9.66                                          | 1.87                                           | 0.26                                   | 53.59                          |
| English & Foreign<br>Languages University | 24.78                           | 20                                               | 9.56                                          | 0.51                                           | 0.09                                   | 54.94                          |

(Source: Table by Researcher)

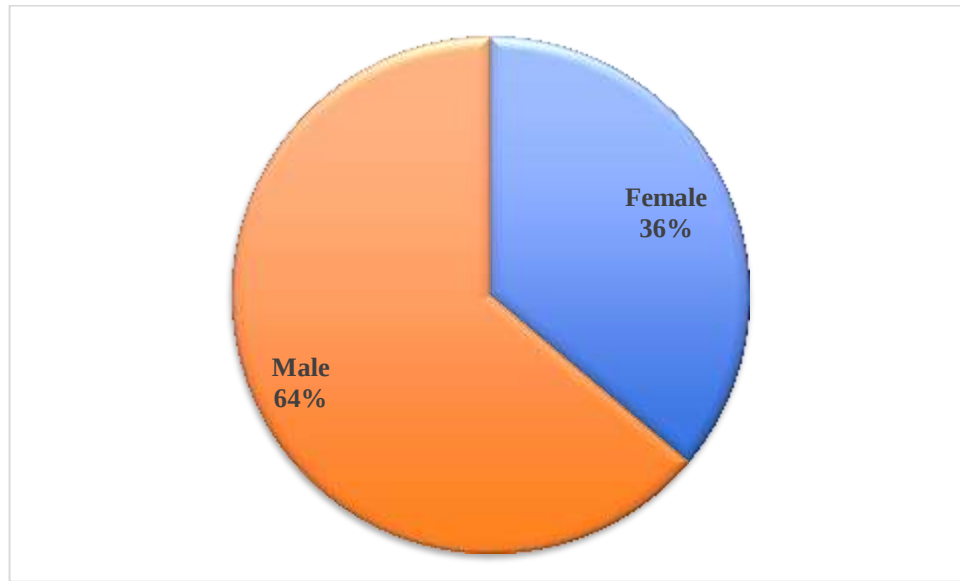
### 6.8. Gender Based Distribution of OA Publications

Gender disparity in research contributions has existed for many years across the globe and in multiple disciplines (Zhu, 2017; Nguyen et al., 2021). Women scholars often face challenges compared to their male counterparts in various cases such as

unequal opportunities, lower visibility, and limited access to resources. At the same time, women's own willingness, determination, and growing participation in research have played a significant role in gradually narrowing this gap. Open Access (OA) publishing further supports this trend by increasing the visibility and reach of research regardless of institutional or geographical boundaries. By making scholarly work freely accessible, OA enhances recognition for underrepresented groups, supports equitable participation, and contributes to greater inclusivity and diversity in global research output. This study identifies the gender disparity in authorship pattern, examining the proportion of male and female contributions to OA research output and how such patterns reflect broader inequalities in scholarly publishing.

#### **6.8.1. Percentage Rate of Male and Female First Authorship**

Identifying the proportion of gender-based research performance provides valuable insight into the contributions of male and female authors from the selected central universities in promoting Open Access. The figure 6.32 illustrates the percentage distribution of male and female first-author contributions to Open Access publications. The results indicate that 64% of first authors are male, while the remaining 36% are female. This indicates that male academicians and researchers from the central universities of India are comparatively more active in producing Open Access research than their female counterparts. The disparity may be influenced by factors such as intake patterns in academic jobs and the research sector, institutional support, mentorship opportunities, and workload distribution, all of which can shape the level of participation and output among male and female researchers.

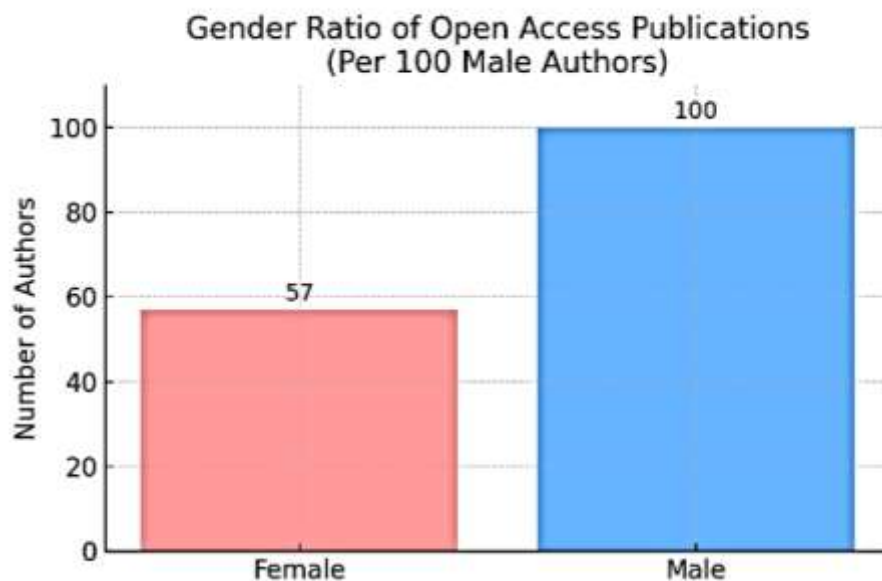


**Figure 6.32: Percentage Rate of Male and Female First Authorship of OA Publications**

(Source: Figure by Researcher)

### **6.8.2. Gender Ratio of OA Publications**

The female-to-male ratio of first authorship in Open Access publications from the selected central universities is approximately 57:100, as presented in Figure 6.33. This means that for every 100 male first authors, there are about 57 female first authors. Such a ratio not only quantifies the observed gender gap but also reinforces the percentage-based findings, indicating that male researchers maintain a higher representation in Open Access scholarly output. This imbalance may be linked to broader systemic factors, including disparities in recruitment and retention in academic positions, unequal access to research funding, and variations in professional networks and collaboration opportunities.



**Figure 6.33: Female-to-male Author Ratio (57:100) Based on Open Access Publications**

(Source: Figure by Researcher)

### 6.9. Ranking of Central Universities Based on the Number of Open Access Publications

Institutional rankings in a specific field help identify leading research hubs that actively contribute to knowledge advancement and innovation. Table 6.11 present the ranking of nineteen central universities based on the number of Open Access (OA) publications, total publications, percentage of OA output, and their NIRF 2022 rank. Also presented in figure 6.34. The analysis reveals that the University of Delhi has the highest number of OA publications (12,215) and total publications (39,065), with an OA proportion of 31.27%, ranking 13th in NIRF. While higher-ranked universities in NIRF tend to have a greater number of OA publications, the percentage of OA output offers a more nuanced understanding of institutional commitment to open access. Visva-Bharati University records the highest OA proportion at 33.07%, followed by Aligarh Muslim University at 30.72%. Additionally, universities with relatively lower total research output such as the Central University of Kerala (24.14%) and Central University of Punjab (26.25%) still show moderate OA representation relative to their total publications. This suggests that while research

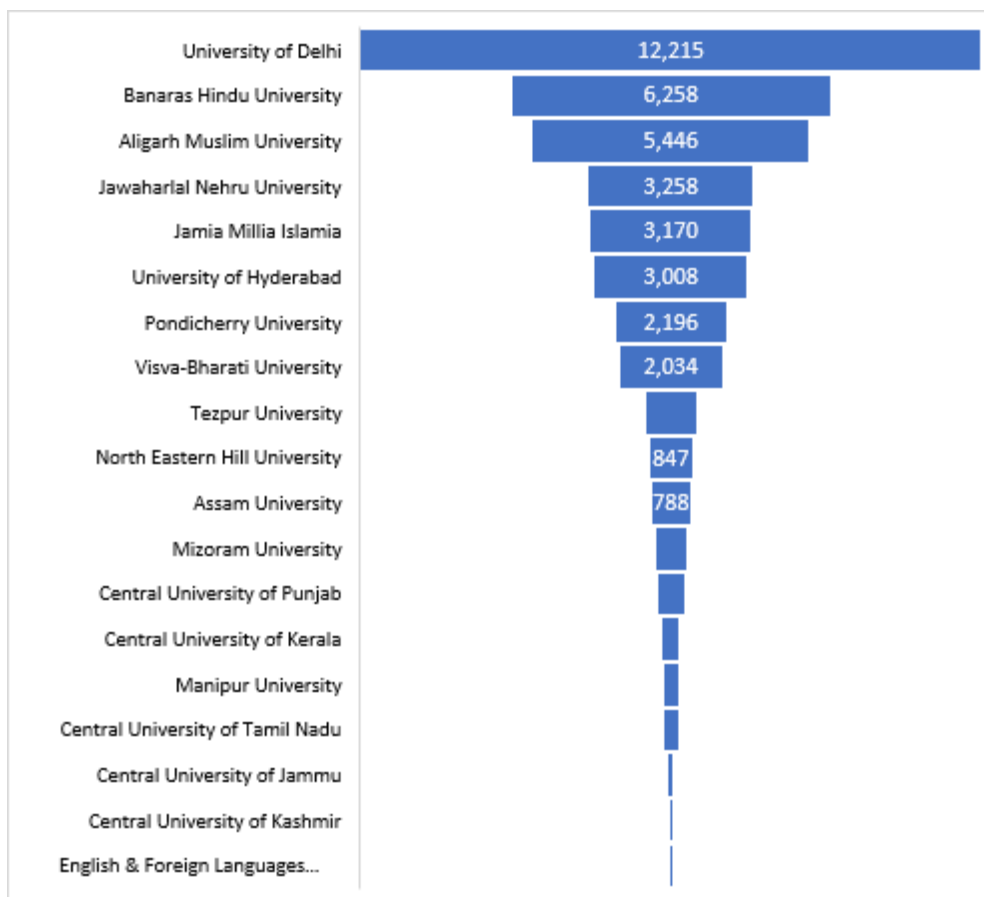
volume and OA output often correlate, the proportion of OA publications varies notably across institutions, reflecting diverse institutional strategies toward open access publishing. Furthermore, the presence of universities with lower NIRF ranks but comparatively higher OA percentages such as Mizoram University (26.58%) and Central University of Tamil Nadu (22.65%) indicates that open access adoption is not strictly dependent on national rankings. Instead, it may be influenced by institutional policies, resource allocations, and field-specific publishing norms.

**Table 6.11: Ranking of Central Universities Based on the Number of Open Access Publications**

| <b>Rank</b> | <b>Central Universities</b>      | <b>Total data</b> | <b>OA data</b> | <b>Percentage of OA</b> | <b>NIRF 2022</b> |
|-------------|----------------------------------|-------------------|----------------|-------------------------|------------------|
| 1           | University of Delhi              | 39,065            | 12,215         | 31%                     | 13               |
| 2           | Banaras Hindu University         | 22,188            | 6,258          | 28.20%                  | 6                |
| 3           | Aligarh Muslim University        | 17,726            | 5,446          | 31%                     | 11               |
| 4           | Jawaharlal Nehru University      | 11,533            | 3,258          | 28.25%                  | 2                |
| 5           | Jamia Millia Islamia             | 15,987            | 3,170          | 29.83%                  | 3                |
| 6           | University of Hyderabad          | 11,530            | 3,008          | 26.08%                  | 10               |
| 7           | Pondicherry University           | 9,453             | 2,196          | 23.23%                  | 68               |
| 8           | Visva-Bharati University         | 6,151             | 2,034          | 33.07%                  | 98               |
| 9           | Tezpur University                | 5,253             | 1,004          | 19.11%                  | 59               |
| 10          | North Eastern Hill University    | 3,692             | 847            | 22.94%                  | 66               |
| 11          | Assam University                 | 2,930             | 788            | 26.89%                  | 101-150*         |
| 12          | Mizoram University               | 2,410             | 641            | 26.58%                  | 78               |
| 13          | Central University of Punjab     | 2,107             | 553            | 26%                     | 81               |
| 14          | Central University of Kerala     | 1,392             | 336            | 24.14%                  | 101-150*         |
| 15          | Manipur University               | 1,620             | 301            | 18.58%                  | 101-150*         |
| 16          | Central University of Tamil Nadu | 1,316             | 298            | 22.65%                  | 85               |
| 17          | Central University of Jammu      | 872               | 110            | 13%                     | 56               |
| 18          | Central University of Kashmir    | 420               | 95             | 23%                     | 53               |
| 19          | English & Foreign Languages      | 119               | 18             | 15.13%                  | 101-150*         |

|              |          |        |        |  |
|--------------|----------|--------|--------|--|
| University   |          |        |        |  |
| <b>Total</b> | 1,55,764 | 42,576 | 27.32% |  |

(Source: Table by Researcher)



**Figure 6.34: Ranking of Indian Central universities Based on Number of OA Publications**

(Source: Figure by Researcher)

## References

- Alem, D. D. (2020). An overview of data analysis and interpretations in research. *International Journal of Academic Research in Education and Review*, 8(1), 1–27.
- Aria, M., Cuccurullo, C., D’Aniello, L., Misuraca, M., & Spano, M. (2024b). Comparative science mapping: a novel conceptual structure analysis with metadata. *Scientometrics*. <https://doi.org/10.1007/s11192-024-05161-6>
- Bhatia, M. K. (2017). Data analysis and its importance. *International Research Journal of Advanced Engineering and Science*, 2(1), 166–168.
- Chen, C. (2017). Science Mapping: A Systematic Review of the literature. *Journal of Data and Information Science*, 2(2), 1–40. <https://doi.org/10.1515/jdis-2017-0006>
- Dindorf, C., Bartaguiz, E., Gassmann, F., & Fröhlich, M. (2022). Conceptual Structure and current trends in Artificial intelligence, machine learning, and deep Learning research in Sports: A Bibliometric review. *International Journal of Environmental Research and Public Health*, 20(1), 173. <https://doi.org/10.3390/ijerph20010173>
- Hugar, J. G. (2019). Impact of Open Access Journals in DOAJ: An Analysis. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3620163>
- Khare, A., & Jain, R. (2022). Mapping the conceptual and intellectual structure of the consumer vulnerability field: A bibliometric analysis. *Journal of Business Research*, 150, 567–584. <https://doi.org/10.1016/j.jbusres.2022.06.039>
- Larivière, V., Haustein, S., & Mongeon, P. (2015). The Oligopoly of Academic Publishers in the Digital Era. *PLoS ONE*, 10(6), e0127502. <https://doi.org/10.1371/journal.pone.0127502>
- Nguyen, H. T. T., Nguyen, M., Le, T., Ho, M., & Vuong, Q. (2021). Open Access Publishing Probabilities Based on Gender and Authorship Structures In Vietnam. *Publications*, 9(4), 45. <https://doi.org/10.3390/publications9040045>
- Piwowar, H., Priem, J., Larivière, V., Alperin, J. P., Matthias, L., Norlander, B., Farley, A., West, J., & Haustein, S. (2018). The state of OA: a large-scale analysis of the prevalence and impact of Open Access articles. *PeerJ*, 6, e4375. <https://doi.org/10.7717/peerj.4375>
- Simao, L. B., Carvalho, L. C., & Madeira, M. J. (2020). Intellectual structure of management innovation: bibliometric analysis. *Management Review Quarterly*, 71(3), 651–677. <https://doi.org/10.1007/s11301-020-00196-4>
- Tahamtan, I., Afshar, A. S., & Ahamdzadeh, K. (2016). Factors affecting number of citations: a comprehensive review of the literature. *Scientometrics*, 107(3), 1195–1225. <https://doi.org/10.1007/s11192-016-1889-2>

- Taherdoost, H. (2020). Different Types of Data Analysis; Data Analysis Methods and Techniques in Research Projects. *International Journal of Academic Research in Management (IJARM)*, 9(1), 1-9
- Zhu, Y. (2017). Who support open access publishing? Gender, discipline, seniority and other factors associated with academics' OA practice. *Scientometrics*, 111(2), 557–579. <https://doi.org/10.1007/s11192-017-2316-z>

# **CHAPTER 7**

## **Findings, Conclusion and Suggestions**

## 7.1. Introduction

This chapter provides a detailed summary of the study's key findings, hypothesis testing, conclusions, and recommendations for future research. The findings are clearly organized in line with the objectives outlined in the previous chapters. The primary aim of the present study is to evaluate the Open Access (OA) publications of the top 19 central universities of India, published between 2005 and 2024, using a data carpentry approach. A total of six objectives were formulated, and the overall analysis was carried out based on these objectives. The study throws an ample light on the level of Open Access adoptability and its various dimensions in research conducted by India's leading academic institutions. The major findings of the study have been presented under two broad categories, as shown below.

- a) Objective-wise findings
- b) General findings of the study

### A. Objective-wise Findings

#### **Objective 1: To Assess the Year-wise Growth of Open Access (OA) Publications Between 2005 to 2024 and Forecast the Future Growth of Research of the Selected Central Universities of India**

- a) In the present study, data were extracted from the Scopus database for all 19 selected central universities of India. The analysis reveals that over the past two decades (2005–2024), these leading universities have published only 27.32% of their total scholarly output as Open Access. This highlights the relatively low adoption of Open Access practices among premier Indian academic institutions as per the Scopus.
- b) The overall research growth indicates a slow but steady increase in Open Access (OA) output, with minor fluctuations observed over the 20-year period. Initially, OA output grew at a slow pace from 2005 to 2014, followed by a decline in 2015. However, from 2016 onwards, OA output began to increase gradually at a relatively higher rate until 2022, after which a decline was noted in 2023 and 2024. The study has also forecasted OA growth for the next two years, i.e., 2025 and 2026, which indicates a positive upward trend.

- c) It was found that Tezpur University, North Eastern Hill University (NEHU), Central University of Tamil Nadu, English and Foreign Languages University, and Manipur University showed an upward trend in OA publications in 2024. In contrast, the remaining universities recorded a decline during the most recent period, particularly in 2023 and 2024, indicating possible shifts in institutional priorities, funding availability, or research output patterns.
- d) The results indicate that most universities experienced a marked rise in OA publications between 2019 and 2022. This surge can likely be attributed to the growing importance of open access research dissemination during the COVID-19 pandemic, when rapid and unrestricted sharing of scientific findings became a global priority. The pandemic period witnessed an increased demand for collaborative research, accelerated peer-review processes, and heightened institutional and funding body mandates for OA publishing. These factors, combined with the widespread use of preprint servers and repository deposits, may have contributed to the substantial growth observed during this period.

**Objective 2: To Analyze the Subject-wise Distribution, Social, Intellectual and Conceptual Structures of OA Publications Trends by Collaboration of Authors and Countries, Citation Impact, and Keywords Analysis**

- a) The study aims to identify the significant subject areas in which most of the research has been carried out and published under the Open Access model. It reveals that authors from the top Indian central universities have mostly worked in the field of Medicine, followed by Biochemistry, Genetics and Molecular Biology, and then Mathematics, while Social Science ranks fourth. It is observed that, comparatively, Open Access researches are mostly conducted in the STEM fields than the other fields.
- b) Over the 20-year period (2005–2024), the citation growth pattern of Open Access publications has shown fluctuations, yet it exhibited an overall upward trend. However, from 2020 onwards, the citation count declined more

sharply up to 2024 possibly because citations typically require time to accumulate.

- c) The most influential papers, based on the number of citations, reveal that research works in the field of Global Burden of Disease (GBD) studies are the most widely discussed in academia.
- d) The top ten prolific journals indicate that publications from Indian central universities are predominantly featured in reputed Open Access journals such as *Scientific Reports* (991 papers), followed by *PLoS ONE* (846 papers), *Journal of High Energy Physics* (592 papers), and seven other journals. This reflects the strong research presence of leading Indian academic institutions and their active contribution to the promotion of Open Science. Moreover, out of the ten journals, eight are fully Open Access, while the remaining two are subscription-based, indicating the availability of funding support and the adoption of the Gold Open Access model to enhance research visibility.
- e) Among the top ten prolific publishers of OA publications, Springer ranks first with the highest number of OA papers, followed by Elsevier BV and Medknow. These publishers are internationally recognized for disseminating high-quality research and have played a significant role in promoting Open Access through their publishing models and extensive global reach.
- f) The co-authorship network of authors from Indian central universities, visualized using VOSviewer, reveals frequent internal collaborations within clusters while also maintaining inter-cluster connections. Authors such as Shyam Sundar, Manish Kumar, and Ashok Kumar appear as central nodes, indicating their strong collaborative roles across multiple research groups.
- g) The co-authorship network shows that Indian central universities have strong international collaborations in open access research, especially with Saudi Arabia, the United States, the United Kingdom, Germany, Japan, South Korea, and the Netherlands. Such partnerships reflect the global reach of their research activities and may contribute to increased visibility, citation impact, research collaboration and knowledge exchange.
- h) The keyword analysis based on occurrences shows that most of the research by Indian central universities has been conducted in areas related to COVID-

19, along with associated themes such as SARS-CoV-2, oxidative stress, apoptosis, machine learning, and deep learning, indicating a strong focus on pandemic-related and interdisciplinary studies. This pattern highlights a strong emphasis on pandemic-driven research as well as the integration of interdisciplinary approaches, combining biomedical sciences with advanced computational techniques.

**Objective 3: To Measure the Open Access Friendliness of the Publications of Central Universities Based on OA Compatibility Parameters (Designed & Developed by Mukhopadhyay, 2022)**

- a) The OA publications contributed by the Indian central universities between 2005 and 2024 are mostly published through the Gold route (58%), followed by Bronze (16%), Hybrid (14%), and lastly, the Green route (12%). This indicates a greater reliance on subscription-based publishing through funding support rather than the self-archiving publishing model.
- b) Over the two decades (2005–2024), OA publications from Indian central universities witnessed the highest growth through the Gold route, marking it as the most preferred model. Hybrid OA showed moderate growth, particularly after 2017. In contrast, Bronze OA declined in recent years, while Green OA recorded the least growth with minimal and inconsistent contributions.
- c) Among the various OA licenses adopted by Indian central universities, CC-BY was the most preferred, with 15,263 publications, followed by CC-BY-NC-ND (3,756) and CC-BY-NC (1,616). Other licenses such as CC-BY-NC-SA, OTHER-OA, and Publisher-Specific OA had relatively lower adoption.
- d) The primary hosting location for most Open Access articles from Indian central universities is publisher platforms (83%), with only 17% having the repository as their main source of access.
- e) When considering secondary copies, 54% of OA articles also have a version archived in an institutional or subject repository, while 46% lack such archiving. This indicates that although Green OA is relatively common as a

supplementary route, there is scope to strengthen self-archiving practices for broader accessibility and long-term preservation.

- f) A larger number of OA articles from Indian central universities are published in journals listed in the DOAJ (21,361) compared to those not listed (18,041). Similarly, 24,887 articles are published in Open Access journals, while 19,606 are in journals that are not fully OA
- g) The OA framework scores reveal notable variations in Open Access adoption and impact across institutions. The Central University of Kerala ranks highest (83%) in OAF score for exceptional OA licensing (11.4%) and citation impact (15%), despite a relatively modest OA share. Mizoram University scores the highest in the licensing parameter with 11.7 out of 20, reflecting its strong commitment to adopting permissive Open Access licenses that maximize the accessibility, reuse, and dissemination of its research outputs. All the selected universities maintain the maximum possible repository share score (20%), indicating good compliance in archiving practices. The Central University of Kerala achieved the highest and full scores in both the citation and Altmetric parameters, indicating exceptional research impact and strong engagement across scholarly and public platforms. Well-known institutions like the University of Delhi and Banaras Hindu University have moderate OAF scores (54.13 and 59.9 respectively), suggesting that high OA output alone does not necessarily guarantee a proportionally higher OA friendliness.
- h) The Central University of Kerala (83), Central University of Punjab (74.91), Central University of Tamil Nadu (64.53), Mizoram University (62.2) and Jawaharlal Nehru University (60.09) ranks among the top five institutions in terms of OA Friendliness (OAF) scores, reflecting their strong performance in Open Access research. Their high scores indicate balanced strengths across OA share, repository availability, licensing practices, citation impact, and Altmetric engagement, highlighting their commitment to advancing open science practices. Rest of the universities have scored below 60 out of 100.
- i) The analysis reveals that several top-ranked central universities in the NIRF standings record comparatively lower OA Friendliness (OAF) scores than mid- to lower-ranked institutions. This suggests that a high national ranking

does not necessarily translate into stronger Open Access practices, indicating potential gaps in OA policy implementation and prioritization even among leading universities.

- j) Although the oldest central universities demonstrate a high volume of OA publications and substantial OA share, several newly established universities compete with them in OA licensing, Altmetric Attention Scores, and citation impact. This indicates that newer institutions may be adopting more progressive and impactful Open Access practices despite having a smaller overall research output.

**Objective 4 To Compare the Open Access Publications Trends in Sciences, Social Sciences and Arts and Humanities Domain**

- a) The subject-wise distribution reveals that 85.3% of OA publications from Indian central universities are in the Science domain, followed by 12.5% in Social Sciences, and only 0.7% in Arts and Humanities. This dominance of science-related research highlights both global publishing patterns and the research priorities of central universities, while the minimal representation of Arts and Humanities suggests limited adoption of OA platforms in these disciplines.

**Objective 5 To Find Out the Gender Ratio of the Open Access Publications of the Selected Central Universities of India**

- a) The gender distribution of first authorship reveals that 64% of first authors are male, while the remaining 36% are female. This indicates that male academicians and researchers from the central universities of India are comparatively more active in producing Open Access research than their female counterparts. The disparity may be influenced by factors such as intake patterns in academic jobs and the research sector, institutional support, mentorship opportunities, and workload distribution, all of which can shape the level of participation and output among male and female researchers.
- b) The female-to-male ratio of first authorship in Open Access publications from the selected central universities is approximately 57:100. This means

that for every 100 male first authors, there are about 57 female first authors. Such a ratio not only quantifies the observed gender gap but also reinforces the percentage-based findings, indicating that male researchers maintain a higher representation in Open Access scholarly output.

**Objective 6 To Rank the Central Universities Based on the Number of Open Access Publications**

- a) Among the selected 19 central universities, the University of Delhi recorded the highest number of Open Access publications (12,215), followed by Banaras Hindu University (6,258) and Aligarh Muslim University (5,446). These three institutions collectively account for over half of the total OA output in the dataset.
- b) When considering the proportion of OA publications relative to total research output, Visva-Bharati University ranks highest with 33.07%, closely followed by Jamia Millia Islamia (29.83%), which also holds the second position in the NIRF rankings among the selected universities. The strong OA ratios of these institutions suggest targeted policies, faculty engagement, or research cultures that prioritize open dissemination, even if their absolute research output is comparatively lower than larger universities.
- c) Out of the total research output of the selected 19 central universities, an average of 27.32% of publications are published through the Open Access route. This proportion of OA research indicates a moderate uptake of OA publishing and it suggests room for growth when compared to global OA adoption rates. Some studies shows that nearly 50% of global research output is currently published via OA, with Gold OA accounting for about 38% of articles in 2023 (STM Association, 2024; Gitnux, 2025).

**B. General Findings of the Study**

- a) A strong surge in OA publications was observed between 2019–2022 across most universities, signifying that the COVID-19 pandemic has accelerated the adoption of open access as a means of rapid knowledge dissemination.

- b) The overall findings of the study reveal that, even though the older central universities based on the year of establishment have a greater number of OA publications than the newly established universities. However, despite having fewer OA publications, the newer universities are found to have stronger OA uptake and have followed OA mandates for promoting Open Science than the older universities.
- c) Among the prolific authors based on the number of OA publications, reveals that the majority are affiliated with the departments of Physics, Chemistry, and Mathematics.
- d) The top contributors of OA publications also belong to the top NIRF-ranked central universities, such as the University of Delhi, Jamia Millia Islamia, and Aligarh Muslim University, indicating a strong alignment between research productivity and institutional ranking.
- e) In terms of receiving the highest Altmetric Attention Scores (AAS) for OA publications, Banaras Hindu University (90,084), Jawaharlal Nehru University (35,037), and the Central University of Punjab (28,025) rank among the top three.
- f) A strong surge in OA publications was observed between 2019–2022 across most universities, signifying that the COVID-19 pandemic has accelerated the adoption of open access as a means of rapid knowledge dissemination.
- g) After 2022, a noticeable decline in OA output is observed in many universities (e.g., JNU, Jamia Millia Islamia, AMU), indicating a post-pandemic normalization and suggesting that the pandemic-driven OA growth was not sustained thereafter.
- h) Several newly established central universities (Central University of Tamil Nadu, Central University of Jammu, Central University of Kashmir) are showing steady upward OA trends despite their shorter history, reflecting growing alignment with national and global OA policies.
- i) While the Indian central universities collaborate widely with collaborators across the globe, the collaboration strength is still unbalanced concentrating with countries like the US, UK, Saudi Arabia, and Bangladesh, leaving a scope for diversifying partnerships with other countries also.

- j) The dominance of a few international publishers like Springer, Elsevier, Wiley etc, in driving OA dissemination highlights limited presence of Indian publishers in large-scale OA publishing, suggesting the need for stronger national/institutional OA platforms.
- k) A large number of OA publications lack clear and authorized license information, which may degrade legal clarity and limit reuse potential, showing the need for stronger advocacy and awareness of standard licensing practices (e.g., Creative Commons).
- l) Although women are contributing significantly to OA publications, the male-dominated first authorship pattern indicates structural imbalances in academic participation and publishing opportunities, which could influence the inclusivity of OA practices in the long term.

## 7.2 Hypothesis Testing

The present study formulated three hypotheses to examine the relationships and determining factors associated with Open Access (OA) publication trends, including contributors' gender, professional status, and the year of establishment of Indian central universities. These hypotheses were developed and subsequently tested based on the findings of the study.

### **H1 There is a significant correlation between the Open Access publication trends and the year of establishment of the central universities.**

A Spearman's rank-order correlation was conducted to examine the relationship between the year of establishment of central universities and their Open Access (OA) publication output. Spearman's correlation was selected because both variables are continuous and the method is appropriate for assessing monotonic relationships without assuming normality. The analysis revealed a strong negative correlation between the two variables,  $\rho = -0.719$ ,  $p < .001$ . This suggests that older universities (established earlier) tend to have higher OA publication outputs compared to those established more recently. The result is statistically significant, indicating that the year of establishment is meaningfully associated with OA publication trends among the sampled central universities.

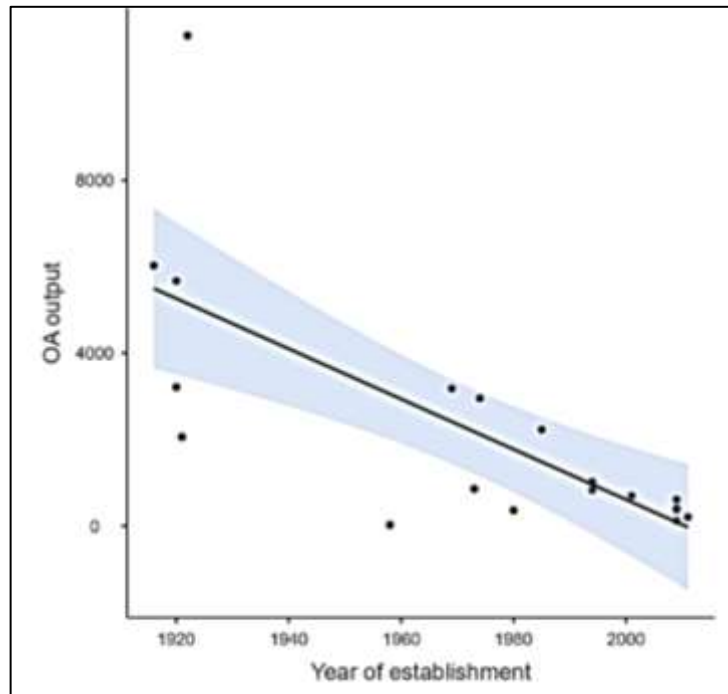
Thus, the hypothesis was supported, as the results showed a strong negative correlation between the year of establishment and OA publication output, indicating that older universities tend to publish more in OA.

**Table 7.1: Spearman's Correlation Between Year of Establishment and OA Publication Output of Central Universities**

| Correlation Matrix    |                |                       |           |
|-----------------------|----------------|-----------------------|-----------|
|                       |                | Year of establishment | OA output |
| Year of establishment | Spearman's rho | —                     |           |
|                       | df             | —                     |           |
|                       | p-value        | —                     |           |
| OA output             | Spearman's rho | -0.719                | —         |
|                       | df             | 17                    | —         |
|                       | p-value        | <.001                 | —         |

*Note.* df=Degree of Freedom, p=value-probability value

(Source: Jamovi)



**Figure 7.1: Scatter Plot Showing the Negative Relationship Between Year of Establishment and Open Access (OA) Publication Output Among Central Universities**

(Source: Jamovi)

## **H2 There is a significant difference in the gender-wise author productivity in OA publications**

The chi-square goodness-of-fit test was conducted to examine gender disparities in OA publication productivity, revealing a statistically significant difference ( $\chi^2 (1) = 2150$ ,  $p < .001$ ). Male authors contributed substantially more publications ( $n = 17,887$ , 63.9%) compared to female authors ( $n = 10,127$ , 36.1%). This robust finding ( $N = 28,014$ ) confirms a systematic gender imbalance in OA publishing output presented in table 7.2. The magnitude of the difference suggests that male authors have a markedly higher share of research dissemination in the OA domain within the studied dataset.

Thus, the hypothesis was supported, as the chi-square test confirmed a significant gender disparity in OA authorship, with male authors contributing a larger share of publications compared to female authors.

**Table 7.2: Gender Distribution of OA Publications with Chi-square Test**

| Proportions - Gender |       |            |
|----------------------|-------|------------|
| Level                | Count | Proportion |
| Female               | 10127 | 0.361      |
| Male                 | 17887 | 0.639      |

| $\chi^2$ Goodness of Fit |    |       |
|--------------------------|----|-------|
| $\chi^2$                 | df | p     |
| 2150                     | 1  | <.001 |

(Source: Jamovi)

## **H3 There is significant correlation between OA Publication Output and status of authors' designation**

A Kruskal–Wallis was conducted to examine whether there is a significant difference in the number of Open Access (OA) publications among the four

designation groups: Professor, Associate Professor, Assistant Professor, and Research Scholar. The Kruskal–Wallis test was selected because the dependent variable (OA output) is continuous, the independent variable (Designation) is ordinal/nominal with more than two groups, and the data did not meet the assumption of normality required for parametric ANOVA. The results presented in Table 7.3, showed no statistically significant difference in the number of OA publications across professional designations,  $\chi^2 (3) = 2.09$ ,  $p = 0.555$ . This means that Professors, Associate Professors, Assistant Professors, and Research Scholars produced OA outputs at statistically comparable levels, and professional status did not appear as a determining factor in OA publishing activity. Professional status does not significantly predict OA publication output in Indian central universities. The null hypothesis of no difference, therefore, the hypothesis is supported..

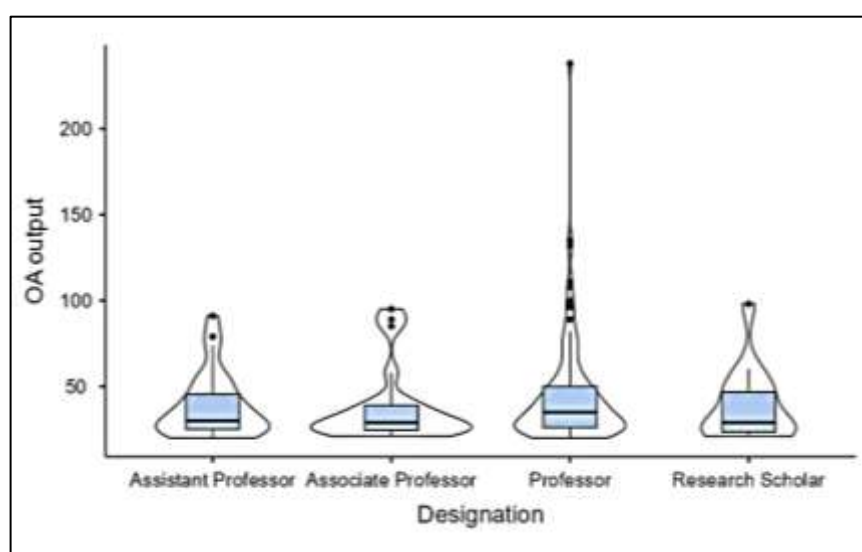
The distribution of OA publications by designation is further illustrated in Figure 7.2 through a combined box–violin plot. The median lines within each box appear closely aligned across groups, and the interquartile ranges overlap substantially, emphasizing the statistical finding of no significant difference. Although Professors demonstrate a slightly wider range of OA publications, this variation is not statistically meaningful given the test results. The violin shapes also indicate that the density of publication output is similarly distributed among all four categories.

Thus, the hypothesis was rejected, as the Kruskal–Wallis test revealed no statistically significant difference in OA publication output across professional designations, suggesting comparable contributions across all status.

**Table 7.3: Kruskal–Wallis Test of OA Publication Output Across Professional Designations**

| Kruskal-Wallis   |          |    |       |
|------------------|----------|----|-------|
|                  | $\chi^2$ | df | p     |
| <b>OA output</b> | 2.09     | 3  | 0.555 |

(Source: Jamovi)



**Figure 7.2: Distribution of Open Access (OA) Publications by Designation Presented Through a Box–violin Plot**

(Source: Jamovi)

### 7.3 Conclusion

The Open Access (OA) movement originated as a response to the rising costs of journal subscriptions, which created significant barriers to accessing scholarly literature. The movement gained significant momentum through landmark initiatives such as the Budapest Open Access Initiative (2002), the Bethesda Statement on Open Access Publishing (2003), the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003). At the national level, the Delhi Declaration on Open Access (2018) further strengthened the movement in the Indian context by emphasizing the importance of free and open access to publicly funded research. Collectively, these initiatives have greatly influenced the global landscape of

scholarly communication by promoting unrestricted access to research outputs, through enhancing knowledge dissemination, fostering academic collaboration, and positively transforming research accessibility across the world.

The movement is primarily driven by diverse group of stakeholders, including researchers, academicians, librarians, educators, policymakers, and the general public, united by the goal of ensuring equitable access to knowledge. Researchers and academicians contribute by publishing their work in open access platforms for making their results freely available to a wider audience. Librarians play a crucial role as the facilitators of institutional repositories, managing open access resources, and guiding authors on self-archiving and licensing options. Educators support the movement by integrating open access materials into teaching and curriculum development, by expanding students' access to quality learning resources. Policymakers strengthen the movement by formulating mandates and funding policies that require publicly funded research to be openly accessible. Similarly, the general public consisting of students, independent scholars and professionals supports the movement by demanding access to research outputs beyond traditional academic boundaries. Altogether, these groups form the backbone of the Open Access movement, working collaboratively toward a more inclusive and democratic system of scholarly communication.

Academic and research institutions serve as primary hubs where a substantial volume of scholarly work is produced and disseminated. Consequently, monitoring the growth of Open Access (OA) research contributions within these institutions is crucial for assessing their level of participation and engagement in promoting the principles of Open Science. Institutional OA output is increasingly regarded as a benchmark for evaluating research visibility, accessibility, and societal impact. It also plays a significant role in policy evaluations and ranking frameworks, where openness and research dissemination are considered indicators of academic excellence. Furthermore, the growing OA contributions of academic institutions reflect the cumulative impact and success of the long-standing efforts made by various international and national bodies to advance the Open Access movement. These contributions not only validate past initiatives but also provide valuable evidence for governments and funding agencies to design and implement effective

policies that further strengthen the culture of openness in research and higher education. Thus, tracking OA growth in academic institutions highlights both their commitment to equitable knowledge sharing and their strategic role in shaping the future of scholarly communication and policy development.

The present study traces the growth and contribution of Open Access (OA) research by selected top central universities of India, as indexed in the Scopus database, for the period 2005–2024. The OA publications have been analyzed using a data carpentry approach, which involves systematic data cleaning, transformation, and organization to ensure accuracy, consistency, and reproducibility. This approach not only facilitates reliable analysis of large-scale bibliometric datasets but also enhances transparency, allowing other researchers to replicate the study or extend it in future investigations. The findings of the study provide a comprehensive insight into the uptake and adoption of Open Access by India's top universities, highlighting their role in promoting open and equitable dissemination of scholarly knowledge. The overall growth of OA publications by the all the nineteen central universities revealed that OA publications constitute only 27.32% of the total research output, indicating moderate adoption among premier Indian universities. OA output grew gradually from 2005 to 2014, declined in 2015, and increased steadily from 2016 to 2022, followed by a slight decline in 2023–2024. Forecasts for 2025–2026 indicate a positive upward trend. Universities such as Tezpur, NEHU, Central University of Tamil Nadu, EFLU, and Manipur exhibited growth in 2024, while others recorded a decline. The surge in OA publications between 2019 and 2022 reflects the impact of the COVID-19 pandemic, which accelerated collaborative research, peer-review processes, and institutional mandates for OA dissemination. The central universities have widely conducted OA research primarily in STEM disciplines, with Medicine leading, followed by Biochemistry, Genetics, and Mathematics, while Social Sciences and Arts remain underrepresented. Citation trends indicate fluctuations but an overall upward trajectory, though post-2020 citations declined due to accumulation lag. Highly cited works include Global Burden of Disease studies, and leading journals such as *Scientific Reports*, *PLoS ONE*, and *Journal of High Energy Physics* host most OA publications, highlighting the prominence of the Gold OA model. International collaborations are notable with countries like USA, UK, Saudi

Arabia, and Germany, while keyword analysis of OA publications reveals a strong focus on COVID-19 and related interdisciplinary themes, including machine learning, deep learning, oxidative stress, and apoptosis, indicating that universities actively responded to global health challenges while integrating computational and biomedical approaches.

The OA friendliness analysis reveals a strong preference for Gold OA (58%), followed by Bronze, Hybrid, and Green routes. CC-BY licenses dominate, and publisher platforms host 83% of OA articles, though 54% are archived in repositories. The OA Friendliness (OAF) framework identifies Central University of Kerala, Central University of Punjab, and Central University of Tamil Nadu as top performers, while some older high-ranking universities exhibit lower OAF scores, reflecting gaps in policy implementation and OA awareness. Gender analysis shows that male authors contribute 64% of first-author publications, indicating structural disparities in research participation.

Ranking of institutions by OA output highlights the University of Delhi, Banaras Hindu University, and Aligarh Muslim University as leaders in volume, whereas Visva-Bharati and Jamia Millia Islamia lead in OA proportion, reflecting institutional commitment to knowledge dissemination. Overall, the study demonstrates moderate OA adoption, concentrated activity in STEM fields, minor gender imbalance in authorship, and variability in OA friendliness across institutions, pointing to both progress and opportunities for strengthening Open Access practices in Indian academia.

Lastly, the present study highlights the evolving significance of Open Access publishing over the past two decades within the landscape of Indian academia. It underscores the growing necessity of Open Access in the present era and emphasizes its critical role in sustaining and advancing scholarly research. Greater recognition and investment in Open Access, supported by appropriate licensing frameworks and the adoption of optimal OA publishing routes, will not only facilitate free and equitable access to research but also establish Indian academia as a role model in the global scholarly communication ecosystem.

#### **7.4. Suggestions**

The present study has generated significant insights into the current scenario of OA publishing and its adoption patterns in Indian central universities. Based on its major findings, several valuable suggestions have been proposed to enhance the adoption of Open Access within the Indian academic landscape. These recommendations are expected to assist institutions, academicians, researchers, and policymakers in promoting global knowledge dissemination and positioning Indian universities more competitively alongside their counterparts in developed countries. The suggestions are as follows:

- 1) Each central university should strengthen the Institutional OA Policies and create a clear institutional open access (OA) policy aligned with national and international mandates.
- 2) Universities should conduct awareness programs through workshops, training, and orientation programs for faculty and research scholars on the benefits and procedures of OA publishing.
- 3) Universities should take initiatives to encourage the researchers by providing incentives for OA Publishing through recognition, awards, or financial incentives for researchers who publish in quality OA journals or deposit work in repositories.
- 4) Although OA aims to democratize access to knowledge, but the Article Processing Charges (APCs) often acts as a significant barrier to publishing in OA platforms. It is therefore recommended that universities should establish dedicated funding mechanisms to cover APCs, with particular emphasis on supporting early-career researchers.
- 5) To broaden the diversity and inclusivity of knowledge exchange, it is recommended that Indian central universities should actively consider research collaborations with underrepresented global regions (such as Africa, Latin America, and Southeast Asia). Such collaborations would not only broaden the scope of significant research ideas but also contribute to global capacity building and equitable knowledge sharing.

- 6) OA research contributions from Indian academic institutions are predominantly focused in STEM disciplines. To achieve a more balanced and comprehensive representation of knowledge, it is recommended to promote OA publishing in the Arts, Humanities, and Social Sciences, which remain comparatively underrepresented.
- 7) Licensing plays a critical role in OA publishing, yet it is found to be moderately weak in the OA research output of Indian central universities. It is therefore recommended to advocate for the adoption of standard Creative Commons licenses (e.g., CC-BY) to maximize research reuse and minimize ambiguity.
- 8) It is recommended to develop mentorship and research-support programs aimed at enhancing women's participation in OA publishing, thereby fostering a more balanced pattern of research authorship
- 9) It is recommended to encourage government–university collaboration to establish a national OA publishing platform, thereby reducing dependence on commercial publishers.
- 10) The creation of inter-university consortia for shared repository infrastructure is recommended as a strategic measure to enhance the visibility and accessibility of research outputs. Such collaborative frameworks would foster a culture of knowledge sharing and motivate greater research participation.
- 11) It is recommended to Strengthen monitoring and evaluation mechanisms for OA adoption is essential to ensure accountability, track progress, and enable evidence-based policy interventions for sustained growth of Open Access practices.
- 12) It is recommended that authors consider publishing in DOAJ-listed journals to ensure credibility, visibility, and quality of their research outputs.
- 13) It is recommended that Indian universities incorporate OA contributions as a criterion in academic performance evaluations for advancing open scholarly communication.
- 14) The initiation of national-level awareness campaigns is recommended to popularize the benefits of OA among researchers and students, thereby fostering a stronger culture of openness in scholarly communication.

- 15) The establishment of structured mentorship programs, pairing senior OA-active researchers with early-career scholars, is recommended to foster research capacity and strengthen the culture of OA publishing.
- 16) Institutions are encouraged to align their OA practices with UNESCO's Recommendation on Open Science (2021), thereby ensuring global recognition, adherence to international standards, and effective benchmarking.

### 7.5. Scope for Future Research

Although the present study has been carried out with certain limitations in terms of database selection (Scopus), institutional coverage (central universities), and time frame (2005–2024), the findings cannot be generalized across the entire Indian higher education landscape. These limitations leave ample scope for future research in this area to obtain more comprehensive results. The potential paths for future research include:

- 1) **Inclusion of Multiple Databases:** The findings of the present study are confined to the Scopus database only. Future research can incorporate other scholarly databases such as Web of Science, Google Scholar, OpenAlex, Dimensions.ai, and PubMed to achieve broader coverage and generate more comprehensive results across wider time periods.
- 2) **Survey-Based Studies:** While this study relied solely on secondary data, future research could employ survey-based methodologies to capture the perceptions, attitudes, and experiences of researchers and academicians regarding Open Access across multiple disciplines.
- 3) **Expanding Institutional Coverage:** The present study focused exclusively on the central universities of India. Future investigations could extend the scope to include state universities, Indian Institutes of Technology (IITs), Indian Institutes of Management (IIMs), and other higher educational and research institutions to develop a more holistic understanding of OA adoption.

- 4) **Ground-Level Practices of Academicians:** To extensively examine the OA practices of Indian academicians, survey-based studies may be conducted to explore the initiatives taken at the ground level including self-archiving, use of repositories, and preferences for specific OA publishing routes.
- 5) **Global Benchmarking and Comparative Analysis:** Future studies may also compare India's Open Access performance with international benchmarks, such as UNESCO's Recommendation on Open Science (2021), Plan S, and similar global initiatives. Such comparative analysis would highlight India's position in the worldwide OA movement and provide valuable insights for aligning national strategies with global best practices.

## References

STM Association. (2024). *The STM open access dashboard 2024*. <https://stm-assoc.org/oa-dashboard/oa-dashboard-2024/>

Gitnux. (2025). *Open access statistics*. <https://gitnux.org/research-and-statistics/>

## BIBLIOGRAPHY

- Addair, K. (2015). Open Access: The Importance of Open Information. 10.13140/RG.2.1.5098.6324
- Alem, D. D., (2020). An Overview of Data Analysis and Interpretations in Research. *International Journal of Academic Research in Education and Review*, 8(1), 1-27.
- Ali, A., Nazim, M., & Ahmad, S. (2024). An Empirical Investigation of Open Access Scholarly Publishing Trends in Social Sciences at High-ranked Central Universities of India. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-02-2024-0102>
- Aligarh Muslim University. (2024). <https://www.amu.ac.in/>
- Allen, C., & Mehler, D. M. A. (2019). Open science challenges, benefits and tips in early career and beyond. *PLoS Biology*, 17(5), e3000246. <https://doi.org/10.1371/journal.pbio.3000246>
- AlRyalat, S. A., Saleh, M., Alaqraa, M., Alfukaha, A., Alkayed, Y., Abaza, M., Saa, H. A., & Alshamiry, M. (2019). The impact of the open-access status on journal indices: a review of medical journals. *F1000Research*, 8, 266. <https://doi.org/10.12688/f1000research.17979.1>
- Altmetric. (2025). *Altmetric*. <https://www.altmetric.com/>
- Antelman, K. (2004). Do Open-Access articles have a greater research impact? *College & Research Libraries*, 65(5), 372–382. <https://doi.org/10.5860/crl.65.5.372>
- Aria, M., Cuccurullo, C., D’Aniello, L., Misuraca, M., & Spano, M. (2024). Comparative science mapping: a novel conceptual structure analysis with metadata. *Scientometrics*. <https://doi.org/10.1007/s11192-024-05161-6>
- Assam University. (2024). <http://www.aus.ac.in/>

Association of College and Research Libraries (2004). *Principles and strategies for the reform of scholarly communication*. American Library Association.

Available:

<http://www.ala.org/ala/acrl/acrlpubs/whitepapers/principlesstrategies.htm>

B, R., & H, R. B (2021). Preferences and Citation Impact of Open Access Publishing by Indian Research Community Indian Research Community. *Library Philosophy & Practice*.

Bailey, C. W. (2006). What is open access? In N. Jacobs (Ed.), *Open access: Key strategic, technical and economic aspects* (pp. 13–26). Chandos Publishing.  
<https://doi.org/10.1016/B978-1-84334-203-8.50002-9>

Baker, J., Moore, C., Priego, E., Alegre, R., Cope, J., Price, L., Stephens, O., Van Strien, D., & Wilson, G. (2016). Library Carpentry: Software skills training for library professionals. *LIBER Quarterly the Journal of the Association of European Research Libraries*, 26(3), 141–162.  
<https://doi.org/10.18352/lq.10176>

Banaras Hindu University. (2024). [https://www.bhu.ac.in/Site/Home/1\\_2\\_16\\_Main-Site](https://www.bhu.ac.in/Site/Home/1_2_16_Main-Site)

Barik, N., & Jena, P. (2021). Does India move toward open access of publications? *Journal of Archival Organization*, 18(1–2), 51–62.  
<https://doi.org/10.1080/15332748.2021.1992203>

Barker, M., Hong, N. P. C., Katz, D. S., Lamprecht, A., Martinez-Ortiz, C., Psomopoulos, F., Harrow, J., Castro, L. J., Gruenpeter, M., Martinez, P. A., & Honeyman, T. (2022). Introducing the FAIR Principles for research software. *Scientific Data*, 9(1). <https://doi.org/10.1038/s41597-022-01710-x>

Baro, E. E., & Eze, M. E. (2017). Perceptions, preferences of scholarly publishing in open access routes. *Information and Learning Sciences*, 118(3/4), 152–169.  
<https://doi.org/10.1108/ils-03-2017-0015>

- Basorum, M. T., Jain, P., Sebina, P. M. and Kalusopa, T. (2013). The evolution of electronic publishing: a literature review. *Transnational Journal of Science and Technology*, 3 (4).
- Bass, R. V., & Good, J. W. (2004). Educare and Educere: Is a Balance Possible in the Educational System? *The Educational Forum*, 68(2), 161–168. <https://doi.org/10.1080/00131720408984623>
- Bautista-Puig, N., Lopez-Illescas, C., De Moya-Anegon, F., Guerrero-Bote, V., & Moed, H. F. (2020). Do journals flipping to gold open access show an OA citation or publication advantage? *Scientometrics*, 124(3), 2551–2575. <https://doi.org/10.1007/s11192-020-03546-x>
- Beasley, G. (2016). Article processing charges: A new route to open access? *Information Services & Use*, 36(3–4), 163–170. <https://doi.org/10.3233/isu-160815>
- Beaudry, C., Prozesky, H., St-Pierre, C., & Mirnezami, S. R. (2023). Factors that affect scientific publication in Africa—A gender perspective. *Frontiers in Research Metrics and Analytics*, 8. <https://doi.org/10.3389/frma.2023.1040823>
- Berkenkotter, C. (1995). The power and the perils of peer review. *Rhetoric Review*, 13(2), 245–248. <https://doi.org/10.2307/465828>
- Bethesda Statement on Open Access Publishing. (2003, June 20). *Bethesda Statement on open access publishing*. Howard Hughes Medical Institute. <https://dash.harvard.edu/handle/1/4725199>
- Bhatia, M. K. (2017). Data analysis and its importance. *International Research Journal of Advanced Engineering and Science*, 2 (1), 166-168.
- Birkbeck, G., Nagle, T., & Sammon, D. (2022). Challenges in research data management practices: a literature analysis. *Journal of Decision System*, 31(1), 153–167. <https://doi.org/10.1080/12460125.2022.2074653>

- Björk, B. (2017). Gold, green, and black open access. *Learned Publishing*, 30(2), 173–175. <https://doi.org/10.1002/leap.1096>
- Björk, B. C. (2004). Open access to scientific publications: An analysis of the barriers to change. *Information Research*, 9(2), Paper 170. <http://informationr.net/ir/9-2/paper170.html>
- Borgman, C.L. (2000). Digital libraries and continuum of scholarly communication. *Journal of Documentation*, 56 (4), 412-430.
- Budapest Open Access Initiative. (2002, February 14). *Budapest Open Access Initiative*. <https://www.budapestopenaccessinitiative.org/>
- Cai, L., & Zhu, Y. (2015). The Challenges of Data Quality and Data Quality Assessment in the Big Data Era. *Data Science Journal*, 14(0), 2. <https://doi.org/10.5334/dsj-2015-002>
- Calabrese, A. (1992). Changing times for scholarly communication: The case of the electronic journal. *Technology in Society*, 14(2), 199–220. [https://doi.org/10.1016/0160-791x\(92\)90004-t](https://doi.org/10.1016/0160-791x(92)90004-t)
- Central University of Jammu. (2024). <https://www.cujammu.ac.in/>
- Central University of Kashmir. (2024). <https://web.cukashmir.in/#/publiczone>
- Central University of Kerala. (2024). <https://www.cukerala.ac.in/>
- Central University of Punjab. (2024). <https://cup.edu.in/>
- Central University of Tamil Nadu. (2024). <https://cutn.ac.in/>
- Chandrashekara, M., & Ramasesh, C. P. (2009, March 6–8). Library and information science research in India. In *Proceedings of the Asia-Pacific Conference on Library & Information Education & Practice* (pp. 530–537). University of Tsukuba, Japan.
- Chen, C. (2017). Science Mapping: A Systematic Review of the literature. *Journal of Data and Information Science*, 2(2), 1–40. <https://doi.org/10.1515/jdis-2017-0006>

- Christian, G. E. (2008). Open access initiative and the developing world. *African journal of Library, Archives and Information Science*, 18(1), 1-22.
- Cintra, P. R., Furnival, A. C., & Milanez, D. H. (2018). The impact of open access citation and social media on leading top Information Science journals. *Investigación Bibliotecológica Archivonomía Bibliotecología E Información*, 32(77), 117. <https://doi.org/10.22201/iibi.24488321xe.2018.77.57874>
- Creative Commons. (n.d.). *About CC licenses*. <https://creativecommons.org/share-your-work/cclicenses/>
- Das, A. K. (2018). Delhi declaration on open access 2018: An overview. *Annals of Library and Information Studies*, 65(1), 83–84.
- Davis, P. M., Lewenstein, B. V., Simon, D. H., Booth, J. G., & Connolly, M. J. L. (2008). Open access publishing, article downloads, and citations: randomised controlled trial. *BMJ*, 337(jul31 1), a568. <https://doi.org/10.1136/bmj.a568>
- Deori, M., Verma M. K. & Nazim, M. (2022). Open Access Availability of India's Scientific Research Funded by National and International Agencies. *DESIDOC Journal of Library & Information Technology*, 42(04), 234-245. [10.14429/djlit.42.4.17810](https://doi.org/10.14429/djlit.42.4.17810)
- Department of Higher Education. (2016). *State private universities*. Ministry of Education, Government of India. <https://www.education.gov.in/en/state-private-universities>
- Dindorf, C., Bartaguiz, E., Gassmann, F., & Fröhlich, M. (2022). Conceptual Structure and current trends in Artificial intelligence, machine learning, and deep Learning research in Sports: A Bibliometric review. *International Journal of Environmental Research and Public Health*, 20(1), 173. <https://doi.org/10.3390/ijerph20010173>
- Dufour, Q., Pontille, D., & Torny, D. (2023). Supporting diamond open access journals. Interest and feasibility of direct funding mechanisms. *bioRxiv*

(Cold Spring Harbor Laboratory).  
<https://doi.org/10.1101/2023.05.03.539231>

Elsevier. (2025). Scopus: Comprehensive, multidisciplinary, trusted abstract and citation database. <https://www.elsevier.com/en-in/products/scopus>

English & Foreign Languages University. (2024). <https://www.efluniversity.ac.in/>

Ferreras-Fernández, T., García-Peñalvo, F., Merlo-Vega, J. A., & Martín-Rodero, H. (2016). Providing open access to PhD theses: visibility and citation benefits. *Program Electronic Library and Information Systems*, 50(4), 399–416. <https://doi.org/10.1108/prog-04-2016-0039>

Fjällbrant, N. (1997). Scholarly communication: Historical development and new possibilities. In *Proceedings of the IATUL Conference* (Paper 5). Purdue University. <https://docs.lib.purdue.edu/iatul/1997/papers/5>

Fraser, N., Momeni, F., Mayr, P., & Peters, I. (2019). *Altmetrics and Open Access: Exploring Drivers and Effects*. ZBW – Leibniz Information Centre for Economics.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2006). *Educational research: Competencies for analysis and applications* (8th ed.). Merrill Prentice Hall.

Gitnux. (2025). *Open access statistics*. <https://gitnux.org/research-and-statistics/>

Greussing, E., Kuballa, S., Taddicken, M., Schulze, M., Mielke, C., & Haux, R. (2020). Drivers and obstacles of open access publishing. A qualitative investigation of individual and institutional factors. *Frontiers in Communication*, 5. <https://doi.org/10.3389/fcomm.2020.587465>

Guerrero, R. and Piqueras, M. (2004). Open access. A turning point in scientific publication. *International Microbiology*, 7, 157-161.

Gulley, N. (2013). Creative Commons: challenges and solutions for researchers; a publisher's perspective of copyright in an open access environment. *Insights the UKSG Journal*, 26(2), 168–173. <https://doi.org/10.1629/2048-7754.107>

- Gupta, A. (2021). Focus on quality in higher education in India. *Indian Journal of Public Administration*, 67(1), 54-70.  
<https://doi.org/10.1177/00195561211007224>
- Gutam, S., Mishra, A. K., Pandey, P. S., Hariharan, C., Chandrasekaran, M., & Guttikonda, A. (2010). *Status of open access repositories in India* [Unpublished manuscript]. Social Science Research Network.  
[http://works.bepress.com/sridhar\\_gutam/54/](http://works.bepress.com/sridhar_gutam/54/)
- Haschak, P. G. (2007). The ‘platinum route’ to open access: a case study of EJASL: The Electronic Journal of Academic and Special Librarianship. *Information Research*, 12(4).
- Hazarika, R., & Sudhier, K. (2025). The growth and impact of global open-access publications in digital archaeology: insights from OpenAlex. *Information Discovery and Delivery*. <https://doi.org/10.1108/idd-08-2024-0125>
- Hazarika, R., & Sudhier, K. G. (2024). Mapping Open Access Publishing Trends in Central Universities of North East India: A Scientometric Approach. *Science & Technology Libraries*, 1–19.  
<https://doi.org/10.1080/0194262x.2024.2416952>
- Hazarika, R., Roy, A., & Sudhier, K. (2024). Mapping the open access publications of Indian non-profit organizations over the last 20 years based on OpenAlex insights. *Global Knowledge Memory and Communication*.  
<https://doi.org/10.1108/gkmc-02-2024-0106>
- Hidalgo, D. B., Bravo, M. V. C., & Iturralde, W. M. P. (2023). Comparative study of Open Access and Non-Open Access journals in subject area Energy. *OALib*, 10(07), 1–11. <https://doi.org/10.4236/oalib.1110426>
- Hoeyer, K., Svendsen, M. N., & Koch, L. (2008). OECD guidelines on open access: commercialization in disguise? *Trends in Biotechnology*, 26(9), 479–482.  
<https://doi.org/10.1016/j.tibtech.2008.05.006>

- Huang, C., Neylon, C., Montgomery, L., Hosking, R., Diprose, J. P., Handcock, R. N., & Wilson, K. (2024b). Open access research outputs receive more diverse citations. *Scientometrics*, 129(2), 825–845. <https://doi.org/10.1007/s11192-023-04894-0>
- Hugar, J. G. (2019). Impact of Open Access Journals in DOAJ: An Analysis. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3620163>
- International Federation of Library Associations and Institutions. (2004). *IFLA statement on open access to scholarly literature and research documentation*. <https://repository.ifla.org/items/9723652d-6d90-47d6-b3cc-4323e2785f4a>
- Jain, V. K., Iyengar, K. P., & Vaishya, R. (2020). Article processing charge may be a barrier to publishing. *Journal of Clinical Orthopaedics and Trauma*, 14, 14–16. <https://doi.org/10.1016/j.jcot.2020.10.039>
- Jalal, S. K. & Mukhopadhyay, P. (2022). Assessing Open Access Friendliness of National Institutes of Technology (NITs): A Data Carpentry Approach, *DESIDOC Journal of Library & Information Technology*, 42(05), 331-338.
- Jalal, S. K. & Mukhopadhyay, P. (2022). Gender differences, data carpentry and bibliometric studies in Mathematics. *COLLNET Journal of Scientometrics and Information Management*, 16(2), 465-476. [10.1080/09737766.2022.2090873](https://doi.org/10.1080/09737766.2022.2090873)
- Jalal, S. K. & Mukhopadhyay, P. (2022). Measuring the Open Access Friendliness of the state universities through Data Carpentry. *SRELS Journal of Information Management*, 69 225-237.
- Jamia Millia Islamia. (2024). <https://jmi.ac.in/>
- Jawaharlal Nehru University. (2024). <https://www.jnu.ac.in/main/>
- Jayakanth, F., Minj, F., Silva, U., & Jagirdar, S. (2008). ePrints@IISc: India's first and fastest growing institutional repository. *OCLC Systems & Services*, 24(1), 59–70. <https://doi.org/10.1108/10650750810847260>

- Jhamb, G. & Samim, A. (2017). Contribution to Open Access Repository by the Central Universities of India: A Case Study of Shodhganga. *Library Philosophy and Practice*. 1559,
- Jilani, M., & Banerjee, A. (2023). Correlation of article processing charges with journal metrics: A study of gold open access journals from India. *South African Journal of Library and Information Science*, 89(1).
- Joshi, A. N., Vatnal, R. M., & Manjunath, G. A. (2012). Open access initiatives: A boon to academic libraries. *Library Philosophy and Practice*, 1.
- Kampa, R. J., Sa, M. K. & Dora, M., (2023). Publications in gold open access and article processing charge expenditure: evidence from Indian scholarly output. *Current Science*, 125(10), 1057-1062. 10.18520/cs/v125/i10/1057-1062
- Khanday, S. A., & Khanam, D. (2019). The research design. *Journal of Critical Reviews*, 6(3), 1–4.
- Khare, A., & Jain, R. (2022). Mapping the conceptual and intellectual structure of the consumer vulnerability field: A bibliometric analysis. *Journal of Business Research*, 150, 567–584. <https://doi.org/10.1016/j.jbusres.2022.06.039>
- Kington, R. S., Arnesen, S., Chou, W. S., Curry, S. J., Lazer, D., & Villarruel, A. M. (2021). Identifying Credible Sources of Health Information in Social Media: Principles and Attributes. *NAM Perspectives*. <https://doi.org/10.31478/202107a>
- Kirtania, D. K. (2018). Bibliometric study of Indian open access social science literature. *Library Philosophy and Practice (e-journal)*
- Kousha, K., & Abdoli, M. (2010). The citation impact of Open Access agricultural research. *Online Information Review*, 34(5), 772–785. <https://doi.org/10.1108/14684521011084618>

- Kulkarni, A. M., Muthumari P. and Nemade, N. D. (2020). Scholarly Communication in India, *International Journal of Management* 11(11), 781-789. 10.34218/IJM.11.11.2020.073
- Kwon, E., Yun, J., & Kang, J. (2023). The effect of the COVID-19 pandemic on gendered research productivity and its correlates. *Journal of Informetrics*, 17(1), 101380. <https://doi.org/10.1016/j.joi.2023.101380>
- Laakso, M., & Björk, B. (2013). Delayed open access: An overlooked high-impact category of openly available scientific literature. *Journal of the American Society for Information Science and Technology*, 64(7), 1323–1329. <https://doi.org/10.1002/asi.22856>
- Laakso, M., Welling, P., Bukvova, H., Nyman, L., Björk, B. C., & Hedlund, T. (2011). The development of open access journal publishing from 1993 to 2009. *PloS one*, 6(6), e20961. <https://doi.org/10.1371/journal.pone.0020961>
- Lal, K. (2008). Open access: Major issues and global initiatives. *DESIDOC Journal of Library & Information Technology*, 28(1), 67-71.
- Langham-Putrow, A., Bakker, C., & Riegelman, A. (2021). Is the open access citation advantage real? A systematic review of the citation of open access and subscription-based articles. *PLoS ONE*, 16(6), e0253129. <https://doi.org/10.1371/journal.pone.0253129>
- Larivière, V., Haustein, S., & Mongeon, P. (2015). The Oligopoly of Academic Publishers in the Digital Era. *PLoS ONE*, 10(6), e0127502. <https://doi.org/10.1371/journal.pone.0127502>
- Lederberg, J. (1993). Communication as the root of scientific progress. *Current Contents* 1(5-11).
- Ling, T. C., Yaacob. M. H & Phang, K.K. (1996). An overview of electronic publishing. *Malaysian Journal of Library & Information Science*, 1(2), 1-11.

- Loan, F. A. & Mushtaq, R. (2018). Open access digital repositories in India and China: a comparative study. *Journal of Indian library association*, 54(4), 195-205.
- M, K, S & A, R. K., (2024). Tracing The Scholarly Footprints of Digital Humanities: A Comparative Study on Citations and Altmetric Attention. *South India Journal of Social Sciences*, 22(3), 124-134.
- M. S. Swaminathan Research Foundation (MSSRF). (2004). *Open Access and Institutional Repository Workshop, Chennai*.  
<https://www.utoronto.ca/~chan/oaindia/index.html>
- Mahesh, V. M., & Kumar, R. A. (2022, February). Open access institutional repositories in India: A status report. In *Proceedings of the International Conference on Transformation of the Library Ecosystem: Terrains and Trajectories* (pp). Calicut University, Kerala, India.
- Maity, A. K. & Maity, S., (2016). Evolution of higher education in India. *International Journal of Advanced Education and Research*, 1(10), 56-59.
- Manipur University. (2024). <https://www.manipuruniv.ac.in/>
- Margoni, T., & Peters, D. (2016). Creative Commons Licenses: Empowering Open Access. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2746044>
- Margoni, T., & Peters, D. M. (2016). Creative Commons licenses: Empowering open access. *Creative Commons*.  
<https://creativecommons.org/licenses/by/4.0/legalcode>
- Marisha, Banshal, S. K., & Singh, V. K. (2017). Research performance of central universities in India. *Current Science*, 2198-2207.  
<http://dx.doi.org/10.18520/cs/v112/i11/2198-2207>
- Mashroofa, M. M. (2016). Open Access Revolution: Is it a paradigm shift of scholarly publishing practices? A literature review of global scenario. *Journal of the University Librarians Association of Sri Lanka*, 19(1), 115–135. <https://doi.org/10.4038/jula.v19i1.7878>

- Max Planck Society. (2003, October 22). *Berlin Declaration on open access to knowledge in the sciences and humanities*.  
<https://openaccess.mpg.de/Berlin-Declaration>
- Mazumder, J., Nath, A., Mukherjee, S. P., Pakira, A. K., & Jana, S. (2023). Measuring alternative research impact of private higher education institutions of India through data carpentry. *DESIDOC Journal of Library & Information Technology*, 43(06), 414–425.  
<https://doi.org/10.14429/djlit.43.06.19045>
- McKiernan, E. C., Bourne, P. E., Brown, C. T., Buck, S., Kenall, A., Lin, J., McDougall, D., Nosek, B. A., Ram, K., Soderberg, C. K., Spies, J. R., Thaney, K., Updegrove, A., Woo, K. H., & Yarkoni, T. (2016). How open science helps researchers succeed. *eLife*, 5.  
<https://doi.org/10.7554/elife.16800>
- MDPI. (2025, January 28). *6 benefits of open access*. MDPI Blog.  
<https://blog.mdpi.com/2024/08/13/6-benefits-of-open-access/>
- Medida, L. H., & Kumar, N. (2024). Addressing Challenges in Data Analytics. In *Advances in computer and electrical engineering book series* (pp. 16–33).  
<https://doi.org/10.4018/979-8-3693-2260-4.ch002>
- Mering, M. & Hoeve, C. D. (2020). A Brief History to the Future of Open Access, *Serials Review*, 46 (03), 1-6.
- Miguel, S., Chinchilla-Rodriguez, Z., & De Moya-Anegón, F. (2011). Open access and Scopus: A new approach to scientific visibility from the standpoint of access. *Journal of the American Society for Information Science and Technology*, 62(6), 1130–1145. <https://doi.org/10.1002/asi.21532>
- Ministry of Education (MoE). (2024). *Ministry of Education*. Government of India.  
<https://www.education.gov.in/>
- Mishra, S. and Shukla, A. (2025). Open access policies of Indian institutions: Based on ROARMAP. *Digital Library Perspectives, ahead-of-print*(ahead-of-print). <https://doi.org/10.1108/DLP-12-2024-0192>

- Misra, D. P. & Agarwal, V. (2019). Open Access Publishing in India: Coverage, Relevance, and Future Perspectives. *Journal of Korean Medical Science*, 34(27) 1-9. <https://doi.org/10.3346/jkms.2019.34.e180>
- Mizoram University. (2024). <https://mzu.edu.in/>
- Mukherjee, B. (2009). Scholarly Communication: A Journey from Print to Web. *Library Philosophy and Practice*.
- Mukherjee, S., Nath, A., Mazumder, J., & Jana, S. (2023). Does openness of articles get higher attention in altmetric? An investigation of medical discipline. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-05-2023-0180>
- Mukhopadhyay, P. (2022). How green is my valley? Measuring open access friendliness of Indian Institutes of Technology (IITs) through data carpentry. In A. Biswas & M. Das Biswas (Eds.), *Panorama of open access: Progress, practices & prospects* (1st ed., pp. 67–89). Ess Ess.
- National Assessment and Accreditation Council. (2024). *National Assessment and Accreditation Council (NAAC)*. <http://naac.gov.in/index.php/en/>
- National Institutional Ranking Framework. (2024). *Parameters*. Ministry of Education. <https://www.nirfindia.org>
- National Knowledge Commission. (2009). *Report to the nation 2006–2009*. Government of India. <https://www.aicte-india.org/downloads/nkc.pdf>
- Nazim, M. (2017). Bibliometric analysis of gold open access in India. *International Information & Library Review*, 50(1), 13–23. <https://doi.org/10.1080/10572317.2017.1326246>
- Nazim, M. (2021). Analysing Open Access Uptake by Academic and Research Institutions in India. *DESIDOC Journal of Library & Information Technology*, 41(2) 108-115. 10.14429/djlit.41.2.16324

- Nazim, M., & Bhardwaj, R. K. (2023). Open access initiatives in European countries: analysis of trends and policies. *Digital Library Perspectives*, 39(3), 371–392. <https://doi.org/10.1108/dlp-06-2022-0051>
- Nazim, M., Bhardwaj, R. K., Agrawal, A., & Bano, A. (2022). Open access publishing in India: trends and policy perspectives. *Global Knowledge Memory and Communication*, 72(4/5), 437–451. <https://doi.org/10.1108/gkmc-09-2021-0158>
- Nguyen, H. T. T., Nguyen, M., Le, T., Ho, M., & Vuong, Q. (2021). Open Access Publishing Probabilities Based on Gender and Authorship Structures In Vietnam. *Publications*, 9(4), 45. <https://doi.org/10.3390/publications9040045>
- Nigavekar, Arun (2003). *Higher Education In India: Issues, Concerns And New Directions*. University Grants Commission. <https://www.ugc.ac.in/oldpdf/pub/he/heindia.pdf>
- North-Eastern Hill University. (2024). <https://www.nehu.ac.in/>
- Nwagwu, W. E. (2024). Mapping the field of global research on data literacy: Key and emerging issues and the library connection. *IFLA Journal*, 50(3), 491–510. <https://doi.org/10.1177/03400352241257669>
- Nygaard, L. P., Aksnes, D. W., & Piro, F. N. (2022). Identifying gender disparities in research performance: the importance of comparing apples with apples. *Higher Education*, 84(5), 1127–1142. <https://doi.org/10.1007/s10734-022-00820-0>
- One Nation One Subscription (ONOS). (2025). *About*. Government of India. <https://www.onos.gov.in/about>
- Open Access India. (2018). *Delhi Declaration on Open Access*. <http://openaccessindia.org/delhi-declaration-on-open-access/>
- Openaccess.nl. (2025). *What is open access?* <https://www.openaccess.nl/en/what-is-open-access>

- Oppenheim, C. (2008). Electronic scholarly publishing and open access. *Journal of Information Science*, 34(4) 577 – 590. 10.1177/0165551508092268
- Pampel, H. (2023). Promoting open access in Research-Performing Organizations: spheres of activity, challenges, and future action areas. *Publications*, 11(3), 44. <https://doi.org/10.3390/publications11030044>
- Pandya, M. Y., Joorel, J. P. S. & Solanki, H. (2021). Research productivity of newly established central universities in India. *Annals of Library and Information Studies*, 68, 67-74.
- Panneerselvam, P. (2017). Scholarly Publications of Central Universities: Study based on Indian Citation Index. *Journal of Library & Information Science*, 7(3).
- Parray, U. Y., Khan, A. M., Mir, A. A., & Mir, S. M. (2023). Unveiling the present status of open access repositories: a comparative analysis of India and China. *Library Management*, 44(1/2), 120–132. <https://doi.org/10.1108/lm-09-2022-0084>
- Pinfield, S. (2010). Paying for open access? Institutional funding streams and OA publication charges. *Learned Publishing*, 23(1), 39–52. <https://doi.org/10.1087/20100108>
- Piwowar, H., Priem, J., & Orr, R. (2019). The Future of OA: A large-scale analysis projecting Open Access publication and readership. *bioRxiv (Cold Spring Harbor Laboratory)*. <https://doi.org/10.1101/795310>
- Piwowar, H., Priem, J., Larivière, V., Alperin, J. P., Matthias, L., Norlander, B., Farley, A., West, J., & Haustein, S. (2018). The state of OA: a large-scale analysis of the prevalence and impact of Open Access articles. *PeerJ*, 6, e4375. <https://doi.org/10.7717/peerj.4375>
- Pondicherry University. (2024). <https://www.pondiuni.edu.in/>

- Pontika, N., & Rozenberga, D. (2015). Developing strategies to ensure compliance with funders' open access policies. *Insights the UKSG Journal*, 28(1), 32–36. <https://doi.org/10.1629/uksg.168>
- Poplašen, L. M., & Hebrang Grgić, I. (2016). Altmetric and bibliometric scores: Does open access matter? *Qualitative and Quantitative Methods in Libraries (QQML)*, 5, 451-460.
- Prajapati, D. (2015). Open Access Products: Issues and Challenges, *International Journal of Research in Humanities & Social Sciences*, 3(6), 41- 45.
- Price, D. J. de S. (1963). *Little science, big science*. Columbia University Press.
- Pryor, G. (2012). Why manage research data? In G. Pryor (Ed.), *Managing research data* (pp. 1–16). Facet.
- Puala, S., Singh, K. & Maharana, B. (2023). A New Era in Scholarly Communication: Open Access Publishing. *Indian Journal of Library and Information Science* 17(3), 231-235. <http://dx.doi.org/10.21088/ijlis.0973.9548.17323.6>
- Rachid, E., Noureddine, T., Tamim, H., Makki, M., Naalbandian, S., & Al-Haddad, C. (2021). Gender disparity in research productivity across departments in the faculty of medicine: a bibliometric analysis. *Scientometrics*, 126(6), 4715–4731. <https://doi.org/10.1007/s11192-021-03953-8>
- Ramdhani, A., Ramdhani, M.A. & Amin, A.S. (2014). Writing a Literature Review Research Paper: A step-by-step approach. *International Journal of Basic and Applied Science*. 3(1), 47-56. <https://digilib.uinsgd.ac.id/5129/1/08IJBAS%283%29%281%29.pdf>
- Rao, S. S., & Rao, N. L. (2018, August 24–30). *Open access policies and mandates: A study of their implementation in academic institutions in India*. Paper presented at the IFLA World Library and Information Congress (WLIC), Kuala Lumpur, Malaysia.

- Ridsdale, C., Rothwell, J., Smit, M., Ali-Hassan, H., Bliemel, M., Irvine, D., & Wuetherick, B. (2015). *Strategies and best practices for data literacy education: Knowledge synthesis report*. Dalhousie University. [https://www.researchgate.net/publication/284029915\\_Strategies\\_and\\_Best\\_Practices\\_for\\_Data\\_Literacy\\_Education\\_Knowledge\\_Synthesis\\_Report](https://www.researchgate.net/publication/284029915_Strategies_and_Best_Practices_for_Data_Literacy_Education_Knowledge_Synthesis_Report)
- Robinson-Garcia, N., Costas, R., & Leeuwen, T. N. van. (2020). Open Access uptake by universities worldwide. *PeerJ*, 8, e9410. doi: 10.7717/peerj.9410
- Roy, A. & Mukhopadhyay, P. (2022). Measuring Open Access Friendliness of Indian Central Universities through Data Carpentry, *SRELS Journal of Information Management*, 59(03), 131-139.
- Roy, A. & Mukhopadhyay, P. (2022). Measuring the open access friendliness of the state universities in India through data carpentry. *Annals of Library and Information Studies*, 69(3). <https://doi.org/10.56042/alis.v69i3.63837>
- Roy, A., & Mukhopadhyay, P. (2022). Assessing open access friendliness of National Institutes of Technology (NITs) a data carpentry approach. *DESIDOC Journal of Library & Information Technology*, 42(5), 331–338. <https://doi.org/10.14429/djlit.42.5.18263>
- Roy, A., & Shukla, A. (2024). Unveiling the Status of Open Access Dairy Research in India through Data Carpentry. *Journal of Data Science Informetrics and Citation Studies*, 3(1), 01–10. <https://doi.org/10.5530/jcitation.3.1.1>
- Roy, A., Shukla, A. & Das, T. K. (2024). Unveiling the Open Access Friendliness of NIRF Ranked Deemed Universities of India through Data Carpentry. *Library Herald* 62(3), 293- 306.
- Roy, A., Shukla, A. & Tripathi, A. (2025). Exploring Open Access Trends in State Agricultural Universities of India: Insights from OpenAlex. *Annals of Library and Information Studies*, 72(01). <https://doi.org/10.56042/alis.v72i1.14179>

- Roy, B. K., Biswas, S. C. & Mukhopadhyay, P. (2012). Open Access to scholarly information in India: Trends and Developments. *Journal of Library & Information Science*, 2(01), 89-101.
- Sa, M. K. & Dora, M. (2019). Research Productivity and Research Trends in the Library and Information Science Subject: A Study with reference to SCOPUS. *Library Philosophy and Practice (e-journal)*, 2661.
- Salisbury, L., Chowdhury, A. R., & Smith, J. J. (2017). Faculty Publications from a Research University: The Scholarly Impact of Open Access versus Non-Open Access. *Science & Technology Libraries*, 36(2), 187–199.  
<https://doi.org/10.1080/0194262x.2016.1273815>
- Samaniego, C., Lindner, P., Kazmi, M. A., Dirr, B. A., Kong, D. T., Jeff-Eke, E., & Spitzmueller, C. (2023). Higher research productivity = more pay? Gender pay-for-productivity inequity across disciplines. *Scientometrics*, 128(2), 1395–1407. <https://doi.org/10.1007/s11192-022-04513-4>
- Sathyanarayana, N. (2008b). Open access and open J-Gate. *DESIDOC Journal of Library & Information Technology*, 28(1), 57–60.  
<https://doi.org/10.14429/djlit.28.1.153>
- Sawant, S. (2012). Past and present scenario of open access movement in India. *The Journal of Academic Librarianship*, 39(1), 108–109.  
<https://doi.org/10.1016/j.acalib.2012.11.007>
- Schultz, T. A., Azadbakht, E., Bull, J., Bucy, R., & Floyd, J. (2019). Assessing the Effectiveness of Open Access Finding Tools. *Information Technology and Libraries*, 38(3), 82–90.
- Seidlmayer, E., Müller, R., & Förstner, K. U. (2020). Data Literacy for Libraries – A Local Perspective on Library Carpentry. *BIBLIOTHEK Forschung Und Praxis*, 44(3), 485–489. <https://doi.org/10.1515/bfp-2020-2038>
- Sheikh, Y. A., (2017). Higher Education in India: Challenges and Opportunities, *Journal of Education and Practice*, 8(1), 39-42

- Shuttleworth, S., & Charnley, B. (2016). Science periodicals in the nineteenth and twenty-first centuries. *Notes and Records the Royal Society Journal of the History of Science*, 70(4), 297–304. <https://doi.org/10.1098/rsnr.2016.0026>
- Simao, L. B., Carvalho, L. C., & Madeira, M. J. (2020). Intellectual structure of management innovation: bibliometric analysis. *Management Review Quarterly*, 71(3), 651–677. <https://doi.org/10.1007/s11301-020-00196-4>
- Singh, P. (2016). Open access repositories in India. *IFLA Journal*, 42(1), 16–24. <https://doi.org/10.1177/0340035215610131>
- Singh, S. P., & Babbar, P. (2014). Doctoral research in library and information science in India: Trends and issues. *DESIDOC Journal of Library & Information Technology*, 34(2), 170–180.
- Singh, S.S. (2024). Significance of hypothesis in legal research. *International journal of advanced research*, 12(06), 823–828. <http://dx.doi.org/10.21474/IJAR01/18945>
- Sohani, F., Shekofteh, M., Shahbodaghi, A., & Jambarsang, S. (2021). Journals on the road: Open access or non-open access? *Library Philosophy and Practice*, 6276. University of Nebraska - Lincoln. <https://digitalcommons.unl.edu/libphilprac/6276>
- Solomon, D. J., & Björk, B. (2011). Publication fees in open access publishing: Sources of funding and factors influencing choice of journal. *Journal of the American Society for Information Science and Technology*, 63(1), 98–107. <https://doi.org/10.1002/asi.21660>
- Springer Nature. (2025). *Green or gold routes to open access*. Retrieved January 31, 2025, from <https://www.springernature.com/gp/open-science/about/green-or-gold-routes-to-oa>
- Springer Nature. (2025). *The fundamentals of open access and open research*. Retrieved January 28, 2025, from <https://www.springernature.com/gp/open-science/about/the-fundamentals-of-open-access-and-open-research>

- STM Association. (2024). *The STM open access dashboard 2024*. <https://stm-assoc.org/oa-dashboard/oa-dashboard-2024/>
- Suber, P. (2004). *A very brief introduction to open access*. <http://www.earlham.edu/~peters/hometoc.htm>
- Suber, P. (2012). *Open access*. MIT Press. <https://library.oapen.org/handle/20.500.12657/26065>
- Suber, P., Brown, P. O., Cabell, D., et al. (2003). *Bethesda Statement on Open Access Publishing*. Retrieved February 1, 2025, from [https://www.researchgate.net/publication/48547523\\_The\\_Bethesda\\_Statement\\_on\\_Open-Access\\_Publishing](https://www.researchgate.net/publication/48547523_The_Bethesda_Statement_on_Open-Access_Publishing)
- Taha, B., Sadda, P., Winston, G., Odigie, E., Londono, C., Greenfield, J. P., Pannullo, S. C., & Hoffman, C. (2021). Increases in female academic productivity and female mentorship highlight sustained progress in previously identified neurosurgical gender disparities. *Neurosurgical FOCUS*, 50(3), E3. <https://doi.org/10.3171/2020.12.focus20939>
- Tahamtan, I., Afshar, A. S., & Ahamdzadeh, K. (2016). Factors affecting number of citations: a comprehensive review of the literature. *Scientometrics*, 107(3), 1195–1225. <https://doi.org/10.1007/s11192-016-1889-2>
- Taherdoost, H. (2020). Different Types of Data Analysis; Data Analysis Methods and Techniques in Research Projects. *International Journal of Academic Research in Management (IJARM)*, 9(1), 1-9
- Taylor, M. (2020). An altmetric attention advantage for open access books in the humanities and social sciences. *Scientometrics*, 125(3), 2523–2543. <https://doi.org/10.1007/s11192-020-03735-8>
- Teal, T. K., Cranston, K., Lapp, H., White, E., Wilson, G. V., Ram, K., & Pawlik, A. (2015). Data Carpentry: Workshops to Increase data Literacy for Researchers. *International Journal of Digital Curation*, 10(1), 135–143. <https://doi.org/10.2218/ijdc.v10i1.351>

- Tennant, J. P., Waldner, F., Jacques, D. C., Masuzzo, P., Collister, L. B., & Hartgerink, C. H. J. (2016). The academic, economic and societal impacts of Open Access: an evidence-based review. *F1000Research*, 5, 632. <https://doi.org/10.12688/f1000research.8460.3>
- Tezpur University. (2024). <http://www.tezu.ernet.in/>
- The Carpentries. (2024). *Past workshops*. The Carpentries. Retrieved August 1, 2024, from <https://carpentries.org/workshops/past-workshops/>
- The Carpentries. (2025). *About us*. The Carpentries. Retrieved on February 6, 2025, from <https://carpentries.org/about-us/>
- To, W., & Yu, B. T. (2020). Rise in higher education researchers and academic publications. *Emerald Open Research*, 1(3). <https://doi.org/10.1108/eor-03-2023-0008>
- UNESCO. (2012). *UNESCO Open Access Strategy*. Retrieved from <https://www.unesco.org>
- UNESCO. (2025). *Open access policy concerning UNESCO publications*. UNESCO, retrieved on 26 February 2025 from <https://unesdoc.unesco.org/ark:/48223/pf0000220872>
- University Grants Commission. (2024). *Consolidated list of all universities* [PDF]. <https://www.ugc.gov.in>
- University of Delhi. (2024). <https://www.du.ac.in/>
- University of Hyderabad. (2024). <https://uohyd.ac.in/>
- Uribe-Bohorquez, M., Rivera-Ordóñez, J., & García-Sánchez, I. (2023). Gender disparities in accounting academia: analysis from the lens of publications. *Scientometrics*, 128(7), 3827–3865. <https://doi.org/10.1007/s11192-023-04718-1>
- Vadhera, A. S., Lee, J. S., Veloso, I. L., Khan, Z. A., Trasolini, N. A., Gursoy, S., Kunze, K. N., Chahla, J., & Verma, N. N. (2022). Open Access Articles Garner Increased Social Media Attention and Citation Rates Compared

- With Subscription Access Research Articles: An Altmetrics-Based Analysis. *The American Journal of Sports Medicine*, 50(13), 3690–3697. <https://doi.org/10.1177/03635465221124885>
- Visva Bharati University. (2024). <https://www.visvabharati.ac.in/>
- Warlick, S. E. and Vaughan, K. T. L., (2007). Factors influencing publication choice: why faculty choose open access. *Biomedical Digital Libraries*, 4(1), 1-12, 10.1186/1742-5581-4-1
- Wilson, G. (2010). *Software Carpentry: Teaching basic lab skills for research computing* [Blog post]. <http://software-carpentry.org/>
- World Health Organization. (2025). *WHO policy on open access*. World Health Organization. Retrieved February 25, 2025, from <https://www.who.int/about/policies/publishing/open-access>
- Xia, J. (2011). An anthropological emic-etic perspective on open access practices. *Journal of Documentation*, 67(1), 75–94. <https://doi.org/10.1108/00220411111105461>
- Zhang, L., & Ma, L. (2024). Different open access routes, varying societal impacts: evidence from the Royal Society biological journals. *Scientometrics*, 129(6), 3407–3431. <https://doi.org/10.1007/s11192-024-05032-0>
- Zhu, Y. (2017). Who support open access publishing? Gender, discipline, seniority and other factors associated with academics' OA practice. *Scientometrics*, 111(2), 557–579. <https://doi.org/10.1007/s11192-017-2316-z>

## BIO-DATA OF THE RESEARCHER

|                                  |                                                                                                                            |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Name                             | Swagota Saikia                                                                                                             |
| Degree                           | Ph.D.                                                                                                                      |
| Department                       | Library & Information Science                                                                                              |
| Title of Thesis                  | Measuring the Open Access Uptake of<br>Selected Central Universities of India: A<br>Study based on Data Carpentry Approach |
| Date of Admission                | 19.08.2022                                                                                                                 |
| Year of Completion of Coursework | 2022                                                                                                                       |
| MZU Registration No.             | 2200192                                                                                                                    |
| Ph.D. Registration No. & Date    | MZU/Ph.D./2046 of 19.08.2022                                                                                               |
| Date of Pre-Submission           | 03/10/2025                                                                                                                 |

### Journal Articles published

1. Saikia, S., Kumar, V., & Verma, M. K. (2023). Analyzing user sentiments toward selected content management software: a sentiment analysis of viewer's comments on YouTube. *Information Discovery and Delivery*, 52(4), 378–387. <https://doi.org/10.1108/idd-01-2023-0009>
2. Saikia, S., Gul, S., & Verma, M. K. (2023). Are libraries ready to serve gamification tools for teaching and learning? A review based on computational mapping. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-04-2023-0114>
3. Verma, N. K., Saikia, S., & Verma, M. K. (2024). Sentiment analysis of users' comments on budget speeches by the Indian Finance Minister (2019–2023): A data mining study based on YouTube videos. *Trends in Information Management*, 13(1), 45–60.
4. Saikia, S., Maurya, A., & Verma, M. K. (2024). Emerging trends and performance measurement of cryptocurrency research during 2013–2022: a systematic review based on computational mapping. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-09-2023-0343>

5. Daimari, V. R., Saikia, S., Kalbande, D., & Verma, M. K. (2024). Libraries in the age of Fourth Industrial Revolution: a systematic review based on scientometric and altmetric tools. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-01-2024-0028>.
6. Oraon, A. D., Saikia, S., & Verma, M. K. (2025). Exploring emerging trends and performance metrics in internet gaming disorder (IGD): a systematic review based on computational mapping. *Global Knowledge Memory and Communication*. <https://doi.org/10.1108/gkmc-06-2024-0377>
7. Saikia, S. & Verma, M. K. (2024). Unveiling the Gender Disparity in Scientometrics Research in India during 2013-2022: An Assessment. *RBU Journal of Library & Information Science*, 26, 104-111.
8. Saikia, S., Verma, N. K., & Chakraborty, S. (2025). Open access adoption in sustainable development goals research among the Indian leading universities. *DESIDOC Journal of Library & Information Technology*, 45(4), 259–268. <https://doi.org/10.14429/djlit.21024>

#### **Paper Presented in Conference/Seminar**

1. Saikia, S., Verma, N. K., & Verma, M. K. (2023). Evaluation of the library website of All India Institutes of Medical Sciences: A webometric analysis. In S. B. Alayon, W. S. A. Frias, & R. D. Funclara (Eds.), *Advancing Asian special libraries towards the fifth industrial revolution: Proceedings of the 8th International Conference of Asian Special Libraries (ICoASL 2023)* (pp. 102–111). Special Libraries Association–Asian Community & Association of Special Libraries of the **Philippines**. ISBN 978-971-91508-1-7.
2. Saikia, S. & Verma, M. K. (2024) Author's gender and citations in open access publications: A study of DESIDOC Journal of Library & Information Technology. In proceeding of the 69th ILA Conference, International Conference on Building the Future: Transforming Libraries for Sustainability, O.N. Chaubey et al. (Eds.), organized by Indian Library Association, (ILA), DLIS, Gauhati University, K.K Handiqui Library, Gauhati University and Assam Library Association (ALA), Guwahati hosted by Gauhati University,

Guwahati, Assam, India on 1-4th February, 2024, **Guwahati:** Indian Library Association, (ILA), New Delhi, pp. 1035-1041. ISBN- 978-81-956643-9-9.

3. Saikia, S., Deori, M. & Verma, M. K., (2023) Gender Disparity in scholarly communication on Scientometrics Research in India during 2013-2022: An Evaluation. In proceeding of the 17th International Conference on Webometrics, Informetrics and Scientometrics (WIS) & 22nd COLLNET Meeting 2023, Dilara Begum (Ed.), organized by COLLNET association with Asian Community, Special Libraries Association (SLA) and Society for Library Professionals (SLP) hosted by East West University, Dhaka, Bangladesh on 08-10th December, 2023, **Dhaka:** Dr. S.R. Lasker Library, East West University, pp. 28. ISBN- 978-984-35-5207-5.
4. Saikia, S., & Verma, M. K. (2025). The Role of Open Science in Shaping the Indian Research Landscape. In proceeding of the National Conference on ReImaging of Libraries: Balancing Tradition and Innovation in a Digital Era, organized by Tata Memorial Hospital & Bombay Science Librarians' Association, hosted by Tata Memorial Hospital, **Mumbai** on 10<sup>th</sup> January, 2025, pp. 77-89, ISBN- 978-93-82963-78-3.
5. Saikia, S., Basumatary, B., & Verma, M. K. (2025). A Systematic Review on the Information Literacy Research of Asian Countries: A Computational Study. *Transactions on Computer Systems and Networks*, 397–411. [https://doi.org/10.1007/978-981-99-8957-7\\_26](https://doi.org/10.1007/978-981-99-8957-7_26)
6. Saikia, S., & Verma, M. K. (2024, March 4–6). *Empowering research: Tracing the impact of open access publishing on Mizoram University* [Conference abstract]. International Seminar on New Era of Social Responsibility and Innovations, School of Economics, Management and Information Science, **Mizoram** University, Aizawl, India.

## Book Chapter

1. Saikia, S., Deori, M. & Verma, M. K. (2023). Viewer's Perception Towards UGC NET YouTube Channels: A Sentiment Analysis. In Tripathi, A., Verma, M. K. & Yadav, A. K. S. (Eds) *Changing Landscape of LIS Education and Research* (pp. 485-494). Shree Publishers & Distributors. ISBN: 978-81-961509-3-8.
2. Saikia, S., Verma, N. K., & Verma, M. K. (2023). Growth and development of Open Access Repositories across the globe: A case study of Open DOAR. In R. Kumar, M. K. Sinha, K. P. Singh, M. Ganjoo, S. Vashist, & K. Choudhary (Eds.), *Recent technological trends in academic libraries: Systems and services* (pp. 440–448). Book Age Publications. ISBN 978-93-93904-18-8.
3. Saikia, S., & Verma, M. K. (2024). Open access publications: A new dimension of knowledge sharing in the digital era. In K. Veeranjanyulu, G. Rathinasabapathy, M. Madhusudhan, & D. D. Lal (Eds.), *Leading the information revolution: The role of LIS in a connected world* (pp. 808–815). BS Publications.

## PARTICULARS OF THE CANDIDATE

|                               |                                                                                                                               |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Name                          | Swagota Saikia                                                                                                                |
| Degree                        | Ph.D.                                                                                                                         |
| Department                    | Library & Information Science                                                                                                 |
| Title of Thesis               | Measuring the Open Access Uptake of<br>Selected Central Universities of India: A<br>Study Based on Data Carpentry<br>Approach |
| Date of Admission             | 19.08.2022                                                                                                                    |
| Approval of Research Proposal |                                                                                                                               |
| 1. DRC                        | 21.04. 2023                                                                                                                   |
| 2. BOS                        | 28. 04.2023                                                                                                                   |
| 3. School Board               | 22.05.2023                                                                                                                    |
| MZU Registration No.          | 2200193                                                                                                                       |
| Ph.D. Registration No. & Date | MZU/Ph.D./2046 of 19.08.2022                                                                                                  |
| Extension (If Any)            | N/A                                                                                                                           |

**Head**  
**Department of Library and**  
**Information Science**

## **ABSTRACT**

### **MEASURING THE OPEN ACCESS UPTAKE OF SELECTED CENTRAL UNIVERSITIES OF INDIA: A STUDY BASED ON DATA CARPENTRY APPROACH**

**AN ABSTRACT SUBMITTED IN PARTIAL FULFILLMENT OF  
THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF  
PHILOSOPHY**

**SWAGOTA SAIKIA**

**MZU REGISTRATION NO.: 2200193**

**Ph.D. REGISTRATION NO.: MZU/Ph.D./2046 of 19.08.2022**



**DEPARTMENT OF LIBRARY AND INFORMATION SCIENCE  
SCHOOL OF ECONOMICS, MANAGEMENT AND  
INFORMATION SCIENCE  
OCTOBER 2025**

**MEASURING THE OPEN ACCESS UPTAKE OF SELECTED CENTRAL  
UNIVERSITIES OF INDIA: A STUDY BASED ON DATA CARPENTRY  
APPROACH**

**BY**

**SWAGOTA SAIKIA**

**Department of Library and Information Science**

**Supervisor**

**Prof. MANOJ KUMAR VERMA**

**Submitted**

**In partial fulfillment of the requirement of the degree of Doctor of Philosophy in  
Library and Information Science of Mizoram University, Aizawl**

## **1. Introduction**

Research has always been a fundamental part for the development and integration of any subject and its scholarly community. The subject Library and Information Science is also not an exception but has obtained rapid changes and growth in different areas of research over time. The initiation of LIS research in India has started since 1950 by Dr. S. R. Ranganathan in the department of Library and Information Science, University of Delhi. By the time of its initiation, a number of studies have been conducted by the LIS professionals and academicians to introduce new ideas, knowledge and theories. With time, the LIS field has undergone enormous changes with new ideas and facts through advancement of scholarly communications. In the present digital era, scholarly publishing is gaining immense importance and also the demand for research publications is at its peak in online platforms. The traditional publishing models and methods have been replaced by online journals and other forms. However, evaluating the research output is an essential step for measuring the quality and impact of the research, identification of research trends, future trends and the performances of researchers. Various tools and techniques have been introduced to measure research productivity and assess researcher's performance, collectively known as research metrics. The research metrics helps to identify the scientific structure of the research such as growth trend, collaboration pattern, highly active researchers, journals, organizations or countries based on the citation impact, H-index, impact factor that indicates the value of the work. The evolution of research metrics basically rooted from Ranganathan's Librametrics (1948), Alan Pritchard's Bibliometrics (1969), T. Braunin's Scientometrics (1977), Tomas Almind and Peter Ingwersen's Webometrics (1997) and Jason Priem's Altmetrics (2010). The application of metrics, especially Bibliometrics and Scientometrics, in the field of Library and Information Science has been growing significantly in recent years. Since LIS professionals are considered information providers, the application of metrics helps them stay updated on the latest developments in the field of research. Therefore, the study of Bibliometrics and Scientometrics is essential for staying informed about the latest developments in the intellectual structure of scholarly communication and the contributions of scholars in any field. In recent years, there has been extensive debate on 'Open Access' in

scientific communication at both national and international levels. In India, scientific research is funded by various institutions, organizations, and public or private agencies. The Government of India has mandated that all publicly funded research publications be made freely accessible to the public. Over time, several initiatives and changes have shaped the landscape of scientific communication in India. Therefore, it is essential to examine the acceptability and practices of Open Access in the publications of central universities in India.

## **2. Open Access**

Since the last two decades, movement of Open Access have impacted the scholarly communication regarding the mode of its access. The Open Access Movement was initiated to make scholarly literature freely accessible to everyone, with the right to reuse it in a digital environment worldwide. The reason behind the movement is the rise of subscription cost of the journals and its barrier in accessing the scientific communication. The Open Access (OA) came into effect out of various efforts initiated by three eminent declarations, Budapest Open Access Initiative (BOAI) is the very first meet on 1 December, 2001 held in Budapest by the Open Society Institute. The BOAI was initiated with the aim to remove barriers in accessing scholarly literature and promote universal education and learning. The next initiative was taken by Bethesda statement in June 2003 followed by the Berlin declaration in October 2003 for free availability of scientific knowledge. Gradually, various academic institutions, libraries and research organization also came forward and joined in these initiatives against subscription-based models.

According to Peter Suber “Open access to scientific journal articles means online access without charge to readers or libraries. Committing to open access means dispensing with the financial, technical, and legal barriers that are designed to limit access to scientific research articles to paying customers. It means that, for the sake of accelerating research and sharing knowledge, publishers will recoup their costs from other sources”. Emergence of OA has paved the way towards subscription free access of content and greater visibility of the scholarly literatures which is also beneficial for receiving more citation that indicates the impact of the work. However, the form of Open Access divided into two degrees i.e., Gratis and Libre (Prajapati,

2015). Gratis open access refers to the contents that are fully free of cost and universally accessible, Libre open access means contents that are freely accessible along with some added restriction for use. Apart from this, there are various routes of open access concerning its rights of access under Creative Common Licenses such as Gold, Green, Bronze and Hybrid (Jalal & Mukhopadhyay, 2022). In the Gold open access route, the publisher or the journal publishes the article in open access mode where the readers can freely download the content but the author have to pay the APC. Green open access provides the facility to self-archive in which an author has the right to deposit a final/accepted version of article of subscription-based journal in an institutional repository (Mering & Hoeve, 2020). Under Bronze open access readers can access the content online but not allowed for reuse because of the no license policy for the readers. However, another mode of access is added to the list as 'Hybrid' journals consist of open access and close access articles as per the subscription fee or authors charge.

The Open Access movement has also influenced Indian scientific communication. According to various studies, several initiatives have been undertaken to promote Open Access. In India, Indian National Academy was the first institution to sign the Berlin Declaration in 2004. In the study of the status of Indian OA journals and Repositories, Nazim et al. (2022) found India to be in the 15<sup>th</sup> and 17<sup>th</sup> rank with 317 journals in DOAJ, 98 repositories in OpenDOAR (Roy & Mukhopadhyay, 2022) and 135 repositories in ROAR. Recently, Government of India has implemented a policy named 'One Nation One Subscription' (ONOS) for promoting countrywide access to scientific and academic content from a single central negotiated mode for the benefit of the academic and research community. Various organizations and institutions have initiated for practicing open access publications in India.

Apart from various discussions regarding OA initiatives, policies, availability of OA journals or repositories available in DOAJ, ROAR, OpenDOAR etc., it is also necessary to adhere some indicators to measure the OA practices. Robinson-Garcia, 2020 have measured the OA policies and research output of 963 institutions from Web of Science database based on Unpaywall. Roy & Mukhopadhyay, 2022 have measured the open access friendliness of top ten Indian central universities through OpenRefine and Unpaywall based on ranking framework.

### **3. Data Carpentry**

Data carpentry is a newly emerging area which focuses on enhancing researcher's skills and knowledge for managing large amount of research data with implication of some tools and techniques. The word carpentry means to make and manage something, data Carpentry is considered as sister of software carpentry. Data carpentry is a great tool for data mining which introduced in January 2018 by a US based non-profit organization (<https://carpentries.org/>). 'The Carpentries' is emphasized to three carpentries such as- Software carpentry (2014), Data carpentry (2018) and Library carpentry (2018) with the mission to help its communities by providing data science skills through conducting programs and workshops. Software carpentry deals with software management and development activities; Library carpentry deals with library management skills using softwares and data carpentry primarily deals with management of research data effectively. Data carpentry basically focuses on promoting the computational skills that are required for data analysis, data management, reproducible data in every domain of research in an effective way. It is a new way of cleaning and wrangling data without any limitations of types and size by using different data carpentry tools. Apparently, since past few years the concept of data carpentry has been applied to various research areas as well as to the field of Library and Information Science for redefining large sets of data.

### **4. Significance of the Study**

In the present era, the importance of research has been doubled with time for growth and development, the research outputs are necessary for the scientific community whether for further research, decision making, policy framing, stake holders and many more. The open access led the availability of scholarly literatures in public domain allowing the public to use, print, reuse, download the full text edition and share the resources. Open Access is a mode of access to scholarly literatures in which the reader can freely access the content they want without the requirement of subscription through payment like the traditional subscription-based access. Open access is not only helpful for accessing information for free but diversely beneficial in areas such as for Authors it gives the opportunity to make their work visible at worldwide level that enables to increase visibility and get higher citation rate; then

for academic institutions, they are beneficial for getting better visibility of their research works at global level as well as without the need for subscribing high-cost journals and promote knowledge at pace. However, various institutions and organizations have adopted open access measures but it is also necessary to study the open access compatibilities implementing parameters to identify the scenario of open access. In academic institutions, in the courses like Masters and Ph.D. level, research is widely practiced and higher research publication enables to achieve better ranking of faculties and institutions. The study is an attempt to identify the selected central universities of India's participation and acceptability of Open Access. The findings of the study will be helpful in designing policy for funding agencies, policy makers to look after the scenario of Open Access among the leading central universities of India.

## **5. Scope of the Study**

The scope of the present study shall be limited to examine the present status and adaptability of open access publications in scholarly communication by selected central universities in India by applying the data carpentry tools based on the Scopus database. At present, there are total 44 central universities listed in the website of Ministry of Education (source: <https://www.education.gov.in/central-universities> dated 28.03.2023). To select the central universities for present study, NIRF ranking 2022 was considered and the central universities listed till rank band II was selected for this study. Thus, the scope of present study is further limited to 19 central universities that were ranked in rank band II of NIRF 2022 ranking as listed in Table-1. The publications data of selected central universities will be count from Scopus database and only that publications will be considered for present study. Further, the study shall also be limited for the 20 years from 2005-2024 as the emergence of OA movement took place in the year 2002.

## **6. Research Design**

A research design is the overall framework of a research study that guides the researcher in achieving the predetermined objectives of the study. It serves as a conceptual blueprint outlining the structure of the study, including the research

questions, data collection methods, and analysis procedures. The design of the research plays a crucial role in determining and validating the reliability of the research findings. It helps determine the step-by-step process of conducting the study using a specific methodology, ensuring the research is systematic and focused.

### **6.1. Statement of the Problem**

In the present digital era, all the traditional publications have been shifted to digital publications from which the importance of open access has aroused. Open access basically allows free access to peer review full-text scholarly publications with very minimum to no restrictions with the right to read, download, share and print. Academic institutions are a platform where research is practiced at a great extent and research contents are the basic need in academics for scholarly communication. According to some researches the academic institutions are increasingly publishing researches in Open Access platforms. However, it is necessary to analyse and evaluate the growing OA publication by application of various open access parameters for identifying the top ranked OA sources. The present study will evaluate the practices and adaptabilities of OA publications regarding the status, license, citation count and altmetric score for measuring the impact of the OA publications as well as determining the subject in which most of the publication are being published, the study will also identify the gender status of the first author for identifying the gender balance in the OA publications of the selected central universities of India.

### **6.2. Objectives of the Study**

1. To assess the year-wise growth of open access (OA) publications between 2005 to 2024 and forecast the future growth of research of the selected central universities of India
1. To analyze the subject-wise distribution, social, intellectual and conceptual structures of OA publications trends by collaboration of authors and countries, citation impact, and key words analysis

2. To measure the open access friendliness of the publications of central universities based on OA compatibility parameters (Designed & Developed by Mukhopadhyay, 2022).
3. To compare the open access publications trends in sciences, Social Sciences and Arts and Humanities Domain.
4. To find out the gender ratio of the Open Access publications of the selected central universities of India
5. To rank the central universities based on the number of Open Access publications.

### **6.3. Hypothesis**

A hypothesis is a crucial component of the research process, formulated at the initial stage to transform the research question into a predictive statement. It represents a tentative assumption made by the researcher, typically expressed as a relationship between dependent and independent variables. Since it is subject to empirical validation, the hypothesis remains provisional until tested. Its primary function is to guide the direction of the study, support the interpretation of observations, and ensure that the research progresses in a systematic and coherent manner.

The present study formulates three hypotheses to explore the relationship between Open Access (OA) publications of the selected central universities of India and various associated components. These hypotheses are outlined below:

**H1:** There is a significant correlation between the Open Access publication trends and the year of establishment of the central universities.

**H2:** There is a significant difference in the gender-wise author productivity in OA publications

**H3:** There is significant correlation between OA Publication Output and status of authors' designation

#### **6.4. Research Methodology**

The present study aims to examine the Open Access friendliness and adoptability of the top 19 ranked Indian central universities. It analyzes the nature and patterns of OA publications using a well-defined framework grounded in the data carpentry approach. To achieve a holistic perspective, the study adopts both quantitative and qualitative research methods, integrating scientometric and altmetric analyses with data carpentry tools. This mixed-methods approach allows for a deeper understanding of institutional engagement with Open Access practices.

Scientometrics is an emerging and widely used tool for evaluating the performance and impact of scientific research. In the present study, scientometric parameters have been employed to examine the growth of Open Access (OA) research publications, assess the contributions of prolific research actors, visualize collaboration patterns, and conduct keyword analysis.

The advancement of the digital era has led to the emergence of altmetrics, a novel tool designed to capture the immediate impact of research on the general public, complementing traditional citation-based metrics. This impact is measured by tracking the attention received by research publications across various social media platforms and online sources. The present study employs altmetrics to assess the societal impact of Open Access (OA) publications on the general public.

Data carpentry is another emerging tool for preparing, cleaning, and organizing large datasets to make them suitable for structured analysis and interpretation in research. In this study, data carpentry techniques were applied using OpenRefine to process both bibliographic and altmetric data. The Unpaywall API was used to determine the Open Access status of publications, while the Altmetric API retrieved real-time attention scores. These tools enabled metadata standardization, duplicate removal, and classification by access type and institution, ensuring data accuracy and supporting transparent, reproducible scientometric and altmetric analyses.

#### **6.4.1. Sample of the Study:**

The present study will examine the 19 central universities of India according to the NIRF 2022 ranking from the Rank band1 (1-100) and Rank band 2 (101-150) under 'University' category. The study will cover the open access publications of the selected 19 central universities of India as reflected in the Scopus and Unpaywall database during the time period of 20 years (2005-2024).

#### **6.4.2. Selection of Databases**

This study solely relies on bibliographic data of research publication of the selected central universities of India. The Scopus database was used to collect bibliographic information of open access (OA) articles and reviews published by the selected Indian central universities. OpenRefine was used to clean and deduplicate the raw data retrieved from Scopus. Additionally, various API keys were integrated using General Refine Expression Language (GREL) expressions to enrich and standardize the dataset for analysis. To determine the open access status of the publications, Unpaywall data was utilized to validate the accessibility and categorize the OA types. The Altmetric score has of the OA publications has been retrieved from the Altmetric.com database. The gender of the selected authors was identified using the NamSor database, which predicts gender based on names and country of origin. These databases were selected due to their extensive coverage and trusted data quality, making them well-suited for the purposes of this study.

**a) Scopus Database:** Scopus is a multidisciplinary abstract and citation database, established in 2004 and introduced by Elsevier. It provides extensive access to global scientific literature, encompassing fields such as science, technology, medicine, social sciences, as well as arts and humanities (Elsevier, 2025). It is one of the largest databases of peer-reviewed literature, including scientific journals, books, and conference proceedings.

**b) Unpaywall:** Unpaywall is an opensource database operated by Ourresearch that contains over 23 million of open-source content. The database contains more than 50,000 journals, open-access repositories and open data from various open-source platforms over the world including repositories of any universities,

governments or opensource publishers and open indexes like DOAJ, Crossref, Pubmed Central etc. The data can be extracted with the help of DOI of the article in the database.

**c) Open Refine:** OpenRefine is a free opensource desktop application developed by Google in the year 2010 specifically used for data cleaning and carpentry activities commonly known as data wrangling. This tool helps the researcher to filtering, cleaning and formatting large scale of data.

**d) Altmetric (Altmetric.com):** Altmetric is one of the largest databases that track the online attention received by research publications across various social media platforms. It assesses the influence of scholarly research by monitoring its visibility and engagement across social media, news outlets, policy documents, and other online sources. Altmetric is a part of Digital Science and was launched in 2011 (Altmetric.com, 2022).

**e) Namsor Database:** Namsor is one of the most trusted databases of names that uses artificial intelligence to identify names by gender, country of origin, ethnicity, and other name-related attributes. Namsor determines the gender of individuals and predict their likely geographic or ethnic origins by analyzing first and last names. Namsor supports various data formats and provides both a user-friendly web interface and API access, allowing users to process large datasets efficiently (Namsor.app, 2025).

#### **6.4.3. Data Collection Procedures**

**a) Collection of Bibliographic Details:** Firstly, the top 19 central universities were identified and selected based on the NIRF Ranking 2022. Subsequently, the primary dataset was extracted from the Scopus database by using the name of each university as a search keyword under the “organization” field extracted on 10<sup>th</sup> January 2025. Only open access (OA) publications were considered for the study, limiting the results to articles published between 2005 and 2024. The data for each of the 19 universities was exported individually in csv format and then merged into a single file for further analysis, resulting in a total of 45,717 documents.

**b) Data Cleaning and OA Validation:** The dataset was cleaned, deduplicated, and structured using OpenRefine, during which 3,141 duplicate and irrelevant entries

were removed, yielding a final dataset of 42,576 documents. These 42,576 OA publications were then analyzed to examine year-wise research growth, citation trends, collaborative research patterns (via network visualization), and keyword distribution using VOSviewer, which requires raw Scopus data for its analyses. Additionally, to verify the actual OA status and retrieve other related metadata for the publications, the Unpaywall database was integrated using its API within OpenRefine through GREL expressions. The API request was formulated as:

*"https://api.unpaywall.org/v2/" + value + "?email=saikiaswagata00@gmail.com"*

where value represents the DOI of each publication. The Unpaywall API provides responses in JavaScript Object Notation (JSON) format by default. The JSON responses obtained through the Unpaywall API were parsed using OpenRefine's GREL functions to extract relevant metadata fields such as *oa\_status*, *is\_oa*, *journal\_name*, *publisher*, and *best\_oa\_location.url* displayed in table 1.2. Moreover, the Unpaywall results revealed that, out of 42,576 OA publications, only 42,188 were confirmed as truly open access. This discrepancy likely occurred because some DOIs may not have been indexed in the Unpaywall database, were incorrectly formatted, or correspond to articles that are no longer openly accessible due to changes in licensing or access policies. Therefore, these 42,188 OA documents have been considered for further open access analysis and for developing the OA compatibility framework.

**Table 1.2: Example of Parsing Unpaywall JSON Response Using GREL Expressions in OpenRefine**

| Unpaywall JSON response                                                                                                                                                                                      | GREL parsing expression                            | Parsed output |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|---------------|
| { "doi": "10.1109/access.2022.3195807", "journal_is_oa": true, "journal_is_in_doaj": true, "is_oa": true, "oa_status": "gold", "has_repository_copy": false, "license": "cc-by", "host_type": "publisher", } | value.parseJson()["is_oa"]                         | TRUE          |
|                                                                                                                                                                                                              | value.parseJson()["oa_status"]                     | Gold          |
|                                                                                                                                                                                                              | value.parseJson()["license"]                       | cc-by         |
|                                                                                                                                                                                                              | value.parseJson()["has_repository_copy"]           | FALSE         |
|                                                                                                                                                                                                              | value.parseJson()["best_oa_location"]["host_type"] | Publisher     |

(Source: Table by Researcher)

**c) Extraction of Altmetric Score:** The Altmetric Attention Score (AAS) for each publication was retrieved by integrating the Altmetric API into OpenRefine using an authorized API key.

**d) Gender Identification:** Moreover, to identify existing gender disparity among the OA publications, the NamSor database was utilized by subscribing to a monthly plan to determine the gender of the first authors. A list of selected first authors was prepared in a separate file by including both their first and last names, which was then uploaded to the NamSor database for gender identification.

#### **6.4.4. Data Analysis**

The collected data will be scrutinized and verified using suitable analytics tools for further analysis. Similarly, the verified data will be visualized in tables and figures according to the requirement. Moreover, for performing the statistical analysis various tools will be used like MS Excel, SPSS to test the hypotheses that is formulated for the study.

**6.4.4.1. Data Analysis Tools:** The present study employed the following tools for data analysis:

- a) **Microsoft Excel:** Microsoft Excel is developed by Microsoft, is a powerful spreadsheet application used for organizing, analyzing, and managing data in a structured, tabular format. It offers a wide range of features that enable users to perform complex calculations, create visual representations such as charts and graphs, and efficiently handle large datasets.
- b) **Tableau:** Tableau is a leading tool for data visualization which converts raw data into interactive and shareable dashboards, charts, and reports. Tableau helps in uncovering patterns, trends, and insights from large datasets, making it a valuable tool for data-driven decision-making.
- c) **VOSviewer:** VOSviewer is a software tool for constructing and visualizing bibliometric networks. It helps users to create maps based on network data such as co-authorship, citation, co-citation, and keyword co-occurrence. It analyzes large-scale scientific datasets, VOSviewer offers powerful visualizations of relationships among publications, authors, journals, and terms, making it an essential tool for bibliometric and scientometric analysis.

#### **6.4.5. Hypothesis Testing**

The hypotheses of this study were tested using the Jamovi statistical software, applying appropriate non-parametric techniques to examine relationships and differences in OA publication trends. Hypothesis 1 (H1) was tested using Spearman's rank-order correlation to assess the association between the year of establishment of central universities and their OA publication output, based on a dataset of 42,188 verified OA publications. Hypothesis 2 (H2) was evaluated through a chi-square goodness-of-fit test to compare gender-wise author productivity in OA publications, using data from 28,014 authorship records. Hypothesis 3 (H3) was examined with the Kruskal–Wallis one-way ANOVA to test differences in OA publication output across four author designations Professor, Associate Professor, Assistant Professor, and Research Scholar.

#### **7. Findings of the Study**

This chapter provides a detailed summary of the study's key findings, hypothesis testing, conclusions, and recommendations for future research. The findings are clearly organized in line with the objectives outlined in the previous chapters. The primary aim of the present study is to evaluate the Open Access (OA) publications of the top 19 central universities of India, published between 2005 and 2024, using a data carpentry approach. A total of six objectives were formulated, and the overall analysis was carried out based on these objectives. The study throws an ample light on the level of Open Access adoptability and its various dimensions in research conducted by India's leading academic institutions. The major findings of the study have been presented under two broad categories, as shown below.

- a) Objective-wise findings
- b) General findings of the study

## **A. Objective-wise Findings**

### **Objective 1: To Assess the Year-wise Growth of Open Access (OA) Publications Between 2004 to 2023 and Forecast the Future Growth of Research of the Selected Central Universities of India**

- a) In the present study, data were extracted from the Scopus database for all 19 selected central universities of India. The analysis reveals that over the past two decades (2005–2024), these leading universities have published only 27.32% of their total scholarly output as Open Access. This highlights the relatively low adoption of Open Access practices among premier Indian academic institutions as per the Scopus.
- b) The overall research growth indicates a slow but steady increase in Open Access (OA) output, with minor fluctuations observed over the 20-year period. Initially, OA output grew at a slow pace from 2005 to 2014, followed by a decline in 2015. However, from 2016 onwards, OA output began to increase gradually at a relatively higher rate until 2022, after which a decline was noted in 2023 and 2024. The study has also forecasted OA growth for the next two years, i.e., 2025 and 2026, which indicates a positive upward trend.
- c) It was found that Tezpur University, North Eastern Hill University (NEHU), Central University of Tamil Nadu, English and Foreign Languages University, and Manipur University showed an upward trend in OA publications in 2024. In contrast, the remaining universities recorded a decline during the most recent period, particularly in 2023 and 2024, indicating possible shifts in institutional priorities, funding availability, or research output patterns.
- d) The results indicate that most universities experienced a marked rise in OA publications between 2019 and 2022. This surge can likely be attributed to the growing importance of open access research dissemination during the COVID-19 pandemic, when rapid and unrestricted sharing of scientific findings became a global priority. The pandemic period witnessed an increased demand for collaborative research, accelerated peer-review processes, and heightened institutional and funding body mandates for OA publishing. These factors, combined with the widespread use

of preprint servers and repository deposits, may have contributed to the substantial growth observed during this period.

**Objective 2: To Analyze the Subject-wise Distribution, Social, Intellectual and Conceptual Structures of OA Publications Trends by Collaboration of Authors and Countries, Citation Impact, and Keywords Analysis**

a) The study aims to identify the significant subject areas in which most of the research has been carried out and published under the Open Access model. It reveals that authors from the top Indian central universities have mostly worked in the field of Medicine, followed by Biochemistry, Genetics and Molecular Biology, and then Mathematics, while Social Science ranks fourth. It is observed that, comparatively, Open Access researches are mostly conducted in the STEM fields than the other fields.

b) Over the 20-year period (2005–2024), the citation growth pattern of Open Access publications has shown fluctuations, yet it exhibited an overall upward trend. However, from 2020 onwards, the citation count declined more sharply up to 2024 possibly because citations typically require time to accumulate.

c) The most influential papers, based on the number of citations, reveal that research works in the field of Global Burden of Disease (GBD) studies are the most widely discussed in academia.

d) The top ten prolific journals indicate that publications from Indian central universities are predominantly featured in reputed Open Access journals such as *Scientific Reports* (991 papers), followed by *PLoS ONE* (846 papers), *Journal of High Energy Physics* (592 papers), and seven other journals. This reflects the strong research presence of leading Indian academic institutions and their active contribution to the promotion of Open Science. Moreover, out of the ten journals, eight are fully Open Access, while the remaining two are subscription-based, indicating the availability of funding support and the adoption of the Gold Open Access model to enhance research visibility.

e) Among the top ten prolific publishers of OA publications, Springer ranks first with the highest number of OA papers, followed by Elsevier BV and Medknow. These publishers are internationally recognized for disseminating high-quality

research and have played a significant role in promoting Open Access through their publishing models and extensive global reach.

f) The co-authorship network of authors from Indian central universities, visualized using VOSviewer, reveals frequent internal collaborations within clusters while also maintaining inter-cluster connections. Authors such as Shyam Sundar, Manish Kumar, and Ashok Kumar appear as central nodes, indicating their strong collaborative roles across multiple research groups.

g) The co-authorship network shows that Indian central universities have strong international collaborations in open access research, especially with Saudi Arabia, the United States, the United Kingdom, Germany, Japan, South Korea, and the Netherlands. Such partnerships reflect the global reach of their research activities and may contribute to increased visibility, citation impact, research collaboration and knowledge exchange.

h) The keyword analysis based on occurrences shows that most of the research by Indian central universities has been conducted in areas related to COVID-19, along with associated themes such as SARS-CoV-2, oxidative stress, apoptosis, machine learning, and deep learning, indicating a strong focus on pandemic-related and interdisciplinary studies. This pattern highlights a strong emphasis on pandemic-driven research as well as the integration of interdisciplinary approaches, combining biomedical sciences with advanced computational techniques.

**Objective 3: To Measure the Open Access Friendliness of the Publications of Central Universities Based on OA Compatibility Parameters (Designed & Developed by Mukhopadhyay, 2022) and Open Access Collaboration Pattern**

a) The OA publications contributed by the Indian central universities between 2005 and 2024 are mostly published through the Gold route (58%), followed by Bronze (16%), Hybrid (14%), and lastly, the Green route (12%). This indicates a greater reliance on subscription-based publishing through funding support rather than the self-archiving publishing model.

b) Over the two decades (2005–2024), OA publications from Indian central universities witnessed the highest growth through the Gold route, marking it as the most preferred model. Hybrid OA showed moderate growth, particularly after 2017.

In contrast, Bronze OA declined in recent years, while Green OA recorded the least growth with minimal and inconsistent contributions.

c) Among the various OA licenses adopted by Indian central universities, CC-BY was the most preferred, with 15,263 publications, followed by CC-BY-NC-ND (3,756) and CC-BY-NC (1,616). Other licenses such as CC-BY-NC-SA, OTHER-OA, and Publisher-Specific OA had relatively lower adoption.

d) The primary hosting location for most Open Access articles from Indian central universities is publisher platforms (83%), with only 17% having the repository as their main source of access.

e) When considering secondary copies, 54% of OA articles also have a version archived in an institutional or subject repository, while 46% lack such archiving. This indicates that although Green OA is relatively common as a supplementary route, there is scope to strengthen self-archiving practices for broader accessibility and long-term preservation.

f) A larger number of OA articles from Indian central universities are published in journals listed in the DOAJ (21,361) compared to those not listed (18,041). Similarly, 24,887 articles are published in Open Access journals, while 19,606 are in journals that are not fully OA

g) The OA framework scores reveal notable variations in Open Access adoption and impact across institutions. The Central University of Kerala ranks highest (83%) in OAF score for exceptional OA licensing (11.4%) and citation impact (15%), despite a relatively modest OA share. Mizoram University scores the highest in the licensing parameter with 11.7 out of 20, reflecting its strong commitment to adopting permissive Open Access licenses that maximize the accessibility, reuse, and dissemination of its research outputs. All the selected universities maintain the maximum possible repository share score (20%), indicating good compliance in archiving practices. The Central University of Kerala achieved the highest and full scores in both the citation and Altmetric parameters, indicating exceptional research impact and strong engagement across scholarly and public platforms. Well-known institutions like the University of Delhi and Banaras Hindu University have moderate OAF scores (54.13 and 59.9 respectively), suggesting that high OA output alone does not necessarily guarantee a proportionally higher OA friendliness.

h) The Central University of Kerala (83), Central University of Punjab (74.91), Central University of Tamil Nadu (64.53), Mizoram University (62.2) and Jawaharlal Nehru University (60.09) ranks among the top five institutions in terms of OA Friendliness (OAF) scores, reflecting their strong performance in Open Access research. Their high scores indicate balanced strengths across OA share, repository availability, licensing practices, citation impact, and Altmetric engagement, highlighting their commitment to advancing open science practices. Rest of the universities have scored below 60 out of 100.

i) The analysis reveals that several top-ranked central universities in the NIRF standings record comparatively lower OA Friendliness (OAF) scores than mid- to lower-ranked institutions. This suggests that a high national ranking does not necessarily translate into stronger Open Access practices, indicating potential gaps in OA policy implementation and prioritization even among leading universities.

j) Although the oldest central universities demonstrate a high volume of OA publications and substantial OA share, several newly established universities compete with them in OA licensing, Altmetric Attention Scores, and citation impact. This indicates that newer institutions may be adopting more progressive and impactful Open Access practices despite having a smaller overall research output.

#### **Objective 4: To Compare the Open Access Publications Trends in Sciences and Social Sciences Domain**

a) The subject-wise distribution reveals that 85.3% of OA publications from Indian central universities are in the Science domain, followed by 12.5% in Social Sciences, and only 0.7% in Arts and Humanities. This dominance of science-related research highlights both global publishing patterns and the research priorities of central universities, while the minimal representation of Arts and Humanities suggests limited adoption of OA platforms in these disciplines.

#### **Objective 5: To Find Out the Gender Ratio of the Open Access Publications of the Selected Central Universities of India**

a) The gender distribution of first authorship reveals that 64% of first authors are male, while the remaining 36% are female. This indicates that male academicians

and researchers from the central universities of India are comparatively more active in producing Open Access research than their female counterparts. The disparity may be influenced by factors such as intake patterns in academic jobs and the research sector, institutional support, mentorship opportunities, and workload distribution, all of which can shape the level of participation and output among male and female researchers.

b) The female-to-male ratio of first authorship in Open Access publications from the selected central universities is approximately 57:100. This means that for every 100 male first authors, there are about 57 female first authors. Such a ratio not only quantifies the observed gender gap but also reinforces the percentage-based findings, indicating that male researchers maintain a higher representation in Open Access scholarly output.

#### **Objective 6: To Rank the Central Universities Based on the Number of Open Access Publications**

a) Among the selected 19 central universities, the University of Delhi recorded the highest number of Open Access publications (12,215), followed by Banaras Hindu University (6,258) and Aligarh Muslim University (5,446). These three institutions collectively account for over half of the total OA output in the dataset.

b) When considering the proportion of OA publications relative to total research output, Visva-Bharati University ranks highest with 33.07%, closely followed by Jamia Millia Islamia (29.83%), which also holds the second position in the NIRF rankings among the selected universities. The strong OA ratios of these institutions suggest targeted policies, faculty engagement, or research cultures that prioritize open dissemination, even if their absolute research output is comparatively lower than larger universities.

c) Out of the total research output of the selected 19 central universities, an average of 27.32% of publications are published through the Open Access route. This proportion of OA research indicates a moderate uptake of OA publishing and it suggests room for growth when compared to global OA adoption rates. Some studies shows that nearly 50% of global research output is currently published via OA, with

Gold OA accounting for about 38% of articles in 2023 (STM Association, 2024; Gitnux, 2025).

## **B. General Findings of the Study**

- a) A strong surge in OA publications was observed between 2019–2022 across most universities, signifying that the COVID-19 pandemic has accelerated the adoption of open access as a means of rapid knowledge dissemination.
- b) The overall findings of the study reveal that, even though the older central universities based on the year of establishment have a greater number of OA publications than the newly established universities. However, despite having fewer OA publications, the newer universities are found to have stronger OA uptake and have followed OA mandates for promoting Open Science than the older universities.
- c) Among the prolific authors based on the number of OA publications, reveals that the majority are affiliated with the departments of Physics, Chemistry, and Mathematics.
- d) The top contributors of OA publications also belong to the top NIRF-ranked central universities, such as the University of Delhi, Jamia Millia Islamia, and Aligarh Muslim University, indicating a strong alignment between research productivity and institutional ranking.
- e) In terms of receiving the highest Altmetric Attention Scores (AAS) for OA publications, Banaras Hindu University (90,084), Jawaharlal Nehru University (35,037), and the Central University of Punjab (28,025) rank among the top three.
- f) A strong surge in OA publications was observed between 2019–2022 across most universities, signifying that the COVID-19 pandemic has accelerated the adoption of open access as a means of rapid knowledge dissemination.
- g) After 2022, a noticeable decline in OA output is observed in many universities (e.g., JNU, Jamia Millia Islamia, AMU), indicating a post-pandemic normalization and suggesting that the pandemic-driven OA growth was not sustained thereafter.
- h) Several newly established central universities (Central University of Tamil Nadu, Central University of Jammu, Central University of Kashmir) are showing

steady upward OA trends despite their shorter history, reflecting growing alignment with national and global OA policies.

i) While the Indian central universities collaborate widely with collaborators across the globe, the collaboration strength is still unbalanced concentrating with countries like the US, UK, Saudi Arabia, and Bangladesh, leaving a scope for diversifying partnerships with other countries also.

j) The dominance of a few international publishers like Springer, Elsevier, Wiley etc, in driving OA dissemination highlights limited presence of Indian publishers in large-scale OA publishing, suggesting the need for stronger national/institutional OA platforms.

k) A large number of OA publications lack clear and authorized license information, which may degrade legal clarity and limit reuse potential, showing the need for stronger advocacy and awareness of standard licensing practices (e.g., Creative Commons).

l) Although women are contributing significantly to OA publications, the male-dominated first authorship pattern indicates structural imbalances in academic participation and publishing opportunities, which could influence the inclusivity of OA practices in the long term.

## **8. Conclusion**

The Open Access (OA) movement originated as a response to the rising costs of journal subscriptions, which created significant barriers to accessing scholarly literature. The movement gained significant momentum through landmark initiatives such as the Budapest Open Access Initiative (2002), the Bethesda Statement on Open Access Publishing (2003), the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003). At the national level, the Delhi Declaration on Open Access (2018) further strengthened the movement in the Indian context by emphasizing the importance of free and open access to publicly funded research. Collectively, these initiatives have greatly influenced the global landscape of scholarly communication by promoting unrestricted access to research outputs,

through enhancing knowledge dissemination, fostering academic collaboration, and positively transforming research accessibility across the world.

The movement is primarily driven by diverse group of stakeholders, including researchers, academicians, librarians, educators, policymakers, and the general public, united by the goal of ensuring equitable access to knowledge. Researchers and academicians contribute by publishing their work in open access platforms for making their results freely available to a wider audience. Librarians play a crucial role as the facilitators of institutional repositories, managing open access resources, and guiding authors on self-archiving and licensing options. Educators support the movement by integrating open access materials into teaching and curriculum development, by expanding students' access to quality learning resources. Policymakers strengthen the movement by formulating mandates and funding policies that require publicly funded research to be openly accessible. Similarly, the general public consisting of students, independent scholars and professionals supports the movement by demanding access to research outputs beyond traditional academic boundaries. Altogether, these groups form the backbone of the Open Access movement, working collaboratively toward a more inclusive and democratic system of scholarly communication.

Academic and research institutions serve as primary hubs where a substantial volume of scholarly work is produced and disseminated. Consequently, monitoring the growth of Open Access (OA) research contributions within these institutions is crucial for assessing their level of participation and engagement in promoting the principles of Open Science. Institutional OA output is increasingly regarded as a benchmark for evaluating research visibility, accessibility, and societal impact. It also plays a significant role in policy evaluations and ranking frameworks, where openness and research dissemination are considered indicators of academic excellence. Furthermore, the growing OA contributions of academic institutions reflect the cumulative impact and success of the long-standing efforts made by various international and national bodies to advance the Open Access movement. These contributions not only validate past initiatives but also provide valuable evidence for governments and funding agencies to design and implement effective policies that further strengthen the culture of openness in research and higher

education. Thus, tracking OA growth in academic institutions highlights both their commitment to equitable knowledge sharing and their strategic role in shaping the future of scholarly communication and policy development.

The present study traces the growth and contribution of Open Access (OA) research by selected top central universities of India, as indexed in the Scopus database, for the period 2005–2024. The OA publications have been analyzed using a data carpentry approach, which involves systematic data cleaning, transformation, and organization to ensure accuracy, consistency, and reproducibility. This approach not only facilitates reliable analysis of large-scale bibliometric datasets but also enhances transparency, allowing other researchers to replicate the study or extend it in future investigations. The findings of the study provide a comprehensive insight into the uptake and adoption of Open Access by India's top universities, highlighting their role in promoting open and equitable dissemination of scholarly knowledge. The overall growth of OA publications by all the nineteen central universities revealed that OA publications constitute only 27.32% of the total research output, indicating moderate adoption among premier Indian universities. OA output grew gradually from 2005 to 2014, declined in 2015, and increased steadily from 2016 to 2022, followed by a slight decline in 2023–2024. Forecasts for 2025–2026 indicate a positive upward trend. Universities such as Tezpur, NEHU, Central University of Tamil Nadu, EFLU, and Manipur exhibited growth in 2024, while others recorded a decline. The surge in OA publications between 2019 and 2022 reflects the impact of the COVID-19 pandemic, which accelerated collaborative research, peer-review processes, and institutional mandates for OA dissemination. The central universities have widely conducted OA research primarily in STEM disciplines, with Medicine leading, followed by Biochemistry, Genetics, and Mathematics, while Social Sciences and Arts remain underrepresented. Citation trends indicate fluctuations but an overall upward trajectory, though post-2020 citations declined due to accumulation lag. Highly cited works include Global Burden of Disease studies, and leading journals such as *Scientific Reports*, *PLoS ONE*, and *Journal of High Energy Physics* host most OA publications, highlighting the prominence of the Gold OA model. International collaborations are notable with countries like USA, UK, Saudi Arabia, and Germany, while keyword analysis of OA publications reveals a strong

focus on COVID-19 and related interdisciplinary themes, including machine learning, deep learning, oxidative stress, and apoptosis, indicating that universities actively responded to global health challenges while integrating computational and biomedical approaches.

The OA friendliness analysis reveals a strong preference for Gold OA (58%), followed by Bronze, Hybrid, and Green routes. CC-BY licenses dominate, and publisher platforms host 83% of OA articles, though 54% are archived in repositories. The OA Friendliness (OAF) framework identifies Central University of Kerala, Central University of Punjab, and Central University of Tamil Nadu as top performers, while some older high-ranking universities exhibit lower OAF scores, reflecting gaps in policy implementation and OA awareness. Gender analysis shows that male authors contribute 64% of first-author publications, indicating structural disparities in research participation.

Ranking of institutions by OA output highlights the University of Delhi, Banaras Hindu University, and Aligarh Muslim University as leaders in volume, whereas Visva-Bharati and Jamia Millia Islamia lead in OA proportion, reflecting institutional commitment to knowledge dissemination. Overall, the study demonstrates moderate OA adoption, concentrated activity in STEM fields, minor gender imbalance in authorship, and variability in OA friendliness across institutions, pointing to both progress and opportunities for strengthening Open Access practices in Indian academia.

Lastly, the present study highlights the evolving significance of Open Access publishing over the past two decades within the landscape of Indian academia. It underscores the growing necessity of Open Access in the present era and emphasizes its critical role in sustaining and advancing scholarly research. Greater recognition and investment in Open Access, supported by appropriate licensing frameworks and the adoption of optimal OA publishing routes, will not only facilitate free and equitable access to research but also establish Indian academia as a role model in the global scholarly communication ecosystem.

## 9. Suggestions

The present study has generated significant insights into the current scenario of OA publishing and its adoption patterns in Indian central universities. Based on its major findings, several valuable suggestions have been proposed to enhance the adoption of Open Access within the Indian academic landscape. These recommendations are expected to assist institutions, academicians, researchers, and policymakers in promoting global knowledge dissemination and positioning Indian universities more competitively alongside their counterparts in developed countries. The suggestions are as follows:

- 1) Each central university should strengthen the Institutional OA Policies and create a clear institutional open access (OA) policy aligned with national and international mandates.
- 2) Universities should conduct awareness programs through workshops, training, and orientation programs for faculty and research scholars on the benefits and procedures of OA publishing.
- 3) Universities should take initiatives to encourage the researchers by providing incentives for OA Publishing through recognition, awards, or financial incentives for researchers who publish in quality OA journals or deposit work in repositories.
- 4) Although OA aims to democratize access to knowledge, but the Article Processing Charges (APCs) often acts as a significant barrier to publishing in OA platforms. It is therefore recommended that universities should establish dedicated funding mechanisms to cover APCs, with particular emphasis on supporting early-career researchers.
- 5) To broaden the diversity and inclusivity of knowledge exchange, it is recommended that Indian central universities should actively consider research collaborations with underrepresented global regions (such as Africa, Latin America, and Southeast Asia). Such collaborations would not only broaden the scope of significant research ideas but also contribute to global capacity building and equitable knowledge sharing.

- 6) OA research contributions from Indian academic institutions are predominantly focused in STEM disciplines. To achieve a more balanced and comprehensive representation of knowledge, it is recommended to promote OA publishing in the Arts, Humanities, and Social Sciences, which remain comparatively underrepresented.
- 7) Licensing plays a critical role in OA publishing, yet it is found to be moderately weak in the OA research output of Indian central universities. It is therefore recommended to advocate for the adoption of standard Creative Commons licenses (e.g., CC-BY) to maximize research reuse and minimize ambiguity.
- 8) It is recommended to develop mentorship and research-support programs aimed at enhancing women's participation in OA publishing, thereby fostering a more balanced pattern of research authorship
- 9) It is recommended to encourage government–university collaboration to establish a national OA publishing platform, thereby reducing dependence on commercial publishers.
- 10) The creation of inter-university consortia for shared repository infrastructure is recommended as a strategic measure to enhance the visibility and accessibility of research outputs. Such collaborative frameworks would foster a culture of knowledge sharing and motivate greater research participation.
- 11) It is recommended to Strengthen monitoring and evaluation mechanisms for OA adoption is essential to ensure accountability, track progress, and enable evidence-based policy interventions for sustained growth of Open Access practices.
- 12) It is recommended that authors consider publishing in DOAJ-listed journals to ensure credibility, visibility, and quality of their research outputs.
- 13) It is recommended that Indian universities incorporate OA contributions as a criterion in academic performance evaluations for advancing open scholarly communication.
- 14) The initiation of national-level awareness campaigns is recommended to popularize the benefits of OA among researchers and students, thereby fostering a stronger culture of openness in scholarly communication.

- 15) The establishment of structured mentorship programs, pairing senior OA-active researchers with early-career scholars, is recommended to foster research capacity and strengthen the culture of OA publishing.
- 16) Institutions are encouraged to align their OA practices with UNESCO's Recommendation on Open Science (2021), thereby ensuring global recognition, adherence to international standards, and effective benchmarking.

## 10. Scope for Future Research

Although the present study has been carried out with certain limitations in terms of database selection (Scopus), institutional coverage (central universities), and time frame (2005–2024), the findings cannot be generalized across the entire Indian higher education landscape. These limitations leave ample scope for future research in this area to obtain more comprehensive results. The potential paths for future research include:

- 1) **Inclusion of Multiple Databases:** The findings of the present study are confined to the Scopus database only. Future research can incorporate other scholarly databases such as Web of Science, Google Scholar, OpenAlex, Dimensions.ai, and PubMed to achieve broader coverage and generate more comprehensive results across wider time periods.
- 2) **Survey-Based Studies:** While this study relied solely on secondary data, future research could employ survey-based methodologies to capture the perceptions, attitudes, and experiences of researchers and academicians regarding Open Access across multiple disciplines.
- 3) **Expanding Institutional Coverage:** The present study focused exclusively on the central universities of India. Future investigations could extend the scope to include state universities, Indian Institutes of Technology (IITs), Indian Institutes of Management (IIMs), and other higher educational and research institutions to develop a more holistic understanding of OA adoption.
- 4) **Ground-Level Practices of Academicians:** To extensively examine the OA practices of Indian academicians, survey-based studies may be conducted to explore

the initiatives taken at the ground level including self-archiving, use of repositories, and preferences for specific OA publishing routes.

5) **Global Benchmarking and Comparative Analysis:** Future studies may also compare India's Open Access performance with international benchmarks, such as UNESCO's Recommendation on Open Science (2021), Plan S, and similar global initiatives. Such comparative analysis would highlight India's position in the worldwide OA movement and provide valuable insights for aligning national strategies with global best practices.