SCHOLARLY COLLABORATIONS IN BANGLADESH: A SCIENTOMETRIC ANALYSIS

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SCHOLARLY COLLABORATIONS IN BANGLADESH: A SCIENTOMETRIC ANALYSIS

Thesis submitted to the University of Dhaka for partial fulfillment
of the Degree of Master of Philosophy in
Information Science and Library Management

BY

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Dedication

To my late parents, the roots of my life and architects of my way forward.

To my family, my constant source of inspiration.

This MPhil thesis is dedicated to you wholeheartedly, with profound gratitude for your unwavering support and boundless love.

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CERTIFICATE

I am pleased to certify that the work incorporated in the thesis entitled **Scholarly Collaborations in Bangladesh: A Scientometric Analysis** was carried out by Md. Ashiqur Rahman under my supervision and guidance.

(DR. S. M. ZABED AHMED)

Supervisor

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DECLARATION

I, Md. Ashiqur Rahman, hereby declare that the MPhil thesis titled *"Scholarly Collaborations in Bangladesh: A Scientometric Analysis"* is my original work. I have not submitted it for any other degree, nor has this thesis been previously published. All sources are duly acknowledged in this thesis.

Md. Ashiqur Rahman

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ABSTRACT

Collaboration is a foundation for advancing knowledge and promoting academic progress in an ever-changing field of education. This thesis presents a comprehensive scientometric analysis of scholarly collaborations in Bangladesh, focusing on the trends, patterns, and impacts of co-authored research within the country's academic landscape. The study employs a quantitative method using bibliometric data from the Scopus database. It explores interdisciplinary and institutional research of 33 selected universities in Bangladesh from 2012 to 2021 through a scientometric analysis, examining authorship, research output patterns, and collaboration trends. The study also uncovers disparities in collaboration intensity across different fields and universities, offering insights into the barriers and remedies of effective scholarly cooperation. By providing a comprehensive overview of the current state of academic collaborations, this thesis contributes to understanding how collaborative efforts enhance research productivity and impact in Bangladesh. The findings offer valuable insights for policymakers and academic institutions to foster a more conducive environment for effective scholarly collaborations, ultimately advancing research and innovation in Bangladesh.

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LIST OF ABBREVIATIONS

DU	University of Dhaka
RU	University of Rajshahi
BAU	Bangladesh Agricultural University
BUET	Bangladesh University of Engineering and Technology
CU	University of Chittagong
JU	Jahangirnagar University
IU	Islamic University, Bangladesh
SUST	Shahjalal University of Science and Technology
KU	Khulna University
USTC	University of Science and Technology Chittagong
NSU	North South University
IUB	Independent University, Bangladesh
AIUB	American International University-Bangladesh
IIUC	International Islamic University Chittagong
AUST	Ahsanullah University of Science and Technology
DIU	Daffodil International University
EWU	East West University
UAP	University of Asia Pacific
BSMMU	Bangabandhu Sheikh Mujib Medical University
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University
HSTU	Hajee Mohammad Danesh Science and Technology University
PSTU	Patuakhali Science and Technology University
BRACU	BRAC University
SAU	Sher-e-Bangla Agricultural University
SU	Stamford University Bangladesh
SEU	Southeast University
CUET	Chittagong University of Engineering and Technology

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UIU	United International University
DUET	Dhaka University of Engineering and Technology
KUET	Khulna University of Engineering and Technology
RUET	Rajshahi University of Engineering and Technology
JnU	Jagannath University
NSTU	Noakhali Science and Technology University

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Chapter 1

Introduction

Research and development are significantly correlated to sustainable development in a country. Hence, most countries are refiguring their education systems, emphasizing research from the beginning of education. For instance, schools in developed countries practice paperwork as a starter for research work. Thus, their pupils are accustomed to research from an early stage and keep practicing at their higher level (Booth, 2007).

Most developed countries have integrated their research endeavors with development strategies. Following the example, developing and least-developed countries are trying to boost research activities, link up with the development process, and create a research culture in education, though mostly in higher studies. As a developing country, Bangladesh is trying to enhance research efforts to turn it into a driving force in its development.

Consequently, research outputs are emerged from individual efforts or collaborative endeavors. Research collaboration is not a new phenomenon; however, the specific patterns of collaboration in Bangladesh have yet to be explored. This research is an effort to examine scholarly collaborations in top-ranked universities in Bangladesh (Hossain & Ahmed, 2020).

Statement of the problem

Co-authorship and organizational partnerships are two major forms of research collaboration in Bangladesh that contribute significantly to scholarly output. However, a number of collaboration-related aspects remain unexplored, such as the types of authorship (single, multiple, local, and international), sources of documents, and annual growth trends. This research aims to provide a detailed scientometric analysis to map the landscape of research collaborations in Bangladesh, highlighting where and how these collaborations occur. By comprehending these patterns, this research hopes to gain a deeper understanding of the dynamics of research output and the possibilities for future cooperative endeavors.

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Purpose

The study reviewed the research collaborations in Bangladesh based on bibliometric data from the Scopus database. The specific objectives of the research were:

i. To focus on the trends of collaboration between Bangladesh and the rest of the world;

ii. To differentiate the traits of collaboration in research outputs;

iii. To find out the areas and scopes of collaborative research works in practice;

iv. To discover future trends of collaboration; and

v. To highlight existing obstacles and recommendations to overcome;

Research questions

i. What are the trends of collaborative research in Bangladesh?

ii. What are the nature and level of collaboration?

iii. In which disciplines or domains does collaborative research come out most?

iv. What are the consequences of collaborative efforts in Bangladesh?

v. What measures should we require to overcome obstacles, and what are the recommendations?

Scope

The study focused on the research outputs in which Bangladeshi researchers were involved as co-authors, multiple authors, or any other involvements with the outputs published worldwide. It also covered the collaborative outcomes published in Bangladesh, where researchers from other countries were engaged as participant writers. The work entitled "Scholarly Collaborations in Bangladesh: A Scientometric Analysis″ aims to highlight the importance of mapping collaboration patterns to identify trends in collaborative research.

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Significance

Research collaboration between Bangladesh and the rest of the world remains unexplored. This study addresses this gap by comprehensively analyzing the patterns and trends in collaborative research. It is instrumental in uncovering authorship patterns, the growing number of collaborative documents, and the trends in collaboration with international scholars. By focusing on the characteristics and potential of collaborative research, this research also predicts future collaboration trends.

Structure of the thesis

Chapter 1: Background of the study, Statement of the problem, Purpose, Research questions, Scope, Significance, and Structure of the thesis.

Chapter 2: Literature Review

Chapter 3: Research Methodology

Chapter 4: Analysis of Documents and Findings

Chapter 5: Analysis of Authors and Findings

Chapter 6: Limitations, Recommendations, Future research directions

Conclusion

Research collaboration is evident across various domains in Bangladesh. Articles are published both domestically and internationally, where local researchers enrolled themselves as co-authors. Despite this widespread collaboration, there is a lack of dedicated research on this topic. The lack of such studies on collaboration underscores the importance of research in this area. This research aims to address this gap by comprehensively examining research collaboration in Bangladesh.

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Chapter 2

Literature Review

Research collaboration is not a new phenomenon. Numerous research studies have been published mentioning its traits, facets, levels, and results. However, researchers provided varied notions outlining research collaboration. Therefore, no common definition can cover all facets. According to Hu & Racherla (2008), research collaboration has been defined from different aspects and diversities of perspectives. Generally, research collaboration refers to partnerships between people and between people and organizations. It brings together people's experience, knowledge, and social skills to create new technology-related knowledge (Bozeman & Youtie, 2019). From an operational point of view, collaborative research is a preplanned set of interactions and activities between academics and decision-makers/practitioners to address social issues. No matter the definition, extensive research into collaborative efforts has led to a trend that has provoked scientists, research organizations, and policymakers (Bammer, 2008; Laudel, 2002). As a result, consensus exists on the growing importance of working together for its positive vibes (Wray, 2006).

Consequently, the number of collaborative articles is increasing gradually, and collaboration occurs with substantial variances among disciplines (Bammer, 2008; Cronin et al., 2003; Newman, 2004). However, collaboration was evident in the mid-40s. Between 1946 and 1957, the proportion of one-author papers declined from 75% to 52%, and a general rise in the proportion of papers by two authors and three authors (Smith, 1958). Studies also revealed statistical evidence of this growth: the number of researchers involved in collaboration rose from only 3.5 percent in 1991 to 41.6 percent in 2005. Over the past few years, research collaboration trends have become more apparent (Luo & Hsu, 2009). Eventually, significant changes became more evident in research, which has been noted over the last few decades, suggesting a higher level of collaboration. Several factors contributed to this shift, and an increase in the existence of international partnerships and coedited publications is a strong indication of its continued expansion. (Schleyer et al., 2012). Interdisciplinary collaborative efforts contributed to this expansion with increased productivity and creativity. Evidently, multidisciplinary teams produce more creative solutions and innovations

due to the diversity of perspectives and expertise involved (Börner et al., 2010). Studies have also discovered that collaborative research can enhance research productivity, and thus, it should be encouraged. Successful collaborative research enhances networking possibilities inside and beyond one's domain, resulting in future research partnerships and career advancement (Cummings & Kiesler, 2007).

Collaborative research is an effective tool for developing or emerging countries to access advanced scientific knowledge and technologies (Kim, 2006). This access is essential to becoming part of the global research community and gaining advantages from developments in different scientific areas. Scientists from developing countries can increase their expertise and understanding through international partnerships. Collaboration of researchers from various countries may lead to developing new research ideas and methods that otherwise would not have been possible. This would enable researchers to make groundbreaking discoveries in research and the development of new technologies and products (Damaševičius & Zailskaitė-Jakštė, 2023). Research collaboration is also widely regarded as an indicator of the quality of researchers and research teams (Kim, 2006). Their competence can be measured through their capacity to apply shared expertise and resources, thus indicating their efficiency and capability in conducting high-quality research. Subsequently, research collaboration has become indispensable in recent years, and governments and organizations support research collaboration in many forms. They tried to bring together individual researchers into groups and accordingly developed many policies to link industries and universities to research collaboration. Research collaboration thus may occur among individuals, groups, disciplines, sectors, institutions, or countries (Katz & Martin, 1997). Sustained growth and innovation rely on this essential support.

However, collaboration occurs in many ways, such as teacher-pupil, among colleagues, supervisor-assistant, researcher-consultant, between organizations, and international (Subramanyam, 1983). These ways involved distinct interactions and organizational hierarchies with different dynamics and benefits.

Collaboration covers two types of research partnerships and interactions: horizontal and vertical. Horizontal collaboration involves peers, such as coworkers in the same department or discipline. Vertical collaboration occurs in higher education and industry (Bozeman & Boardman, 2014).

Collaboration works in several manifestations based on the operational process: Interdisciplinary, inter-organizational, public and private sector. Interdisciplinary teamwork involves researchers from various fields working together to solve problems and encourage innovation. Inter-organizational collaboration is defined as an alliance between academic institutions and industry partners. Public and private sector collaborations consume the knowledge and resources of both sectors to solve more significant social challenges (Etzkowitz & Leydesdorff, 2000).

Collaboration functions at different levels. Though researchers could not come to a consensus about the level of collaboration, it may be differentiated into interpersonal, institutional, and international collaborations. Interpersonal collaboration involves researchers within the same discipline or institution collaborating on shared projects. Institutional collaboration includes entire organizations or departments for large projects that require coordinated efforts. International collaboration enrolls researchers from different countries to collaborate and integrate diverse viewpoints and expertise (Hu & Racherla, 2008; Stokols et al., 2008; Wagner & Leydesdorff, 2005).

Many forms of collaboration have become popular in recent years, though co-authorship and multi-authorship are widely known (Smith, 1958). Authorship can also be distributed between co-authorship and sub-authorship. Co-authorship includes shared authorship, where all participants share their efforts in the research and writing process. Sub-authorship means assistance to authorship, where the role of authorship is to support the research without being principal authors (Heffner, 1981).

Collaboration comes in two stages: theoretical and technical (Heffner, 1981). The theoretical stage encompasses the strategic plan to form a collaborative effort, whereas the technical stage includes the operations.

However, research collaboration is characterized as teamwork. Researchers in collaborative works might have different interests in interactive performances to attain a purposive goal (Jassawalla & Sashittal, 1998). In particular, the trait is tagged precisely as "individuals who differ in notable ways sharing information and working toward a particular purpose." (Amabile et al., 2001). Collaboration is also considered a manufacturing unit of interactive researchers that shares resources, competencies, and communication. (Melin & Persson, 1996). It can be assessed at two levels: the organizations participating and the specific science sector concerned (Abramo et al.,

2011). A number of research endeavors used co-authorship as an assessment metric for evaluating research collaboration, proving an extensive effort to collaborate among authors from various departments, institutions, and countries. Studies recognized the continued growth in research collaboration (Adams et al., 2005; Leydesdorff & Wagner, 2008; Narin et al., 1991; Ordóñez-Matamoros et al., 2010; Persson et al., 2004; van Raan, 2004)

This outline incorporates collaborative research as a system of R&D activities that involves several participants working together in the functional framework and coordinating their efforts to achieve an objective related to their respective interests. It also includes non-researchers' engagement in research but excludes partnerships formed just for money or access to research venues. Collaboration is not usually interdisciplinary, although it is typically possible (Denis & Lomas, 2003).

Effective communication and trust are characteristics of successful research collaboration. Both official and informal communication is essential to establish and sustain confidence among partners (Cummings & Kiesler, 2007). However, well-defined objectives and goals are the significant characteristics of successful collaboration. Clear perceptions of the research aims and purposes create associations among collaborators and calibrate teams to attain goals (Eisenhardt, 1989).

Conflict management capability is another characteristic of successful collaboration. Effective mediators of conflicts are better able to deal with controversies constructively in collaborative research (Tjosvold, 1998). Authorship and co-authorship distribution is a critical argument in collaborative research. Authorship agreements help preventing divergences and promote ethical standards.

Effective leadership and project management abilities are the characteristics of successful collaborative research. They are essential for planning and managing research initiatives (Deloitte, 2016). Periodic assessment and feedback mechanisms are also valiant as they enhance the rapidity of research and facilitate attaining goals (Bauer et al., 2010).

One of the crucial features of collaborative research is integrity. Maintaining integrity requires loyalty to ethical rules and standards, such as data sharing and confidentiality agreements (Resnik, 2018).

There are several factors affecting the collaboration. Social interaction can be a significant factor since humans are complex phenomena for effective communication and trade. Collaboration is naturally a social process, and, as with any form of human interaction, there may be at least as many contributing factors as individuals involved (Katz & Martin, 1997). However, the effective role and functions of the social context of research in collaborative efforts could be factors in collaboration. Each participant could fulfill their objectives in addition to the collaboration's common goal (Sonnenwald, 2007). The success and sustainability of collaborative efforts profoundly depend on the dynamics of these interactions. Mutual respect, open communication, and the ability to navigate interpersonal relationships constructively are the prerequisites for a successful collaboration.

The desire of researchers to increase their scientific popularity is a factor that affects collaboration. Consequently, researchers are motivated to work in partnership for visibility and recognition (O'Conner, 1970). However, the need to gain experience or train apprentice researchers might also affect collaboration (Beaver & Rosen, 1978).

A well-defined integration plan influences collaboration. The ability to work together in various disciplines could encourage creativity and innovation; however, it can be challenging to ensure seamless integration without adopting a coherent strategy under the evolution of language and methodologies (Bozeman & Boardman, 2014).

Technical know-how is an essential aspect of research collaboration. Collaboration mainly concerns individuals' scientific and technical knowledge (Bozeman & Dietz, 2001). The quality and impact of the research may be increased by engaging technical expertise. Team members with technical skills can contribute drastically to make a collaborative effort successful.

Research collaboration may be influenced by several variables, such as the professions of the participants, institutional affiliation, and organizational level of the collaboration (Amabile et al., 2001). In addition, the disciplinary focus and the geographical views can be other variables (Sonnenwald, 2007). However, researchers feel comfortable collaborating within the same discipline or in a known community because of common interests and informal interaction.

The challenges faced by individual researchers in mobilizing resources required for effective research could be essential factors for Collaboration (Kling et al., 2000). Collaborative

opportunities may be shrunk due to limited funding, facilities, and other resources. Consequently, impartial and appropriate resource allocation and support are needed for successful collaboration.

The key drivers of collaboration are the sufficient incentive and recognition of collaborative efforts. Researchers may not be interested in partnership if there is a possibility of less recognition (Wuchty et al., 2007). The impartiality in the distribution of credits among participant researchers is crucial to maintaining interest and dedication to collaborative projects.

The nature of collaborative research may vary in its duration. It may differ in short-term projects or a long-term partnership (Cummings & Kiesler, 2007). The researchers' participation often depends on the partnership's duration, which helps maintain productivity and relevance in their work.

Regional location can influence collaboration, and studies have shown that closer physical proximity is often associated with increased cooperation (Breschi et al., 2010). Geographic proximity enables collaboration by receiving uninterrupted logistic support and effective communication. It also affects creating personal relationships and regional communities that encourage collaborative efforts. Changing funding patterns also became a factor as funders preferred collaborative projects to earn more impact and promote interdisciplinary approaches (Heffner, 1981).

However, the collaboration factors may vary in terms of research culture and activities in a country. Hence, the collaboration between Bangladesh and the rest of the world may differ in many ways, which needs to be explored. Given this extensive literature review, a scientometric analysis of academic collaboration in Bangladesh would provide valuable insight into the current state, trends, and impact of research cooperation in the country. In addition, it would help identify areas for improvement and potential focus for policymakers, researchers, and institutions involved in promoting collaborative research in Bangladesh,

Chapter 3

Research Methodology

Introduction

This Chapter discusses the methodology used to systematically investigate research collaboration in selected universities in Bangladesh, examining its outcomes, characteristics, patterns, and future directions of collaboration trends. It outlines the data collection, analysis, and interpretation to provide a detailed understanding of research collaboration in the universities of the country.

Research Design

This research employed scientometric analysis to examine the research collaboration in the universities of Bangladesh. The bibliometric data were obtained from 33 top-ranked universities in the country (Hossain & Ahmed, 2020).

Study Design

The research began with a systematic literature review to explore various facets of collaborative research, including definitions, trends, characteristics, necessity, methods, forms and levels, and factors affecting the research collaboration. Subsequently, a scientometric analysis was performed using data of selected universities in Bangladesh, downloaded from Scopus databases.

Data sources

Given that the study is predominately quantitative, the primary focus was on collecting authorship data. Scopus served as the major source for collecting data, aiding in the analysis of publication patterns, author productivity, collaboration networks, and other bibliographic data. These analyses provided insights into research trends and the structure of scholarly collaboration. Scopus also facilitated comparisons of research output and impact across different institutions. Additionally, it

enabled the assessment of research performance within institutions and the identification of potential collaborations by exploring publication and research metrics.

Population and sample design

The representative sample was selected purposefully based on the needs of the study, ensuring the required characteristics. Due to its subjective nature, this method is beneficial because of its time and cost-effectiveness (Shantikumar, 2018).

Sample Size

To ensure representativeness from universities in Bangladesh, 33 Public and private universities were selected for this study. The names of the universities, year of establishment, university type, location, and subject area/specialization are presented in Table 3.1:

Table 3.1: List of universities

Year estd.	**university type**	**University name and abbr.**	**Subject areas/ specialization**	**University location**
1921	Public	University of Dhaka (DU)	General	Dhaka
1953	Public	University of Rajshahi (RU)	General	Rajshahi
1961	Public	Bangladesh Agricultural University (BAU)	Agriculture	Mymensingh
1962	Public	Bangladesh University of Engineering and Technology (BUET)	Engineering	Dhaka
1966	Public	University of Chittagong (CU)	General	Chittagong
1970	Public	Jahangirnagar University (JU)	General	Savar, Dhaka
1979	Public	Islamic University, Bangladesh (IU)	General and Religion	Khustia
1986	Public	Shahjalal University of Science and Technology (SUST)	Science and Technology	Sylhet
1991	Public	Khulna University (KU)	General	Khulna
1992	Private	University of Science and Technology Chittagong (USTC)	Science and Technology	Chittagong
1992	Private	North South University (NSU)	General	Dhaka
1993	Private	Independent University, Bangladesh (IUB)	General	Dhaka
1994	Private	American International University-Bangladesh (AIUB)	General	Dhaka
1995	Private	International Islamic University Chittagong (IIUC)	General	Chittagong
1995	Private	Ahsanullah University of Science and Technology (AUST)	Engineering	Dhaka
1995	Private	Daffodil International University (DIU)	General	Dhaka
1996	Private	East West University (EWU)	General	Dhaka

Table 3.1 Continued

Year estd.	university type	University name and abbr.	Subject areas/ specialization	University location
1996	Private	University of Asia Pacific (UAP)	General	Dhaka
1998	Public	Bangabandhu Sheikh Mujib Medical University (BSMMU)	Medical	Dhaka
1998	Public	Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	Agriculture	Gazipur
1999	Public	Hajee Mohammad Danesh Science and Technology University (HSTU)	Science and Technology	Dinajpur
2000	Public	Patuakhali Science and Technology University (PSTU)	Science and Technology	Patuakhali
2001	Private	BRAC University (BRACU)	General	Dhaka
2001	Public	Sher-e-Bangla Agricultural University (SAU)	Agriculture	Dhaka
2002	Private	Stamford University Bangladesh (SU)	General	Dhaka
2002	Private	Southeast University (SEU)	General	Dhaka
2003	Public	Chittagong University of Engineering and Technology (CUET)	Engineering	Chittagong
2003	Private	United International University (UIU)	General	Dhaka
2003	Public	Dhaka University of Engineering and Technology, Gazipur (DUET)	Engineering	Gazipur
2003	Public	Khulna University of Engineering and Technology (KUET)	Engineering	Khulna
2003	Public	Rajshahi University of Engineering and Technology (RUET)	Engineering	Rajshahi
2005	Public	Jagannath University (JnU)	General	Dhaka
2006	Public	Noakhali Science and Technology University (NSTU)	Science and Technology	Noakhali

Techniques of Data Collection

In this study, 33 universities were chosen as the sample (Hossain & Ahmed, 2020). Data on the number of scholarly papers produced by each discipline at these universities from 2012 to 2021 was retrieved from Scopus.

Data were searched in Scopus using affiliation and subject. All available records for each discipline were downloaded to Microsoft Excel for further analysis. Table 3.2 presents the sample headings of Scopus data.

Table 3.2: Sample Scopus record headings

Authors
Author(s) ID
Title
Year
Source title
Volume
Issue
Art. No.
Page start
Page end
Page count
Cited by
DOI
Link
Affiliations
Authors with affiliations
Abstract
Author Keywords
Index Keywords
Molecular Sequence Numbers
Chemicals/CAS
Tradenames
Manufacturers
Funding Details
Funding Text 1
References
Correspondence Address
Editors
Sponsors
Publisher
Conference name
Conference date
Conference location
Conference code
ISSN
ISBN
CODEN
PubMed ID
Language of Original Document
Abbreviated Source Title
Document Type
Publication Stage
Open Access
Source
EID

The Excel data were analyzed using the 'Biblioshiny' package of the R. Some of the results from this analysis met the requirements of the study. For example, the number of Documents, Authors, Authors of single-authored docs, Single-authored docs, International co-authorships %, and article numbers were analyzed through the 'Biblioshiny.' Table 3.3 represents the sample data table for a discipline prepared by analyzing the Scopus data.

Table 3.3: Analyzed Scopus data using the 'Biblioshiny' of the R package

Description	**Results**
MAIN INFORMATION ABOUT THE DATA	
Timespan	2020:2020
Sources (Journals, Books, etc.)	86
Documents	128
Annual Growth Rate %	0
Document Average Age	3
Average citations per doc	20.13
References	4668
DOCUMENT CONTENTS	
Keywords Plus (ID)	1477
Author's Keywords (DE)	535
AUTHORS	
Authors	567
Authors of single-authored docs	4
AUTHORS COLLABORATION	
Single-authored docs	8
Co-Authors per Doc	7.98
International co-authorships %	45.31
DOCUMENT TYPES	
article	64
book chapter	1
conference paper	47
editorial	2
letter	1
note	1
review	12

Other data analyses were conducted using simple arithmetic calculations, such as addition, subtraction, percentage, etc. The following formulas were used for calculations:

1. **Collaborative author** = Total author-single author
2. **Collaborative documents** = Total documents-single author documents
3. **International collaboration (author)** = Collaborative author % International co-authorship (%)
4. **Local collaboration (author)** = Collaborative Author-International collaboration (Author)
5. **Annual growth** = Increased number of Documents-Based number of documents/Based number of documents *100.

Table 3.4 shows the datasheet prepared from the analyzed Scopus data and data calculations using the above formulas. Collaborative author, Collaborative documents, International collaboration (author), Local collaboration (author), and Annual growth were calculated from the given data in Table 3.3.

Table 3.4: Sample datasheet extracted from Table 3.3

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	7009	2203	2375	1710	2545	4087	1630	2218	1384	1785	1628	263	752	134	151	47
University of Rajshahi (RU)	3897	1174	1501	496	973	4969	1132	1380	1052	994	663	157	555	66	175	8

However, data retrieved from Scopus using affiliation and the subject area was analyzed through the 'Biblioshiny' tool and later transferred to tables. To identify more specific aspects of collaboration in disciplines and universities, data on these tables were transferred to MS Excel for further analysis. Table 3.5 and Table 3.6 represent the sample data tables retrieved from Table 3.4.

Table 3.5: Sample datasheet on disciplines extracted from Table 3.4

Disciplines	Documents
Medicine	7642
Computer Science	15513
Engineering	15976
Social Sciences	4746
Environmental Science	5789
Biochemistry, Genetics and Molecular Biology	4732
Physics and Astronomy	7666
Agricultural and Biological Sciences	6290
Materials Science	5152
Chemistry	3354
Pharmacology, Toxicology and Pharmaceutics	2513
Mathematics	4043

Table 3.6: Sample datasheet on Universities extracted from Table 3.4

Universities	Number of Documents
University of Dhaka (DU)	12018
University of Rajshahi (RU)	7161
Bangladesh Agricultural University (BAU)	4331
Bangladesh University of Engineering and Technology	11903
University of Chittagong (CU)	3541
Jahangirnagar University (JU)	5221
Shahjalal University of Science and Technology (SUST)	3622
Khulna University (KU)	3557
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1689
Bangabandhu Sheikh Mujibur Rahman Agricultural	1507
Patuakhali Science and Technology University (PSTU)	1396
Khulna University of Engineering and Technology (KUET)	4769
North South University (NSU)	4185
Rajshahi University of Engineering and Technology	3840
BRAC University (BRACU)	3802

To visualize the analyzed data, data on each table was processed through MS Excel, and figures were drawn using the program. Figure 3.5 and Figure 3.6 were drawn from the table 3.5 and table 3.6.

Figure 3.5: Sample datasheet on disciplines extracted from table 3.4

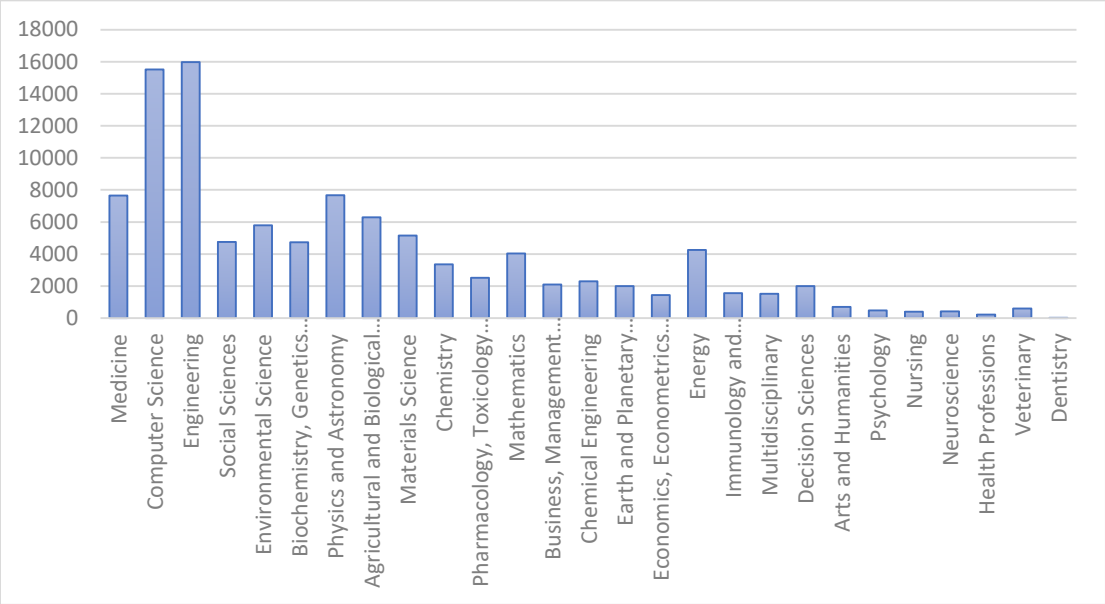
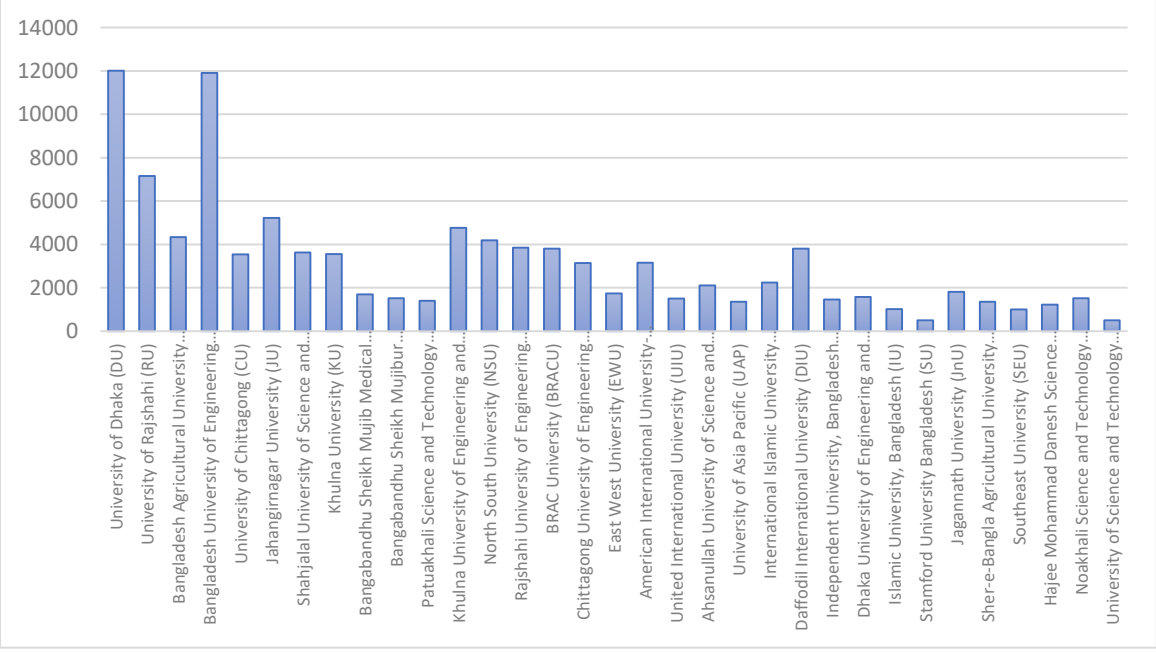


Figure 3.6: Sample datasheet on universities extracted from table 3.4



Finally, patterns and trends were explored from the data tables and figures, and aspects of collaboration were identified through the study.

Data Processing and Analysis

Data retrieved from Scopus, analyzed through the "Biblioshiny" of the R package, sorted using simple calculations, later divided into categories, and arranged according to affiliation, year, and subject area. For example, the number of authors of each institution was separated in a new table to identify the progression and regression of authors in number. The number of research outputs in the subject area presented the disciplines where collaboration emerged maximum. Likewise, each category denoted the patterns, trends, and characteristics of that institution's collaborative efforts, resulting in an overview of scholarly collaborations in Bangladesh as a whole.

For this research, Microsoft Excel was utilized to create and display Scientometric data. These representations were used to analyze co-authorship and collaboration patterns and measure collaboration's influence on research results.

Interpretation of results

The findings were interpreted based on calculations. After processing and analyzing the data, the study presented them in tables and figures, providing clear interpretations to convey the numerical results. For example, collaborative trends can be measured from the research outputs over the years, and the level of collaboration can be interpreted through local and international collaborations.

Chapter 4

Document Analysis and Findings

4.1 Total Documents

The data on research outputs of disciplines in 33 sample universities were downloaded from the Scopus database (Appendix 1) and were subdivided by discipline and university.

4.1.1 Total Documents in Disciplines

Table 4.1.1 was extracted from Appendix 1. It represented different disciplines on the left, while the total number of documents in each discipline from 2012 to 2021 on the right. This information served as a representation of research outputs across various disciplines. A higher value signified a greater emphasis on research within a particular discipline, whereas a lower value indicated a comparatively weaker focus on research.

Table 4.1.1: Total Documents in Disciplines

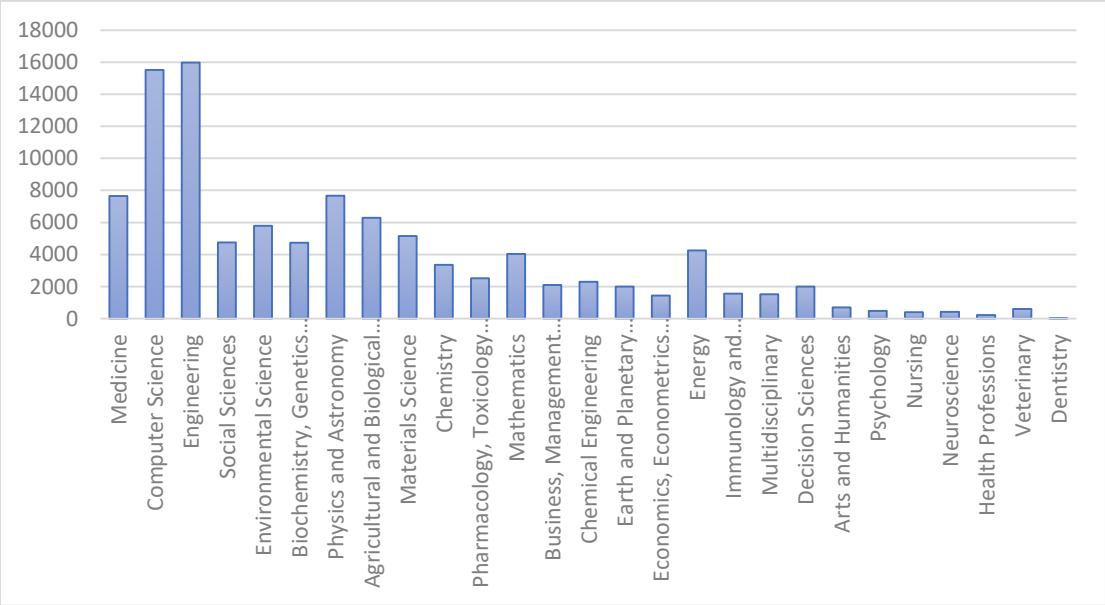
Disciplines	Documents (2012-2021)
Medicine	7642
Computer Science	15513
Engineering	15976
Social Sciences	4746
Environmental Science	5789
Biochemistry, Genetics and Molecular Biology	4732
Physics and Astronomy	7666
Agricultural and Biological Sciences	6290
Materials Science	5152
Chemistry	3354
Pharmacology, Toxicology and Pharmaceutics	2513
Mathematics	4043
Business, Management and Accounting	2102
Chemical Engineering	2303
Earth and Planetary Sciences	1994
Economics, Econometrics and Finance	1438
Energy	4264
Immunology and Microbiology	1553
Multidisciplinary	1513

Table 4.1.1 Continued

Disciplines	Documents (2012-2021)
Decision Sciences	2003
Arts and Humanities	699
Psychology	491
Nursing	410
Neuroscience	421
Health Professions	218
Veterinary	608
Dentistry	26

Figure 4.1.1.1 visually represented Table 4.1.1. It displayed disciplines on the X-axis, while the Y-axis indicated the number of research outputs in those disciplines.

Figure 4.1.1.1: Total Documents in Disciplines



Among the disciplines, Engineering (15976) and Computer science (15513) produced the highest number of documents. Conversely, disciplines like Medicine (7642) and Physics and Astronomy (7666) demonstrated exemplary performances. Environmental Science (5,295), Social Science (4746), Material Science (5152), Agriculture and Biological Science (6290), Biochemistry, Genetics and Molecular Biology (4732), Mathematics (4043), and Energy (4264) showed moderately higher research outputs. Chemistry exhibited the lower end of the range with 3354 publications, while Pharmacology and toxicology had 2513 publications. Business, Management

and Accounting closely followed with 2102 publications, and Chemical Engineering boasted 2303 publications. Earth and Planetary Science had 1994 publications, and Decision Science had 2003 publications.

Further down the list, the research outputs of disciplines such as Economics, Econometrics, and Finance (1,438), Immunology and Microbiology (1553), and Multidisciplinary Studies (1,513) were comparatively lower. Arts and Humanities (699), Veterinary (608), Psychology (491), Nursing (410), Neuroscience (421), Health Professions (218), and Dentistry (26) also exhibited a relatively lower output of research papers.

Patterns and trends:

1. **Engineering and Computer Science Dominance:**
   The dominance of Engineering and Computer Science was visible in the extensive number of documents in the research landscape, highlighting a significant focus on exploration, innovation, and scholarly output in these disciplines. This domination emphasized a crucial role in shaping technological advancements in these areas.

2. **Biomedical and Life Sciences Focus:**
   A significant number of scholarly outputs were published in medicine, physics and astronomy, biochemistry, genetics and molecular biology, pharmacology, toxicology, and pharmaceutics. This finding focused on health and life sciences research and proved a passion for understanding and advancing medical knowledge and biotechnology applications.

3. **Environmental Awareness:**
   The outstanding nature of the environmental science and energy literature mirrored the growing awareness and commitment to solve environmental issues. The results highlighted sustainable energy solutions and ecological concerns and established an increasing awareness of the importance of responsible research for global environmental issues.

4. **Interdisciplinary Research:**

   A significant number of documents in the multidisciplinary domains indicated contemporary trends in interdisciplinary research. It revealed that researchers were increasingly collaborating across various fields and moving away from traditional disciplinary boundaries.

5. **Materials Science and Agricultural Sciences:**

   Materials Science and Agricultural and Biological Sciences played an essential role in research output and represented an ongoing commitment to materials development and the advancement of agriculture. The finding revealed the importance of sustained exploration to promote technological and agricultural development in the region.

6. **Social Sciences and Economics:**

   A large number of documents in Social Sciences, Economics, Econometrics, and Finance improved the understanding of social and economic factors as essential aspects in many areas of research. This substantial output established a commitment to understanding and solving complex human behavior, social structures, and economic issues.

7. **Low Representation in Arts and Humanities:**

   The Arts and Humanities discipline exhibited relatively lower publication numbers, indicating less attention was paid to research in this field. This observation signified the necessity to encourage scholarly engagement and exploration within this domain.

8. **Medical Specializations:**

   The medical field encompassed a variety of specializations, including Medicine, Immunology and Microbiology, Nursing, Health Professions, and Dentistry. The coverage of disciplines reflected the diversity of health-related research.

9. **Low Representation in Psychology and Neuroscience:**

   Comparatively, psychology and neuroscience had fewer publications. This insight forecasted the opportunity to dedicate more attention and resources to explaining the complexity of the human mind and neurological processes.

10. Business and Decision Sciences:

The number of documents in Business, Management, Accounting, and Decision Sciences demonstrated the importance of business research. This approach emphasized the significance of generating knowledge to support effective decision-making processes in various sectors and promote an essential role for research in businesses.

The above patterns and trends exposed the distribution of research outputs across disciplines. The study highlighted the strength of disciplines regarding research outputs and identified the areas of development, eventually allowing researchers to distinguish areas that require more attention.

4.1.2 Total Documents in Universities

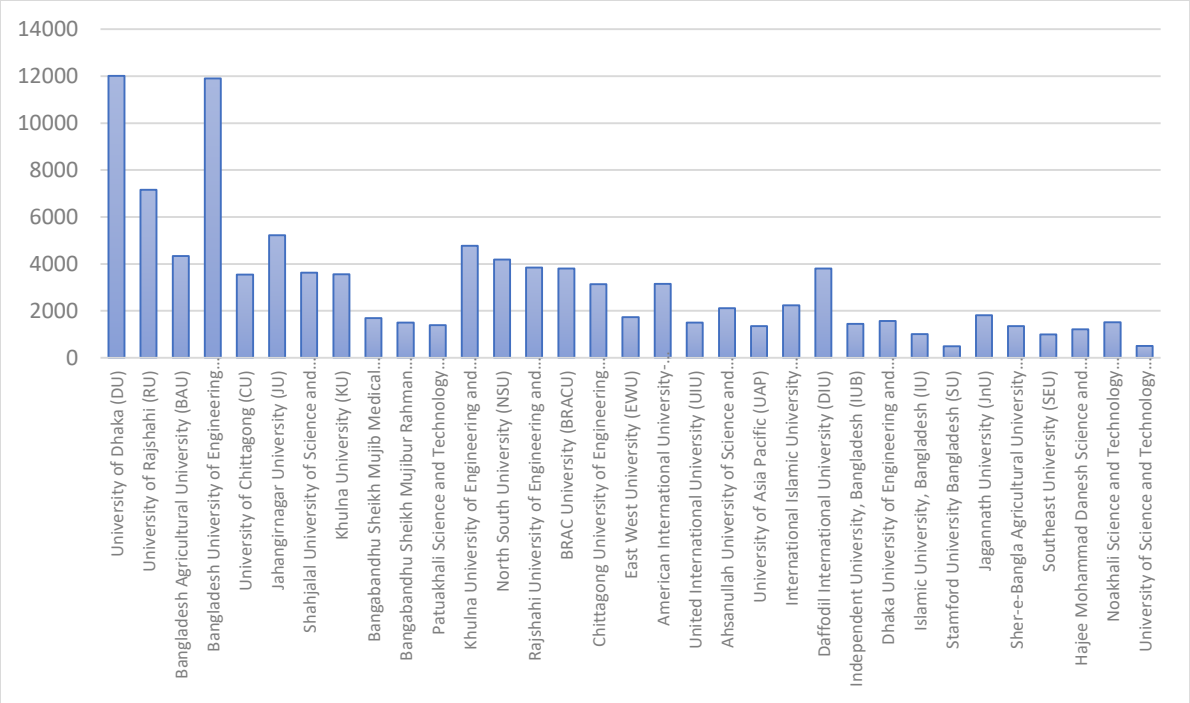
Table 4.1.2 presented the research outputs of various universities from 2012 to 2021. The table showcased the universities' names on the left, the number of documents on the right, together with the number of research outputs published by universities in Bangladesh.

Table 4.1.2 Total Documents in Universities

Universities	**Number of Documents (2012-2021)**
University of Dhaka (DU)	12018
University of Rajshahi (RU)	7161
Bangladesh Agricultural University (BAU)	4331
Bangladesh University of Engineering and Technology	11903
University of Chittagong (CU)	3541
Jahangirnagar University (JU)	5221
Shahjalal University of Science and Technology (SUST)	3622
Khulna University (KU)	3557
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1689
Bangabandhu Sheikh Mujibur Rahman Agricultural	1507
Patuakhali Science and Technology University (PSTU)	1396
Khulna University of Engineering and Technology (KUET)	4769
North South University (NSU)	4185
Rajshahi University of Engineering and Technology	3840
BRAC University (BRACU)	3802
Chittagong University of Engineering and Technology	3138
East West University (EWU)	1731
American International University-Bangladesh (AIUB)	3146
United International University (UIU)	1496
Ahsanullah University of Science and Technology (AUST)	2109
University of Asia Pacific (UAP)	1348
International Islamic University Chittagong (IIUC)	2238
Daffodil International University (DIU)	3810
Independent University, Bangladesh (IUB)	1451
Dhaka University of Engineering and Technology, Gazipur	1566
Islamic University, Bangladesh (IU)	1013
Stamford University Bangladesh (SU)	494
Jagannath University (JnU)	1813
Sher-e-Bangla Agricultural University (SAU)	1347
Southeast University (SEU)	991
Hajee Mohammad Danesh Science and Technology	1218
Noakhali Science and Technology University (NSTU)	1508
University of Science and Technology Chittagong (USTC)	500

Figure 4.1.2.1 visually represented Table 4.1.2. It displayed universities on the X-axis and the number of research outputs on the Y-axis.

Figure 4.1.2.1: Total Documents in Universities



The University of Dhaka, Bangladesh University of Engineering and Technology, and the University of Rajshahi were the leaders, demonstrating the highest publication counts of 12,018, 11,903, and 7,161, respectively. Jahangirnagar University, Khulna University, and North South University followed with 5,221, 4,769, and 4,185 documents, respectively.

Rajshahi University of Science and Technology, BRAC University, Daffodil International University, Shahjalal University of Science and Technology, Khulna University of Science and Technology, Chittagong University of Science and Technology, and American International University enhanced the academic landscape by contributing significantly. These esteemed institutions published many scholarly works, with publication figures ranging from 3,840 to 3,146.

In the lower tiers of the hierarchy, universities such as International Islamic University Chittagong, Ahsanullah University of Science and Technology, Dhaka University of Engineering and Technology, Gazipur, Bangabandhu Sheikh Mujib Medical University, Jagannath University, East

West University, United International University, Noakhali Science and Technology University, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Independent University Bangladesh, Sher-e-Bangla Agricultural University, Bangladesh Agricultural University, and Hajee Mohammad Danesh Science and Technology University contributed to scholarly endeavors. The number of publications of these universities ranges from 2,238 to 1,218, indicating a relatively lower level of productivity.

Among other institutions analyzed, Islamic University, Bangladesh, University of Asia Pacific, Southeast University, Islamic University, University of Science and Technology Chittagong, and Stamford University Bangladesh were documented for their limited influence in the lower levels of the hierarchy. These institutions produced a small amount of documents, ranging from 1,013 to 494.

The extensive examination highlighted the wide range of research outputs from universities in Bangladesh, providing valuable insights into the distribution of scholarly contributions within the academic landscape.

Patterns and Trends:

This analysis revealed several key patterns and trends regarding the production of scholarly papers at universities:

1. **Top Universities in Document Count**

   University of Dhaka (DU) and Bangladesh University of Engineering and Technology (BUET) produced the highest number of documents, followed by the University of Rajshahi (RU) and Jahangirnagar University (JU).

2. **Engineering and Technology Focus**

   A substantial number of documents in the Engineering and Technology domains were produced by Bangladesh University of Science and Technology (BUET), Khulna University of Engineering and Technology (KUET), and Chittagong University of Engineering and Technology (CUET) that mirrored the significance of these areas.

3. **Private Universities Representation**

   Prominent Private universities such as North South University (NSU), Daffodil International University (DIU), BRAC University (BRACU), and American International University-Bangladesh (AIUB) generated a noteworthy number of documents representing their remarkable achievements in the academic and research domains.

4. **Medical and Agricultural Universities**

   In the Medical and Agriculture domains, Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh Agricultural University (BAU), and Sher-e-Bangla Agricultural University (SAU) produced a substantial number of documents. Their significant presence proved the diverse landscape of the country's research endeavors.

5. **Emerging Universities**

   Southeast University (SEU), Stamford University Bangladesh (SU), and University of Science and Technology Chittagong (USTC) exhibited a lower document count. This finding indicated a distinct research focus or less emphasis on research endeavors in these universities.

6. **Geographic Distribution**

   The divergence of the geographical distribution of institutions revealed the dissemination of focus on education and research countrywide. This finding underscored the inclusiveness of the country's educational environment.

7. **Establishment Influence**

   The analysis disclosed that the institutions' ages made an impact on the research outputs. The earlier established institutions generated more scholarly outputs than others. For example, the University of Dhaka (DU), founded in 1921, contributed significantly with 12,018 documents. Similarly, the University of Rajshahi (RU), established in 1953, substantially contributed with 7,161 documents; Bangladesh Agricultural University (BAU), founded in 1961, produced 4331 documents. Bangladesh University of Engineering and Technology (BUET), established in 1962, generated 11,903 documents; the University of Chittagong was established in 1966 and generated

3541 documents, and the Jahangirnagar University was established in 1970 and produced 5221 documents.

On the other hand, comparatively newer institutions like Dhaka University of Engineering and Technology, Gazipur (DUET), Rajshahi University of Engineering and Technology (RUET), Khulna University of Engineering and Technology (KUET), and Chittagong University of Engineering and Technology (CUET), established in 2003 and produced 3138, 1566, 3,840 and 4,769 documents, respectively.

In addition, Noakhali Science and Technology University (NSTU) and Jagannath University (JnU) were established in 2006 and 2005 and generated 1508 and 1813 documents, respectively.

8. Public vs. Private Dynamics

Both public and private universities exhibited variation in their research outputs. Private universities such as the University of Science and Technology Chittagong (USTC), North South University (NSU), Independent University of Bangladesh (IUB), American International University of Bangladesh (AIUB), International Islamic University of Chittagong (IIUC), Ahsanullah University of Science and Technology (AUST), Daffodil International University (DIU), East West University (EWU), University of the Asia Pacific (UAP), BRAC University (BRACU), Stamford University Bangladesh (SU), Southeast University (SEU) and United International University (UIU) produced varied number of documents. Remarkably, NSU, AIUB, and DIU significantly impacted research, producing a substantial number of documents.

Public Universities, on the other hand, produced a comparatively higher number of documents. For example, Dhaka University (DU) generated an impressive number of documents, followed closely by Rajshahi University (RU), Bangladesh University of Engineering and Technology (BUET) and Jahangirnagar University (JU). However, public universities exhibited extensive progress in their research outputs.

9. **Variability in Document Counts**

The analysis revealed the divergence in document production. Several universities produced a higher number of documents, whereas some universities generated significantly lower numbers of documents. This finding signified differences in research emphasis, academic opportunity, and funding, which may require detailed data analysis.

4.2 Single-authored Documents

The data on total documents were analyzed through the "Biblioshiny" tool. The number of single-authored documents was retrieved through the analysis and later divided according to disciplines and universities.

4.2.1 Single-authored Documents in Disciplines

Table 4.2.1 was extracted from Appendix 2. It showcased different disciplines on the left, while the single-authored documents in each discipline from 2012 to 2021 on the right. These figures served as a representation of individual research outputs across various disciplines.

Table 4.2.1: Single-authored documents by Disciplines

Disciplines	**Number of Documents (2012-2021)**
Medicine	192
Computer Science	424
Engineering	469
Social Sciences	842
Environmental Science	208
Biochemistry, Genetics and Molecular Biology	81
Physics and Astronomy	223
Agricultural and Biological Sciences	102
Materials Science	162
Chemistry	35
Pharmacology, Toxicology and Pharmaceutics	46
Mathematics	142
Business, Management and Accounting	258
Chemical Engineering	50
Earth and Planetary Sciences	93
Economics, Econometrics and Finance	212
Energy	150
Immunology and Microbiology	17
Multidisciplinary	16
Decision Sciences	61
Arts and Humanities	215
Psychology	40
Nursing	12
Neuroscience	7
Health Professions	7
Veterinary	3
Dentistry	1

Figure 4.2.1.1 visually represented Table 4.2.1. It displayed the disciplines on the X-axis. The Y-axis indicated the number of research outputs in disciplines.

Figure 4.2.1.1: Single-authored documents in Disciplines

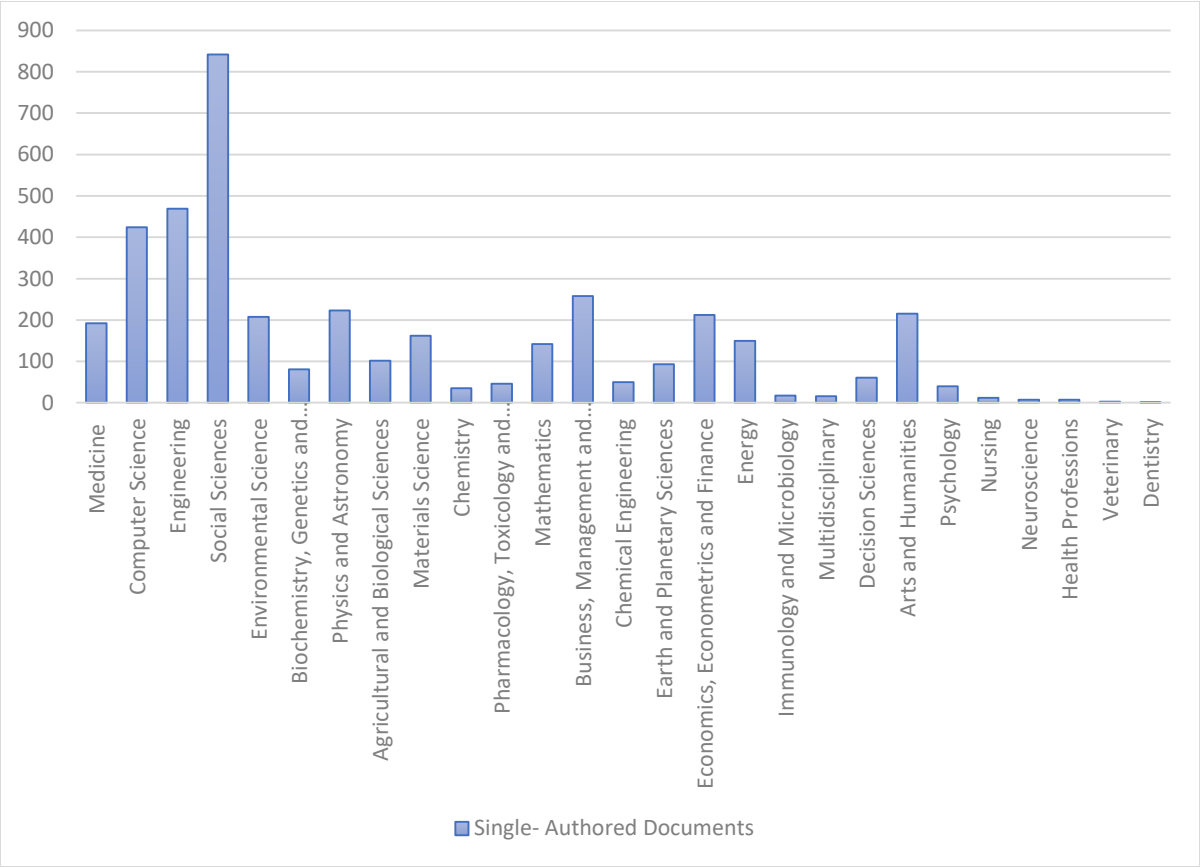


Table 4.2.1 provided a detailed examination of the publication outputs associated with single-author documents across various academic disciplines. Among the disciplines, Social Sciences, Engineering, and Computer Science emerged as leaders, displaying the highest number of single-author publications, 842, 469, and 424, respectively. Business, Management, and Accounting were closely behind and exhibited a substantial presence with 258 publications. Similarly, Physics and Astronomy, Arts and Humanities, Economics, Econometrics, and Finance also demonstrated substantial contributions with 223, 215, and 212 publications, respectively.

Environmental Science, Medicine, Materials Science, Energy, and Mathematics contributed significantly with 208, 192, 162, 150, and 142 publications, respectively.

On the other hand, Earth and Planetary Sciences had 93 publications, followed by Agricultural and Biological Sciences with 102 publications, and Biochemistry, Genetics, and Molecular Biology with 81 publications.

Several disciplines demonstrated a lower number of single-author documents. Particularly, Decision Sciences, Chemical Engineering, Pharmacology, Toxicology, and Pharmaceutics, Psychology, and Chemistry were included in this category, with respective document counts of 61, 50, 46, 40, and 35.

In contrast, disciplines such as Immunology and Microbiology, Multidisciplinary, Nursing, Neuroscience, Health Professions, Veterinary, and Dentistry displayed lower production of single-author publications, reporting only 17, 16, 12, 7, 7, 3, and 1, respectively.

Patterns and Trends:

1. **High Single-Authored Documents:**
   A large number of single-author publications were observed in Social Sciences, Engineering, and Computer Science, with total numbers of 842, 469, and 424, respectively. There was a trend in these fields where researchers frequently emphasized individual contributions.
2. **Low Single-Authored Documents:**
   In contrast, single-authored documents were lower in disciplines such as Immunology and Microbiology, Health Professions, Veterinary, and Dental Science. This phenomenon was attributed to the inherent nature of collaborative research in these areas.
3. **Dominance of Social Sciences:**
   The dominance of social sciences in individual academic research was visible, with a remarkable number of 842 single-authored documents. This representation highlighted the isolated nature of social sciences research on scholarly dialogs and research pursuits.
4. **Engineering and Computer Science:**
   Engineering and Computer Science were notable areas of study for individual research, securing the second and third positions with 469 and 424 single-authored documents, respectively. The substantial number of single-authored publications in these fields underlined the significant presence of single research contributors.

5. **Diversity in Individual Research Areas:**

   The dataset presented a comprehensive overview of disciplines, reflecting the diversity of individual research interests. It included a wide range of fields, including Medicine, Computer Science, Engineering, Social Sciences, Environmental Science, Biochemistry, Genetics and Molecular Biology, Physics and Astronomy, Agricultural and Biological Sciences, Materials Science, Chemistry, Pharmacology, Toxicology and Pharmaceutics, Mathematics, Business, Management and Accounting, Chemical Engineering, Earth and Planetary Sciences, Economics, Econometrics and Finance, Energy, Immunology and Microbiology, Multidisciplinary, Decision Sciences, Arts and Humanities, Psychology, Nursing, Neuroscience, Health Professions, Veterinary, Dentistry. This compilation effectively revealed the remarkable diversity of the individual academic research landscape.

6. **Biological and Medical Sciences:**

   The collective presence of Medicine, Biochemistry, Genetics and Molecular Biology, Chemistry, Pharmacology, Toxicology and Pharmaceutics, Immunology and Microbiology considerably influenced the academic research landscape in single-authored research. These disciplines, together, formed a partnership in a single-authored research domain emphasizing the high impact of biological and medical sciences.

7. **Low Representation in Certain Fields:**

   However, specific disciplines, particularly Dentistry, Veterinary, Health Professions, and Nursing, demonstrated a lower rate of single-authored documents. This observation highlighted potential variations in research activity or a preference for collaborative research within these domains.

8. **Emerging Fields:**

   Although the Immunology and Microbiology, and Neuroscience fields had few single-authored documents, their inclusion indicated the rise of new research areas requiring further investigation and attention.

9. **Disciplinary Variances:**

   Proportionally, non-scientific disciplines exhibited more single-authored documents than scientific disciplines.

   In Social Sciences, for instance, out of 4746 documents, only 842 were written by single authors. Business, management, and accounting contributed significantly with 2102 documents, of which single authors wrote 258. The economics, econometrics, and finance generated 1438 documents, including 212 single-authored works. The Arts and Humanities documented 699 works, of which single authors published 215. In contrast, nursing had a relatively lower proportion, with only 12 out of 410 documents.

   On the other hand, the production of single-author documents was relatively lower in science and engineering compared to their total output. For example, In computer science, out of 15513 documents, only 424 were authored by a single author. Similarly, engineering had 466 single-authored documents out of 15976 documents. Environmental Science contributed 5,789 documents, with 198 being single-authored. Biochemistry, Genetics, and Molecular Biology added 4732 documents, of which 79 were single-authored. Physics and astronomy stand out with 7,666 documents; among them, 223 were single-authored. Lastly, Materials Science contributed 5152 documents, with 162 resulting from single-authored efforts.

   This inconsistency in the proportion of single-authored works between non-scientific and scientific disciplines highlighted the nature of collaborative research in the academic domains.

10. **Discipline-Specific Examples:**

    In some fields, there was a regular trend where a small number of documents were regularly produced by single authors, regardless of the overall volume of document production. For example, 1553 documents were generated within Immunology and Microbiology, with 17 single-authored, 1513 documents were published in the multidisciplinary field, of which single authors wrote 16. In Nursing, a total of 410 documents were produced, of which 12 were single-authored. The domain of Neuroscience witnessed a total of 421 documents, with 7 being single-authored. Health Professions generated a sum of 218 documents, including 7 single-authored works. Veterinary sciences significantly contributed with 608 documents, of which only 3 were single-authored. On the other hand, Dentistry produced 26 documents, with only 1 single-authored work.

11. **Disciplines Embrace Diversity:**

    Trendy Disciplines produced more single-authored documents than less-popular disciplines. Among the trendy disciplines, Medicine distinguished itself with 192 single-authored publications, whereas Computer Science and Engineering generated 424 and 466 publications, respectively. Contributing to this pattern, Environmental Science, Physics and Astronomy, Materials Science, Mathematics, Business, Management, and Accounting produced 198, 223, 162, 142, and 258 single-authored publications, respectively.

    Conversely, not being considered trendy, less popular disciplines such as Earth and planetary sciences generated comparatively fewer single-authored documents at 93, and Immunology and Microbiology at 17. Multidisciplinary, Decision Sciences, and Psychology added 16, 61, and 39 documents, respectively.

4.2.2 Single-authored documents in Universities

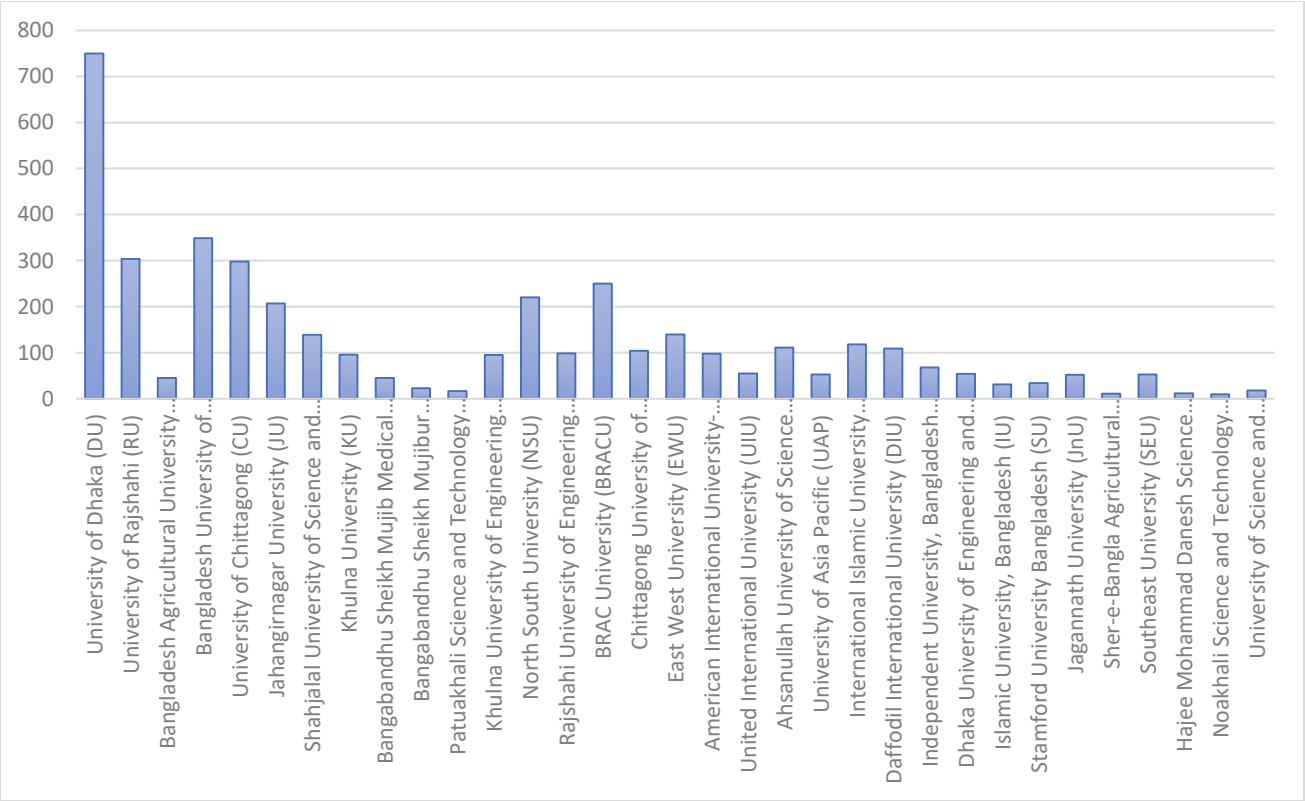
Table 4.2.2 showcased different universities on the left, while the total number of single-authored documents in each university from 2012 to 2021 was displayed on the right.

Table 4.2.2: single-authored documents in Universities

Universities	**Number of Documents**
University of Dhaka (DU)	750
University of Rajshahi (RU)	304
Bangladesh Agricultural University (BAU)	45
Bangladesh University of Engineering and Technology (BUET)	349
University of Chittagong (CU)	298
Jahangirnagar University (JU)	207
Shahjalal University of Science and Technology (SUST)	139
Khulna University (KU)	96
Bangabandhu Sheikh Mujib Medical University (BSMMU)	45
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	23
Patuakhali Science and Technology University (PSTU)	17
Khulna University of Engineering and Technology (KUET)	95
North South University (NSU)	220
Rajshahi University of Engineering and Technology (RUET)	99
BRAC University (BRACU)	250
Chittagong University of Engineering and Technology (CUET)	104
East West University (EWU)	140
American International University-Bangladesh (AIUB)	98
United International University (UIU)	55
Ahsanullah University of Science and Technology (AUST)	111
University of Asia Pacific (UAP)	53
International Islamic University Chittagong (IIUC)	118
Daffodil International University (DIU)	109
Independent University, Bangladesh (IUB)	68
Dhaka University of Engineering and Technology, Gazipur (DUET)	54
Islamic University, Bangladesh (IU)	31
Stamford University Bangladesh (SU)	34
Jagannath University (JnU)	52
Sher-e-Bangla Agricultural University (SAU)	11
Southeast University (SEU)	53
Hajee Mohammad Danesh Science and Technology University (HSTU)	12
Noakhali Science and Technology University (NSTU)	10
University of Science and Technology Chittagong (USTC)	18

Figure 4.2.2.1 represented the visualization of Table 4.2.2. It visually denoted the universities on the X-axis. The Y-axis indicated the number of research outputs in universities.

Figure 4.2.2.1: Single-authored documents in Universities



An examination of various universities revealed that the University of Dhaka led the production of single-authored publications, with a remarkable output of 750 documents. Bangladesh University of Engineering and Technology (BUET) distinguished itself with 349 documents, while the University of Rajshahi made a noteworthy contribution with 304 documents. Private institutions like BRAC University and North South University also made exemplary efforts, contributing 250 and 220 documents, respectively. Jahangirnagar University obtained a respectable number of 207 documents.

With a focus on STEM subjects, Shahjalal University of Science and Technology (SUST) and Ahsanullah University of Science and Technology (AUST) published 139 and 111 single-authored documents, respectively. East West University (EWU) distinguished itself in the private sector with 140 documents. In contrast, Daffodil International University (DIU) and American International

University-Bangladesh (AIUB) contributed significantly with 109 and 98 single-authored documents, respectively.

Chittagong University of Engineering and Technology (CUET), Rajshahi University of Engineering and Technology (RUET), and Dhaka University of Engineering and Technology, Gazipur (DUET) published 104, 99, and 54 documents, respectively. In contrast, Khulna University (KU) and Khulna University of Engineering and Technology (KUET) individually generated 96 and 95 documents.

Among the private universities, Independent University, Bangladesh (IUB), United International University (UIU), and the University of Asia Pacific (UAP) hold significant positions. Their publication count was 68, 55, and 53 documents, respectively. On the other hand, South East University (SEU) and Jagannath University (JnU) published 53 and 52 documents individually.

The Bangabandhu Sheikh Mujib University (BSMMU) published 45 single-authored documents. Meanwhile, Stamford University Bangladesh (SU) contributed 34 documents.

Public universities, such as Islamic University, Bangladesh (IU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Patuakhali Science and Technology University (PSTU), Bangladesh Agricultural University (BAU), Hajee Mohammad Danesh Science and Technology University (HSTU), Sher-e-Bangla Agricultural University (SAU), and Noakhali Science and Technology University (NSTU), played a significant role in research domain. These universities made identical contributions in science, technology, and agriculture disciplines. The number of single-authored documents these institutions produced ranges from 31 to 10, showcasing their inputs to individual research.

Patterns and Trends

1. **Overall Authorship Patterns:**

   Universities generally produced a relatively small number of single-author documents. Out of a total of 103459 documents, only 4068 were single-authored.

2. **Large Public Universities:**

   Large public universities demonstrated a significant correlation between their total document output and the production of single-authored documents. Usually, universities with a higher quantity of total documents generated a more substantial number of single-author documents. For instance, the University of Dhaka produced 12018 documents, of which 750 were single-authored. Bangladesh University of Engineering and Technology (BUET) generated 11903 documents, of which 349 were single-authored. University of Chittagong (CU) contributed 3541 documents, including 298 single-authored documents. Conversely, the University of Rajshahi (RU) added 7161 documents, including 304 single-authored documents.

3. **Private Universities' Proportional Impact:**

   Proportionally, private universities produced a higher number of single-authored documents than public universities. For example, BRAC University (BRACU) published 3802 documents, including 250 single-authored documents. North South University (NSU) produced 4185 documents, of which 220 were single-authored; East West University (EWU) followed the same pattern and generated 1731 documents, including 140 single-authored documents.

4. **Top Universities by Document Count:**

   Among the universities, the University of Dhaka (DU) distinguished itself as the topper, producing 750 single-authored documents, followed by BRAC University (BRACU) and the Bangladesh University of Engineering and Technology (BUET), with document counts of 250 and 349, respectively. Among other remarkable institutions, North South University (NSU) and the University of Rajshahi (RU) produced 220 and 330 single-authored documents, respectively.

5. Distribution of Document Counts:

A pattern was observed in the universities based on analyzing the distribution of document counts. Most of the universities produced single-authored documents ranging from 10 to 250. Exceptions were also observed at Dhaka University (DU), BRAC University (BRACU), and Bangladesh University of Engineering and Technology (BUET). They generated documents over the ranges. However, this finding provided insights into a similar pattern of focus on individual research.

6. **Variability in Document Counts:**

   Analyzing variability in document counts showed an identical pattern. Several universities generated very few single-authored documents, suggesting they produced limited total document output or focused on collaborative efforts.

7. **Clusters of Universities:**

   Several prominent universities, such as the University of Chittagong (CU), Jahangirnagar University (JU), and North South University (NSU), generated single-authored documents ranging from 200 to 300. This observation indicated a similar pattern of research outputs and participation.

8. **Specialized Universities:**

   Some specialized universities, such as Bangabandhu Sheikh Mujib Medical University (BSMMU) and Sher-e-Bangla Agricultural University (SAU), generated a limited number of single-authored documents. This finding indicated that these institutions emphasized specific areas or collaborative efforts.

9. **Emerging Universities:**

   Several universities, such as Hajee Mohammad Danesh Science and Technology University (HSTU), Noakhali Science and Technology University (NSTU), and the University of Science and Technology Chittagong (USTC), produced very few single-authored documents. These universities were emerging as they had areas of research development and would flourish in the future.

10. Private vs. Public Universities

Both public and private universities, such as Dhaka University (DU), Rajshahi University (RU), and North South University (NSU), BRAC University (BRACU), practiced diversity in their singular research production. This observation focused on the inclusiveness of the country in research.

11. Engineering and Technology Focus

Engineering and technology-based universities such as Bangladesh University of Engineering and Technology (BUET), Chittagong University of Engineering and Technology (CUET), and Khulna University of Engineering and Technology (KUET) exhibited substantial amounts of documents. This observation indicated significant singular research endeavors in this domain.

12. Medical University:

Bangabandhu Sheikh Mujib Medical University (BSMMU) remained an outlier in producing single-authored documents, representing a distinct research norm within medical research.

The patterns and trends outlined the variation and widespread exercise of individual research in universities, focused on areas requiring attention and specializations in the research landscape.

4.3 Collaborative-Authored Documents

The data on the collaborative-authored documents was retrieved from the following simple arithmetic formula: *Collaborative author = Total author-single author.* Later, the outcomes were divided according to disciplines and universities.

4.3.1 Collaborative Author Documents in Disciplines

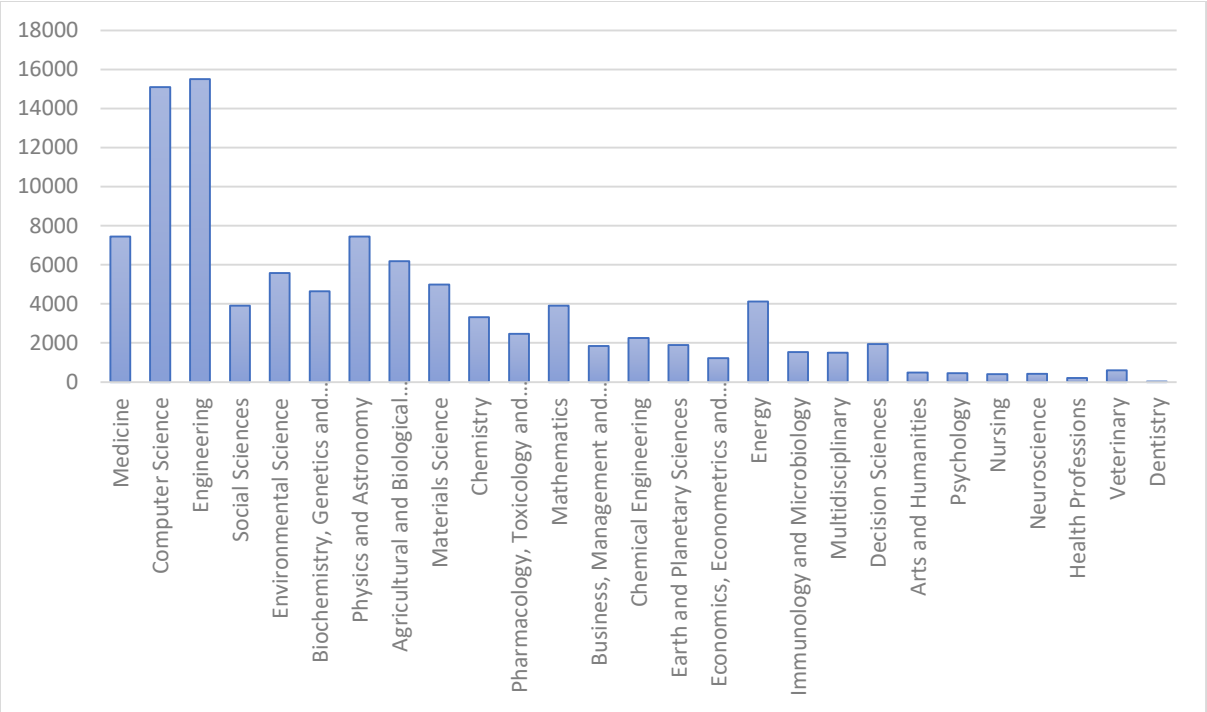
Table 4.3.1 was extracted from Appendix 3. It showcased different disciplines on the left and collaborative-authored documents in each discipline on the right. A higher value signified a greater emphasis on collaborative research within a particular discipline, whereas a lower value indicated a comparatively weaker focus on collaborative research.

Table 4.3.1: Collaborative Author Documents in Disciplines

Disciplines	**Collaborative-Authored Documents**
Medicine	7450
Computer Science	15089
Engineering	15507
Social Sciences	3904
Environmental Science	5581
Biochemistry, Genetics and Molecular Biology	4651
Physics and Astronomy	7443
Agricultural and Biological Sciences	6188
Materials Science	4990
Chemistry	3319
Pharmacology, Toxicology and Pharmaceutics	2467
Mathematics	3901
Business, Management and Accounting	1844
Chemical Engineering	2253
Earth and Planetary Sciences	1901
Economics, Econometrics and Finance	1226
Energy	4114
Immunology and Microbiology	1536
Multidisciplinary	1497
Decision Sciences	1942
Arts and Humanities	484
Psychology	451
Nursing	398
Neuroscience	414
Health Professions	211
Veterinary	605
Dentistry	25

Figure 4.3.1.1 visually represented Table 4.3.1. It displayed the disciplines on the X-axis. The Y-axis exhibited the number of collaborative research outputs across various disciplines.

Figure 4.3.1.1: collaborative author documents in Disciplines



In terms of collaborative author documents, Engineering (15507) and Computer Science (15089) distinguished themselves as the leading disciplines, followed by Medicine (7450) and Physics and Astronomy (7443). A significant number of collaborative author documents were observed in Environmental Science (5581), Materials Science (4990), Biological and Agricultural Sciences (6188), Biochemistry, Genetics, and Molecular Biology (4651), as well as Energy (4114).

Social Sciences (3904), Mathematics (3901), Chemistry (3319), Pharmacology, Toxicology, and Pharmaceutics (2467), and Chemical Engineering (2253) also made substantial contributions to collaborative author documents. Similarly, Decision Sciences (1942), Earth and Planetary Sciences (1901), Business, Management, and Accounting (1844), Multidisciplinary (1497), Immunology and Microbiology (1536), and Economics, Econometrics, and Finance (1226) also contributed significantly to this endeavor.

On the other hand, Veterinary (608), Arts and Humanities (484), Psychology (451), Neuroscience (414), Nursing (398), Health Professions (211), and Dentistry (25) demonstrated the lowest number of collaborative author documents.

Patterns and Trends:

1. **Highly Collaborative Disciplines:**
   Within the academic landscape, disciplines like Computer Science, Engineering, Physics, and Astronomy unveiled a notable trend for collaboration. It was proved by the high number of collaborative author documents they produced. Such a pattern indicated the presence of a strong culture that appreciated teamwork and collective contributions. Consequently, researchers in these disciplines actively collaborated to develop the boundaries of knowledge.

2. **Biological and Medical Sciences:**
   Biological and Medical Sciences disciplines such as Medicine, Biochemistry, Genetics and Molecular Biology, and Environmental Science promoted collaboration in research endeavors. Collaboration was aligned with the multidimensional characteristics of these disciplines' medical and ecological challenges. Researchers often collaborate with fellows from other disciplines to integrate diverse skills in solving complex problems in the academic landscape.

3. **Interdisciplinary Fields:**
   A substantial number of collaborative authored documents were produced from Multidisciplinary and Decision Sciences disciplines, representing the interdisciplinary landscape of these domains. Researchers often collaborated to confront adverse arguments, signifying interdisciplinary approaches beyond the limits of traditional disciplines.

4. **Low Collaborative Disciplines:**
   Dentistry generated the lowest number of collaborative-authored documents. These findings indicated that a singular research tendency was promoted in this domain or very few research

outputs were published, and thus, proportionally collaborative efforts were less than in other disciplines.

5. **Social Sciences and Economics:**

   A moderate level of collaborative authored documents were produced from Social Sciences, Economics, Econometrics, and Finance. A substantial proportion of singular research outputs were evidenced in these domains; however, a moderate number of collaborative outputs indicated the cordial presence of collective efforts.

6. **Emerging Trends:**

   A significant number of collaborative-authored documents were produced by Energy, representing its interest in interdisciplinary research. This observation proved the multidimensional layer of energy-related arguments and provoked researchers from various domains to seek groundbreaking results.

7. **Size of Research Communities:**

   Collaborative authorship functioned as a tool to measure a discipline's research areas and scope. A wide-ranging collaborative network indicated a more vigorous and extensive research landscape.

8. **Potential for Innovation:**

   Disciplines with more excellent collaborative outputs exposed the substantial competency of innovation. Significant creativity and progress may come from integrating diverse ideas, skills, approaches, and revolutionary efforts.

9. **Research Focus in Medicine:**

   Medicine produced a significant number of collaborative-authored documents demonstrating their collective efforts to confront complex challenges in health domains. This finding suggested a futuristic research approach as researchers predominantly collaborate with their collective insights and expertise.

10. Technology and Materials Science:

The substantial number of collaborative documents in Computer Science, Engineering, and Materials Science indicated the extensive collaboration culture in these domains. This observation reflected the interdisciplinary essence of technological progress as researchers collectively explored the networks of diverse scientific domains.

11. Discipline Influence

The disciplines that produced the highest number of documents also exhibited the highest number of collaborative author documents. Academic fields like Medicine, Computer Science, and Engineering were at the forefront regarding document production and collaborative authorship. In Medicine, out of 7642 documents, 7450 were authored collaboratively. Similarly, out of 15513 documents, 15089 were the outcome of collaborative efforts in Computer Science. On the other hand, engineering had 15976 documents, of which 15507 were collaborative.

Social Sciences and Environmental Science also contributed significantly, although with a slightly lower proportion of collaborative author documents. Social Sciences produced 4746 documents, with 3904 being collaborative. Environmental Science generated 5789 total documents, with 5581 collaborative documents. Biochemistry, Genetics, and Molecular Biology produced 4732 documents, with 4651 being collaborative. Physics and Astronomy generated 7666 documents, of which 7443 were collaborative. Agricultural and Biological Sciences produced 6290 documents, with 6188 being collaborative. Lastly, Materials science produced 5152 documents, with 4990 being collaborative.

12. Disciplinary Breakdown

In terms of proportion, collaborative authorship witnessed substantial contributions from the fields of Science and Engineering. To be more specific, the discipline of Computer Science generated a total of 15089 documents, while Engineering contributed 15507 documents. Furthermore, Physics and Astronomy produced 7443 documents, Materials Science contributed 4990 documents, Mathematics generated 3901 documents, and Energy contributed 4,114 documents.

In contrast, disciplines like Social Science, Arts, Humanities, and some specific medical fields witnessed a decrease in the number of collaborative author documents. To illustrate, Social

Sciences generated 3904 documents, Arts and Humanities produced 484, Psychology produced 451, Nursing produced 398, Neuroscience produced 466, Health Professions produced 322, Veterinary produced 775, and Dentistry produced 65 collaborative authored documents.

4.3.2 Collaborative Author Documents in Universities

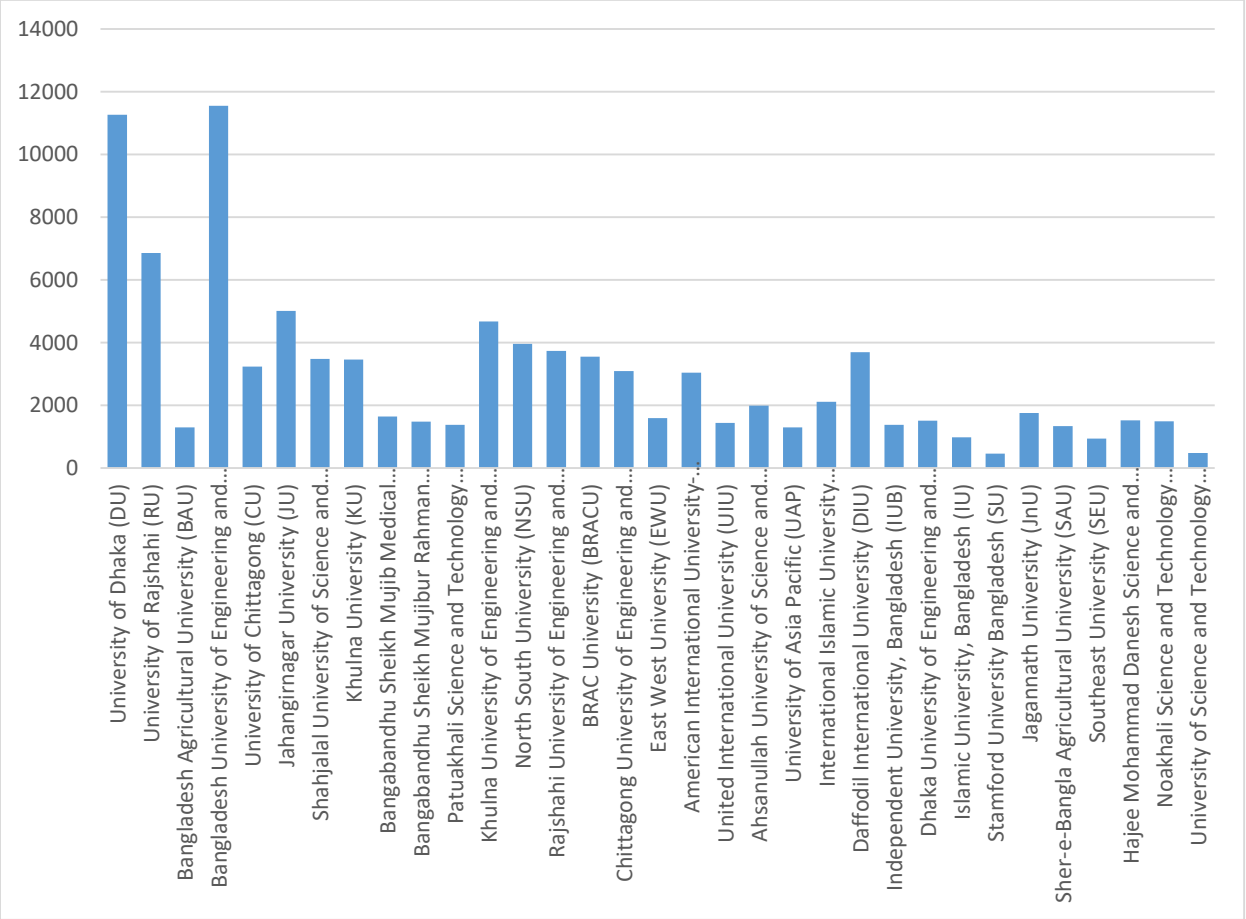
Table 4.3.2 was extracted from Appendix 3. It represented various universities on the left, while the right displayed the number of collaborative-authored documents in each university from 2012 to 2021. These statistics served as a representation of collaborative research outputs across different universities.

Table 4.3.2: Collaborative Author Documents in Universities

Universities	**Number of Collaborative Author Documents**
University of Dhaka (DU)	11268
University of Rajshahi (RU)	6857
Bangladesh Agricultural University (BAU)	4286
Bangladesh University of Engineering and Technology (BUET)	11554
University of Chittagong (CU)	3243
Jahangirnagar University (JU)	5014
Shahjalal University of Science and Technology (SUST)	3483
Khulna University (KU)	3461
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1644
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	1484
Patuakhali Science and Technology University (PSTU)	1379
Khulna University of Engineering and Technology (KUET)	4674
North South University (NSU)	3965
Rajshahi University of Engineering and Technology (RUET)	3741
BRAC University (BRACU)	3552
Chittagong University of Engineering and Technology (CUET)	3034
East West University (EWU)	1591
American International University-Bangladesh (AIUB)	3048
United International University (UIU)	1441
Ahsanullah University of Science and Technology (AUST)	1998
University of Asia Pacific (UAP)	1295
International Islamic University Chittagong (IIUC)	2120
Daffodil International University (DIU)	3701
Independent University, Bangladesh (IUB)	1383
Dhaka University of Engineering and Technology, Gazipur (DUET)	1512
Islamic University, Bangladesh (IU)	982
Stamford University Bangladesh (SU)	460
Jagannath University (JnU)	1761
Sher-e-Bangla Agricultural University (SAU)	1336
Southeast University (SEU)	938
Hajee Mohammad Danesh Science and Technology University (HSTU)	1206
Noakhali Science and Technology University (NSTU)	1498
University of Science and Technology Chittagong (USTC)	482

Figure 4.3.2.1 visually represented Table 4.3.2. It displayed universities on the X-axis. The Y-axis indicated the number of collaborative research outputs in universities. This figure offered valuable insights into the extent and pattern of collaborative research production.

Figure 4.3.2.1: collaborative author documents in Disciplines



The Bangladesh University of Engineering and Technology (BUET) led the production of collaborative-authored documents with a remarkable amount of 11,554. Following closely, Dhaka University (DU) produced 11,268 documents. The University of Rajshahi (RU) and Jahangirnagar University (JU) made a substantial number of 6,857 and 5,014 documents, respectively. Khulna University of Engineering and Technology (KUET) also produced 4,674 documents.

However, North South University (NSU) contributed to the collaborative landscape producing 3,965 documents, Rajshahi University of Engineering and Technology (RUET) with 3,741

documents, Daffodil International University (DIU) with 3,701 documents, BRAC University (BRACU) with 3,552 documents, Shahjalal University of Science and Technology (SUST) with 3,483 documents, Khulna University (KU) with 3,461 documents, University of Chittagong (CU) with 3,243 documents, and Chittagong University of Engineering and Technology (CUET) with 3,092 documents.

International Islamic University Chittagong (IIUC) generated a moderate number of collaborative documents (2120), followed by Ahsanullah University of Science and Technology (AUST) with 1998 documents, Jagannath University (JnU) with 1761 documents, Bangabandhu Sheikh Mujib Medical University (BSMMU) with 1644 documents, East-West University (EWU) with 1591 documents, Hajee Mohammad Danesh Science and Technology University (HSTU) with 1521 documents, Dhaka University of Engineering and Technology, Gazipur (DUET) with 1512 documents.

Down the list, Noakhali Science and Technology University (NSTU) produced 1498 documents, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) 1484 documents, United International University (UIU) 1441 documents, Independent University, Bangladesh (IUB) 1383 documents, and Patuakhali Science and Technology University (PSTU) 1379 documents.

Additionally, Sher-e-Bangla Agricultural University (SAU) contributed with 1336 documents, Bangladesh Agricultural University (BAU) with 1303 documents, and the University of Asia Pacific (UAP) with 1295 documents.

In contrast, Islamic University, Bangladesh (IU) (982), Southeast University (SEU) (938), University of Science and Technology Chittagong (USTC) (482), and Stamford University Bangladesh (SU) (460) exhibited the lowest amount of collaborative author documents compared to other universities.

Patterns and Trends:

1. **Top Universities by Number of Collaborative Author Documents:**
   The University of Dhaka (DU), Bangladesh University of Engineering and Technology (BUET), and the University of Rajshahi (RU) exhibited the highest number of collaborative author documents. This finding highlighted an emphasis on collaborative endeavors in these institutions.

2. **Engineering and Technology Focus:**
   Engineering and technology-based universities such as Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), Rajshahi University of Engineering and Technology (RUET), Chittagong University of Engineering and Technology (CUET), Ahsanullah University of Science and Technology (AUST), University of Asia Pacific (UAP) emphasized generating a considerable number of collaborative author documents, highlighting a robust movement toward research collaboration.

3. **Medical and Agricultural Focus:**
   Medical and agricultural sciences-focused universities, namely, Bangabandhu Sheikh Mujib Medical University (BSMMU) and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), produced a substantial number of collaborative author documents indicating the growing research collaborations in these focused areas.

4. **Private Universities:**
   Several private universities such as North South University (NSU), BRAC University (BRACU), East West University (EWU), American International University-Bangladesh (AIUB), United International University (UIU), Ahsanullah University of Science and Technology (AUST), Daffodil International University (DIU) and Independent University, Bangladesh (IUB) produced a substantial number of collaborative-authored documents indicating their dedication to collective research.

5. **Geographical Distribution:**

   The study covered universities from different regions, for instance, Dhaka, Rajshahi, Khulna, Chittagong, Gazipur, and Noakhali, demonstrating the diversity and widespread distribution of research areas. This observation proved the futuristic approach to total management of the research environment.

6. **Medium-Sized Universities:**

   Several universities produced a substantial number of collaborative authored documents covering the medium range regarding research outputs. They were an integral part of research ecology. Jahangirnagar University (JU), Shahjalal University of Science and Technology (SUST), Chittagong University (CU), Khulna University (KU), Patuakhali Science and Technology University (PSTU), North South University (NSU), Rajshahi University of Engineering and Technology (RUET), BRAC University (BRACU), Chittagong University of Engineering and Technology (CUET), East West University (EWU), American International University-Bangladesh (AIUB), Independent University, Bangladesh (IUB), Dhaka University of Engineering and Technology (DUET), Jagannath University (JnU), Sher-e-Bangla Agricultural University (SAU), Hajee Mohammad Danesh Science and Technology University (HSTU) fall in this range.

7. **Smaller Universities:**

   Small and newly established universities produced a comparatively reduced number of collaborative-authored documents. Islamic University (IU), Stamford University (SU), Noakhali Science and Technology University (NSTU), and the University of Science and Technology Chittagong (USTC) were regarded as smaller universities in terms of collaborative authored document production, indicating them as emerging institutions for collaborative efforts.

8. **Potential Collaboration Opportunities:**

   Lower-ranking universities can maximize their research production by collaboration. Increasing research networks and encouraging corporations may enable these universities to produce research outputs.

9. **Interdisciplinary Collaboration:**

Interdisciplinary collaboration was encouraged in various universities' disciplines like Engineering, Medical Sciences, Agriculture, and Technology. This observation emphasized that multidisciplinary partnerships were essential for confronting robust research obstacles.

10. **Consideration for Research Funding and Development:**

A higher proportion of collaborative-authored documents in universities revealed the existence of research collaboration culture and research funding in collective efforts. However, universities can enhance their productivity by promoting collaboration and contributing to knowledge domains.

11. **University Productivity**

A pattern was observed in the production of collaborative-authored documents. The proportion of collaborative-authored documents depended on the production of total documents. Universities that produced higher total documents generated higher collaborative author documents. For example, the University of Dhaka (DU) generated 12,018 documents, of which 11,268 were collaborative. The Bangladesh University of Engineering and Technology (BUET) contributed 11,903 total documents, of which 11,554 were collaborative. The University of Rajshahi (RU) contributed 7,161 documents, including 6,857 collaborative authored documents. Jahangirnagar University (JU) generated 5,221 documents, of which 5,014 were collaborative. The Khulna University of Engineering and Technology (KUET) produced 4,769 documents, including 4,674 collaborative authored documents. Lastly, North South University (NSU) contributed 4,185 documents, of which 3,965 were collaborative.

Conversely, Universities that produced a limited number of total documents proportionally generated fewer collaborative author documents. For example, Hajee Mohammad Danesh Science and Technology University (HSTU) generated 1218 documents, including 1206 collaborative-authored documents. Islamic University, Bangladesh (IU) contributed 1013 documents, of which 982 were collaborative. Southeast University (SEU) produced 991 documents, of which 938 were collaborative. University of Science and Technology Chittagong (USTC) produced 500 documents, with 482 collaborative-authored documents. Lastly, Stamford University Bangladesh (SU) generated 494 documents, of which 460 were collaborative.

12. University Type Impact

An interesting pattern was also observed in universities' collaborative-authored document production. Proportionally, public universities produced more collaborative-authored documents than private universities. For instance, public universities such as the University of Dhaka (DU) produced 12,018 documents, including 11,268 collaborative-authored documents. Bangladesh University of Engineering and Technology (BUET) contributed 11,903 documents, of which 11,554 were collaborative. University of Rajshahi (RU) generated 7,161 documents, of which 6,857 were collaborative, and Jahangirnagar University (JU) contributed 5,221 documents, including 5,014 collaborative-authored documents.

Conversely, private universities such as North South University (NSU) produced 4185 total documents, of which 3965 were collaborative. Daffodil International University (DIU) contributed 3810 documents, including 3701 collaborative-authored documents. BRAC University (BRACU) generated 3802 documents, of which 3552 were collaborative. American International University-Bangladesh (AIUB) contributed 3146 documents containing 3048 collaborative-authored documents.

13. Authorship Comparison

Proportionally, universities contributed more collaborative-authored documents than single-authored documents, indicating a healthy collaborative environment that enhanced research outputs. For instance, the University of Dhaka (DU) produced 750 single-authored documents along with 11,268 collaborative-authored documents. Bangladesh University of Engineering and Technology (BUET) generated 349 single-authored documents besides 11,554 collaborative-authored documents. The University of Rajshahi (RU) produced 304 single-authored documents plus 6,857 collaborative-authored documents, and Jahangirnagar University (JU) generated 207 single-authored documents and 5,014 collaborative-authored documents.

Among private universities, North South University (NSU) contributed 220 single-authored documents and 3,965 collaborative-authored documents. Daffodil International University (DIU) produced 109 single-authored documents and 3,701 collaborative author documents. Lastly,

BRAC University (BRACU) generated 250 single-authored documents and 3,552 collaborative-authored documents.

The analysis could be summarized by suggesting interdisciplinary collaboration within universities with high-performing collaborative outputs, enhancing collaboration and networks among other universities.

4.4 Comparative Analysis of Documents

The data on the total, collaborative-authored, and single-authored documents were analyzed, and the comparison was conducted based on disciplines and universities.

4.4.1 Comparative Analysis of Documents in Disciplines

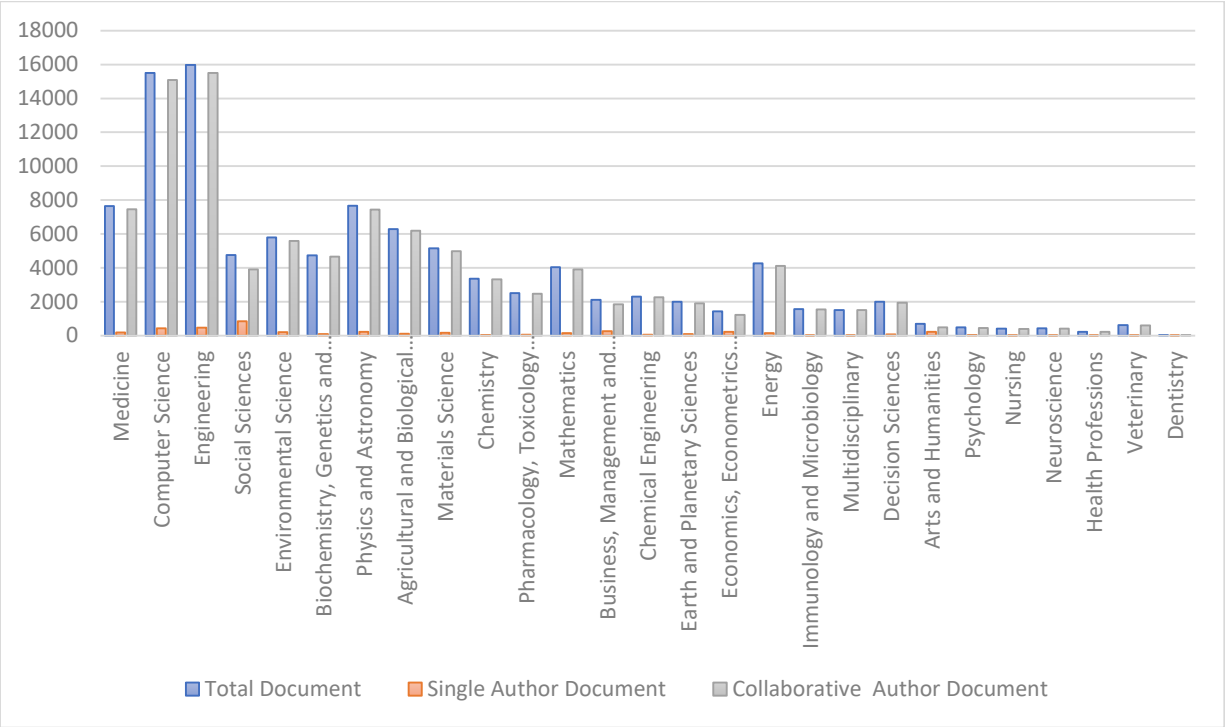
Table 4.4.1 exhibited research outputs produced by authors of 33 sample universities in Bangladesh from 2012 to 2021. Each row corresponded to a specific discipline, and each column represented document categories, together with the corresponding number of documents in each category of disciplines. Several interesting trends and patterns emerged from this data, providing helpful insight into these disciplines' research landscape.

Table 4.4.1: Comparative analysis of documents in disciplines

Discipline	**Total Document**	**Single Author Document**	**Collaborative Author Document**
Medicine	7642	192	7450
Computer Science	15513	424	15089
Engineering	15976	469	15507
Social Sciences	4746	842	3904
Environmental Science	5789	208	5581
Biochemistry, Genetics and Molecular Biology	4732	81	4651
Physics and Astronomy	7666	223	7443
Agricultural and Biological Sciences	6290	102	6188
Materials Science	5152	162	4990
Chemistry	3354	35	3319
Pharmacology, Toxicology and Pharmaceutics	2513	46	2467
Mathematics	4043	142	3901
Business, Management and Accounting	2102	258	1844
Chemical Engineering	2303	50	2253
Earth and Planetary Sciences	1994	93	1901
Economics, Econometrics and Finance	1438	212	1226
Energy	4264	150	4114
Immunology and Microbiology	1553	17	1536
Multidisciplinary	1513	16	1497
Decision Sciences	2003	61	1942
Arts and Humanities	699	215	484
Psychology	491	40	451
Nursing	410	12	398
Neuroscience	421	7	414
Health Professions	218	7	211
Veterinary	608	3	605
Dentistry	26	1	25

Figure 4.4.1.1 visually represented Table 4.4.1. It displayed the disciplines on the X-axis. The Y-axis indicated the number of research outputs in each discipline's categories. This figure offered valuable insights into the extent and pattern of research production.

Figure 4.4.1.1: Comparative analysis of documents in disciplines



The comparative analysis of documents across various disciplines is illustrated in Table 4.4.1. A thorough examination of documents was carried out, showing interesting patterns in terms of authorship dynamics. Notably, the field of medicine exhibited a significant level of collaboration, as indicated by 7,642 documents. Among these, 192 were single-authored documents, while 7,450 involved collaborative efforts.

On the contrary, Computer Science presented greater collaboration, producing 15513 documents, including 424 single-authored documents and 15089 collaborative-authored documents. Engineering followed a similar pattern, with 15976 documents comprising 469 single-authored documents and 15507 collaborative-authored documents. The field of social sciences heavily relied on collaboration, as evidenced by the presence of 3904 collaborative-authored documents compared to 842 Single-authored documents, resulting in a collective document count of 4746. Environmental Science also exhibited a strong inclination towards collaboration, with a total of

5789 documents comprising 208 single-authored documents and 5581 collaborative-authored documents.

The field of Biochemistry, Genetics, and Molecular Biology consisted of 4732 documents, of which only 81 were single-authored. This observation highlighted the collaborative nature of research in this field, as most documents (4651) had multiple authors. Conversely, there were 7666 documents in Physics and Astronomy, with a noticeable imbalance between single-author (223) and collaborative-author (7443) documents. The Agricultural and Biological Sciences included 6290 documents, of which collaborative authorship emerged as the dominant trend, with 6188 documents and 102 single-authored documents.

Collaboration levels varied across materials science, chemistry, pharmacology, toxicology, and pharmaceuticals. There was a moderate collaboration in materials science, with 5152 documents, of which 162 were single-authored and 4990 were collaborative-authored. On the other hand, chemistry exhibited a higher level of collaboration, with 3354 documents, including 35 single-authored and 3319 collaborative-authored documents. In the fields of pharmacology, toxicology, and pharmaceuticals, there were 2513 documents, with 46 being single-authored and 2467 collaborative-authored.

Various disciplines, including mathematics, business, management, accounting, and chemical engineering, exhibited distinct patterns. Among the 4043 documents in mathematics, there was a disparity in distribution, with 142 being single-authored and 3901 being collaborative-authored. In the field of Business, Management, and Accounting, there were 2102 documents where collaboration (1844 documents) was given more importance compared to single-author contributions (258). Chemical engineering showcased a prominent inclination towards collaborative authorship, with 2253 documents among 2303. However, the discipline produced only 50 single-authored documents.

Down the list, different authorship patterns were observed in various academic disciplines such as Earth And Planetary Sciences, Economics, Econometrics, Financial Analysis, and Energy. In Earth and Planetary Sciences, a significant amount of collaborative efforts was visible; with 1994

documents, 1901 were co-authored, and only 93 were single-authored, indicating a robust collaborative approach. In the disciplines of Economics, Econometrics, and Finance, there were 1,438 documents, with 1,226 displaying collaboration and 212 being single-authored contributions. The field of Energy showed a clear preference for collaborative authorship, as evidenced by the presence of 4,264 documents, of which 4,114 were collaborative and 150 were single-authored.

Different patterns were observed at the bottom of the list, including Immunology and Microbiology, Multidisciplinary, and Decision Sciences. The field of Immunology and Microbiology consisted of 1553 documents, most of which were collaborative-authored (1536), while only 17 were single-authored contributions. In Multidisciplinary, out of 1,513 documents, collaboration (1,497) was emphasized over single-authored efforts (16). Decision Sciences, on the other hand, displayed an uneven distribution between single-author (61) and collaborative author (1,942) efforts in its 2,003 documents.

In the realm of Arts and Humanities, scholarly activity was robust, with a total of 699 documents. Among these, 215 were single-authored, showcasing significant individual contributions, while 484 were collaborative efforts. Psychology demonstrated a notable volume of research output with 491 total documents. Collaborative endeavors dominated this field, comprising 451 documents, while single-authored documents were relatively fewer at 40. Nursing reflected an active area of academic inquiry with 410 total documents. Collaborative research efforts prevailed, accounting for 398 documents, while single-authored contributions were low at 12. Neuroscience showcased considerable scholarly engagement with 421 total documents. Collaborative endeavors were predominant, comprising 414 documents, while single-authored contributions were limited to 7.

Health Professions exhibited moderate scholarly activity with 218 total documents. Collaborative efforts were prominent, comprising 211 documents, while single-authored contributions were minimal at 7. Veterinary demonstrated robust scholarly output, with 608 total documents. Collaborative endeavors dominated this field, accounting for 605 documents, while single-authored contributions were only 3.

Dentistry presented the lowest numbers across all categories, comprising 26 total documents. Collaborative efforts were predominant, containing 25 documents, while single-authored contributions were minimal at 1.

Patterns and Trends:

A significant volume of scholarly output across various disciplines characterized the research landscape. Evaluating the dynamics of research collaboration and individual contributions requires a comprehensive understanding of the distribution of documents and authorship patterns. This study enabled identifying the following patterns and trends:

1. **Overall Trends:**
   Divergent document production patterns were evidenced in different disciplines. Computer Science, Engineering, and Medicine led the production with the highest research outputs, whereas Dentistry, Veterinary, and Health Professions produced a comparatively lower number of documents, signifying an identical research culture.

2. **Collaborative vs. Single Authorship:**
   Disciplines produced significantly more collaborative-authored documents than single-authored, though some disciplines showed substantial individual research outputs. Computer Science, Engineering, and Medicine predominantly exhibited collaboration and interdisciplinary research. On the contrary, a higher proportion of single-author documents was found in Arts and Humanities, Psychology, and Dentistry.

3. **Discipline-specific Patterns:**
   Discipline-specific Patterns were evidenced in the production of research outputs. For example, Medicine, Computer Science, and Engineering exhibited outstanding research production, indicating their contributions to the academic landscape, whereas Social Sciences, Environmental Science, and Biochemistry, Genetics, and Molecular Biology produced a moderate number of documents indicating their prominence in research. However, Arts and Humanities, Dentistry, and Veterinary made a lower impact on research production with a limited number of outputs.

4. **The ratio of Single Author to Collaborative Documents:**

   The extent of collaboration may be calculated by identifying the ratio of collaborative-authored and single-authored documents. For instance, Dentistry and Arts and Humanities exhibited comparatively a higher ratio of single-authored documents, indicating a decreased level of collaboration.

5. **Interdisciplinary Trends:**

   The cross-disciplinary approach in research was evidenced in multidisciplinary and Decision science, highlighting the increasing recognition of this method. This observation revealed an encouraging environment of the research landscape beyond traditional disciplinary boundaries.

6. **Low Document Counts:**

   Dentistry produced only 26 documents indicating disciplines with such limited outputs either provided less effort in research productivity or had identical research cultures with specialization. A further investigation may reveal the reasons behind this limited production.

7. **Outlier:**

   Social Sciences was regarded as an outlier, producing a higher number of single-authored documents compared to other disciplines. This observation suggested a unique research environment emphasizing individual research. An examination may clarify the deeper understating of this nature.

In summary, collaborative trends, diversity in research culture, and potential interdisciplinary methodologies were evidenced in disciplines. A threadbare investigation may reveal the dynamics of scholarly outputs within the research domains.

4.4.2 Comparative Analysis of Documents in Universities

The research outputs produced by authors of 33 sample universities in Bangladesh from 2012 to 2021 were shown in Table 4.4.2. Each row corresponded to specific universities, and each column represented document categories, together with the corresponding number of documents in each category of universities. Several interesting trends and patterns emerged from this data, providing helpful insight into these disciplines' research landscape.

Table 4.4.2: Comparative Analysis of Documents in Universities

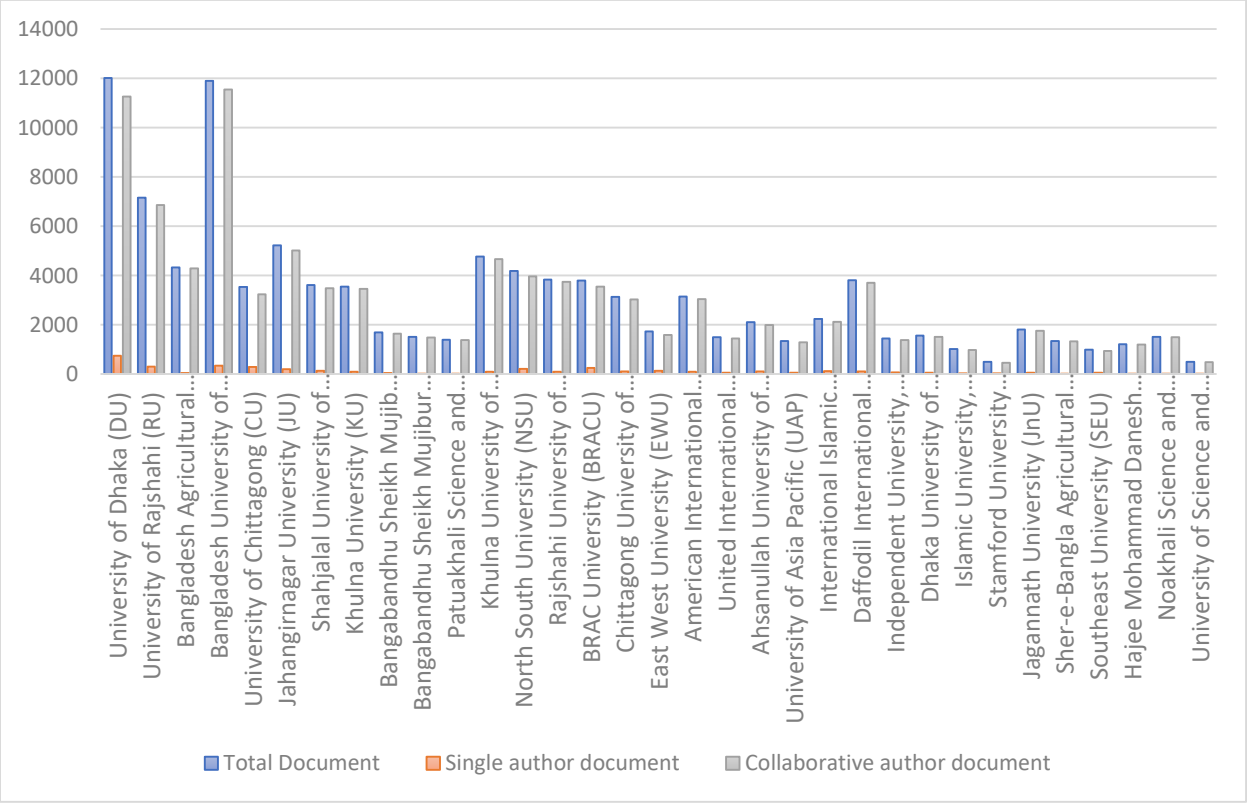
Universities	**Total Document**	**Single author document**	**Collaborative author document**
University of Dhaka (DU)	12018	750	11268
Bangladesh University of Engineering and Technology (BUET)	11903	349	11554
University of Rajshahi (RU)	7161	304	6857
Jahangirnagar University (JU)	5221	207	5014
Khulna University of Engineering and Technology (KUET)	4769	95	4674
Bangladesh Agricultural University (BAU)	4331	45	4286
North South University (NSU)	4185	220	3965
Rajshahi University of Engineering and Technology (RUET)	3840	99	3741
Daffodil International University (DIU)	3810	109	3701
BRAC University (BRACU)	3802	250	3552
Shahjalal University of Science and Technology (SUST)	3622	139	3483
Khulna University (KU)	3557	96	3461
University of Chittagong (CU)	3541	298	3243
American International University-Bangladesh (AIUB)	3146	98	3048
Chittagong University of Engineering and Technology (CUET)	3138	104	3034
International Islamic University Chittagong (IIUC)	2238	118	2120
Ahsanullah University of Science and Technology (AUST)	2109	111	1998
Jagannath University (JnU)	1813	52	1761
East West University (EWU)	1731	140	1591
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1689	45	1644
Dhaka University of Engineering and Technology, Gazipur (DUET)	1566	54	1512

Table 4.4.2 Continued

Universities	Total Document	Single author document	Collaborative author document
Noakhali Science and Technology University (NSTU)	1508	10	1498
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	1507	23	1484
United International University (UIU)	1496	55	1441
Independent University, Bangladesh (IUB)	1451	68	1383
Patuakhali Science and Technology University (PSTU)	1396	17	1379
University of Asia Pacific (UAP)	1348	53	1295
Sher-e-Bangla Agricultural University (SAU)	1347	11	1336
Hajee Mohammad Danesh Science and Technology University (HSTU)	1218	12	1206
Islamic University, Bangladesh (IU)	1013	31	982
Southeast University (SEU)	991	53	938
University of Science and Technology Chittagong (USTC)	500	18	482
Stamford University Bangladesh (SU)	494	34	460

Figure 4.4.2.1 was a visual representation of Table 4.4.2. It signified the universities on the X-axis. The Y-axis exhibited the number of research outputs in each document category of universities.

Figure 4.4.2.1: Comparative Analysis of Documents in Universities



Among the universities, the University of Dhaka (DU) produced 12,018 documents, of which 750 were single-authored and 11,268 were collaborative-authored. The Bangladesh University of Engineering and Technology (BUET) followed with 11,903 total documents, containing 349 single-authored documents and 11,554 collaborative authored documents. The University of Rajshahi (RU) generated 7,161 documents, comprising 304 single-authored and 6,857 collaborative-authored documents. Jahangirnagar University (JU) contributed 5,221 documents, including 207 single-authored and 5,014 collaborative-authored documents. Khulna University of Engineering and Technology (KUET) possessed 4,769 documents, of which 95 were single-authored and 4,674 were collaborative-authored. Bangladesh Agricultural University (BAU) contributed 4331 documents, of which 45 were single-authored and 4286 were collaborative-authored.

North South University (NSU) generated 4,185 documents, of which 220 were single-authored and 3,965 collaborative-authored documents. Rajshahi University of Engineering and Technology (RUET) contributed 3,840 documents, including 99 single-authored and 3,741 collaborative-authored documents.

Daffodil International University (DIU) generated 3,810 documents, of which 109 were single-authored and 3,701 were collaborative-authored. BRAC University (BRACU) produced 3,802 documents, including 250 single-authored and 3,552 collaborative-authored documents. Shahjalal University of Science and Technology (SUST) produced 3,622 documents, of which 139 were single-authored and 3,483 collaborative-authored. Khulna University (KU) contributed 3,557 documents, of which 96 were single-authored and 3,461 were collaborative-authored. The University of Chittagong (CU) generated 3,541 documents, containing 298 single-authored and 3,243 collaborative-authored documents. American International University-Bangladesh (AIUB) produced 3,146 documents, of which 98 were single-authored and 3,048 were collaborative-authored.

Chittagong University of Engineering and Technology (CUET) contributed 3,138 documents, containing 104 single-authored and 3,092 collaborative-authored documents. The International Islamic University Chittagong (IIUC) produced 2,238 documents, of which 118 were single-authored and 2,120 were collaborative-authored. Ahsanullah University of Science and Technology (AUST) generated 2,109 documents, containing 111 single-authored documents and

1,998 collaborative-authored documents. Jagannath University (JnU) produced 1,813 documents, including 52 single-authored and 1,761 collaborative-authored.

East West University (EWU) generated 1,731 documents, including 140 single-authored and 1,591 collaborative-authored. Bangabandhu Sheikh Mujib Medical University (BSMMU) contributed 1,689 documents, of which 45 were single-authored and 1,644 were collaborative-authored. Dhaka University of Engineering and Technology, Gazipur (DUET) contributed 1,566 documents, including 54 single-authored and 1,512 collaborative-authored. Noakhali Science and Technology University (NSTU) generated 1,508 documents, containing 10 single-authored and 1,498 collaborative-authored. Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) produced 1,507 documents, of which 23 were single-authored and 1,484 were collaborative-authored. United International University (UIU) contributed 1,496 documents, containing 55 single-authored and 1,441 collaborative-authored documents.

Independent University, Bangladesh (IUB) contributed 1,451 documents, of which 68 were single-authored and 1,383 were collaborative-authored. Patuakhali Science and Technology University (PSTU) produced 1,396 documents, containing 17 single-authored and 1,379 collaborative-authored documents.

The University of Asia Pacific (UAP) produced 1,348 documents, including 53 single-authored and 1,295 collaborative-authored documents. Sher-e-Bangla Agricultural University (SAU) generated 1,347 documents, of which 11 were single-authored and 1,336 collaborative-authored.

Hajee Mohammad Danesh Science and Technology University (HSTU) contributed 1,218 documents, containing 12 single-authored and 1,206 collaborative-authored documents. Islamic University, Bangladesh (IU) produced 1,013 documents, including 31 single-authored and 982 collaborative-authored.

Southeast University (SEU) generated 991 documents, counting 53 single-authored and 938 collaborative-authored documents. The University of Science and Technology Chittagong (USTC) generated 500 documents, of which 18 were single-authored and 482 were collaborative-authored. Stamford University Bangladesh (SU) contributed 494 documents, comprising 34 single-authored and 460 collaborative-authored documents.

Patterns and Trends:

1. **Top Universities by Total Documents:**

   The University of Dhaka (DU), Bangladesh University of Engineering and Technology (BUET), and the University of Rajshahi (RU) were the leaders in producing research outputs. Their significant number of productions considerably impacted the academic domain and motivated others to pursue scholarly endeavors.

2. **Single Author Document Comparison**

   The University of Dhaka (DU), Bangladesh University of Engineering and Technology (BUET), and the University of Rajshahi (RU) produced a significantly higher number of single-authored documents, indicating their individual contributions to research production and independent nature of scholarly outputs.

   .

3. **Collaborative Author Document Comparison**

   Universities produced predominantly collaborative-authored documents, indicating their preferences for collaborative research. For example, the University of Dhaka (DU) led the production of collaborative documents, closely followed by the Bangladesh University of Engineering and Technology (BUET), signifying an extensive collaborative approach in academic domains.

4. **University with the highest ratio of single-authored and collaborative-authored documents**

   The University of Dhaka (DU) emerged as the producer of the highest number of collaborative authored and single-authored documents, though there was an imbalance between their production. This observation indicated the diverse academic strategies of the University of Dhaka (DU) to promote individual and collective scholarly efforts.

5. **Observations on Smaller Universities**

   Noakhali Science and Technology University (NSTU) and Hajee Mohammad Danesh Science and Technology University (HSTU) produced the lowest number of document production. This

observation indicated their emerging role in academic debate; thus, their impact on the research domain cannot be ignored.

6. **Variability in Research Output:**

   The varied range of document production, categorically collaborative and individual, indicated the importance of universities' research outputs, methodologies, nature, and environment. This variability indicated a diversity of research endeavors in institutions.

7. **Consideration of University Types:**

   The dataset revealed comparatively higher research production of engineering and technology-oriented universities, such as Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), Rajshahi University of Engineering and Technology (RUET), Shahjalal University of Science and Technology (SUST), Ahsanullah University of Science and Technology (AUST). This finding indicated identical roles, research efforts, domain's nature, and specialization of these institutions.

In summary, the analysis provided insight into the patterns and trends of university research production. University of Dhaka (DU) and Bangladesh University of Engineering and Technology (BUET) led the research production in all categories, including total, single-authored, and collaborative-authored documents. Smaller universities like the University of Science and Technology Chittagong (USTC) and Stamford University Bangladesh (SU) produced the lowest research output. Engineering and technology universities exhibited high research productivity. Overall, the patterns and trends presented a diverse research landscape of the country drawn from both individual and collaborative efforts.

4.5 Total Articles

The data on total documents were analyzed through the “Biblioshiny” tool. The number of articles was retrieved through the analysis and later divided according to disciplines and universities.

4.5.1 Number of articles in disciplines

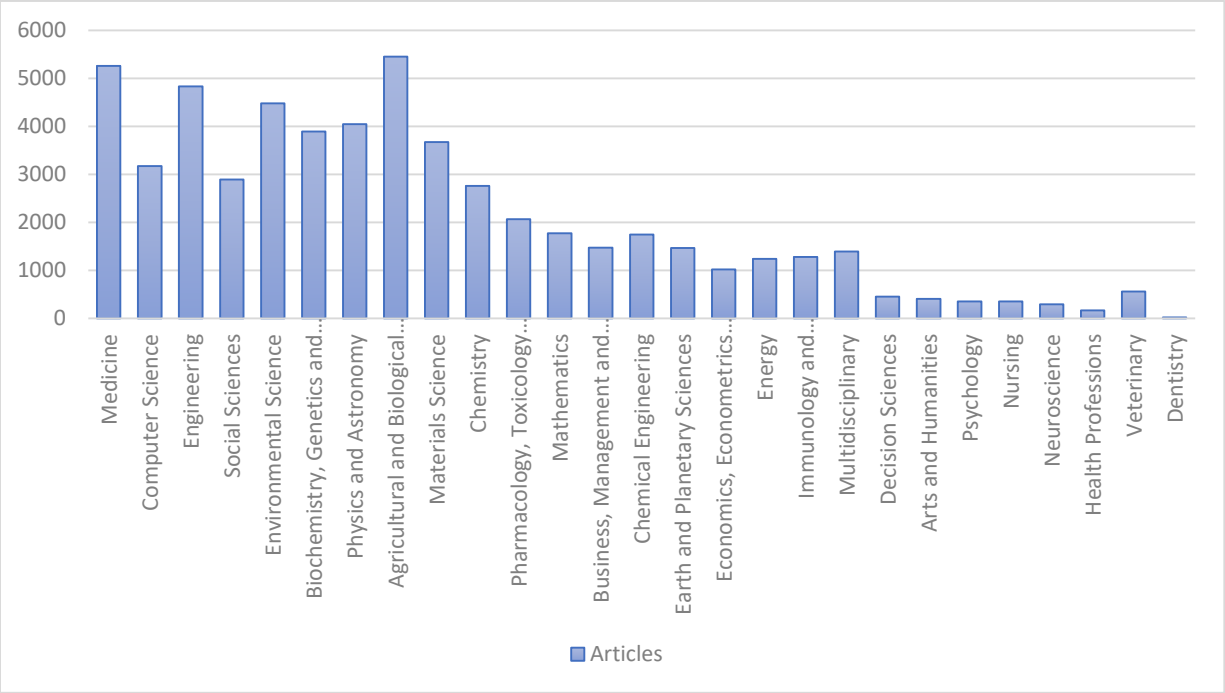
Table 4.5.1 was extracted from Appendix 4. It displayed various disciplines on the left, while the total number of articles in each discipline from 2012 to 2021 on the right. These statistics effectively illustrated the research outputs across diverse disciplines.

Table 4.5.1: Number of articles in disciplines

Disciplines	**Articles**
Medicine	5257
Computer Science	3171
Engineering	4834
Social Sciences	2895
Environmental Science	4478
Biochemistry, Genetics and Molecular Biology	3893
Physics and Astronomy	4045
Agricultural and Biological Sciences	5453
Materials Science	3674
Chemistry	2760
Pharmacology, Toxicology and Pharmaceutics	2067
Mathematics	1776
Business, Management and Accounting	1473
Chemical Engineering	1750
Earth and Planetary Sciences	1467
Economics, Econometrics and Finance	1022
Energy	1238
Immunology and Microbiology	1280
Multidisciplinary	1393
Decision Sciences	454
Arts and Humanities	406
Psychology	356
Nursing	358
Neuroscience	298
Health Professions	168
Veterinary	560
Dentistry	23

Figure 4.5.1.1 visually represented Table 4.5.1. It displayed the disciplines on the X-axis. The Y-axis indicated the number of articles in disciplines. This Figure offered valuable insights into the extent and pattern of article production.

Figure 4.5.1.1: Number of articles in disciplines



The data showed the number of articles published by 33 universities between 2012 and 2021. Among the disciplines, Agricultural and Biological Sciences emerged as the most productive field with 5453 articles, closely followed by Medicine with 5257 articles, Engineering with 4834, Environmental Science with 4478, and Physics and Astronomy with 4045 articles.

Moving down the rankings, Biochemistry, Genetics, and Molecular Biology contributed 3893 articles, while Materials Science recorded 3674 articles. Computer Science trailed with 3171 articles, followed by Social Sciences with 2895, Chemistry with 2760, Pharmacology, Toxicology, and Pharmaceutics with 2067 articles.

Further down the list, Mathematics possessed 1776 articles; Chemical Engineering 1750; Business, Management, and Accounting 1473; Earth and Planetary Sciences 1467; Multidisciplinary 1393; Immunology and Microbiology 1280, Energy 1238; and Economics, Econometrics and Finance 1022 articles.

Towards the bottom, Veterinary recorded 560 articles, Decision Sciences 454, Arts and Humanities 406, Nursing 358, Psychology 356, Neuroscience 298, and Health Professions 168 articles. Dentistry grasped the last position with 23 articles.

Patterns and Trends

1. **Medicine Dominance:**

   The dataset provided clear evidence of Medicine's dominance, containing the highest number of articles. This dominance emphasized the field's prominence within the academic landscape and suggested a dynamic research and development environment, reflecting the sector's crucial role in advancing methodical knowledge.

2. **STEM Fields:**

   The substantial prevalence of Science, Technology, Engineering, and Mathematics (STEM) fields, including Computer Science, Engineering, Physics, Chemistry, and Mathematics, demonstrated the dedication to these fundamental areas. This observation highlighted the shared objective of enhancing perception and creativity in critical areas that drive technological and scientific progress.

3. **Life Sciences Emphasis:**

   Biochemistry, Genetics and Molecular Biology, Environmental Science, Agricultural and Biological Sciences, Immunology and Microbiology, and Neuroscience generated considerable articles. These disciplines were regarded as part of the broader field of Life Science. However, their significant production indicated a dedication to explaining the complexities of Life and Biological systems.

4. **Materials Science and Chemistry:**

   The substantial article in Materials Science and Chemistry focused on exploring, developing, and discovering cutting-edge ideas and chemical procedures, indicating their commitment to enhancing technological progress and insight into fundamental chemical principles.

5. **Interdisciplinary Research:**

   The presence and progress of "Multidisciplinary" and Decision Sciences in article production highlighted the popularity of interdisciplinary research. This finding denoted the importance of collaboration by including different research ideas to explore more sophisticated understandings.

6. **Social Sciences Involvement:**

   The significant presence of social issues in different research areas indicated the importance of understanding Social Sciences and explained the substantial amount of article production. This finding highlighted the interdisciplinary nature of this discipline. However, such a multifaceted discipline requires an inclusive methodology to address its complex issues.

7. **Low Representation in Arts and Humanities:**

   Arts and Humanities produced a lower number of articles, indicating less emphasis on research in this discipline. However, there may be a breach in the research environment or a potential absence of a collaborative approach in this research area.

8. **Low Representation in Dentistry:**

   Dentistry produced limited articles indicating a smaller research community or specialization in research activities. This finding also highlighted the absence of interdisciplinary nature and collaborative efforts in this domain.

9. **Emerging Fields:**

   Emerging fields such as Energy and Earth and Planetary Sciences conducted research on ecological and energy-related issues. Their dedication indicated they were focused on contemporary topics that encompassed global concerns.

10. **Health Professions:**

    Health professions produced a moderate number of articles indicating less effort in this area. This observation also underlined the lack of collective efforts or a pleasant research environment.

The above analysis indicated the distribution of research outputs among disciplines and their priorities for engaging efforts. However, a threadbare investigation may extract more insights into the patterns and trends of article production.

4.5.2: Number of articles in universities

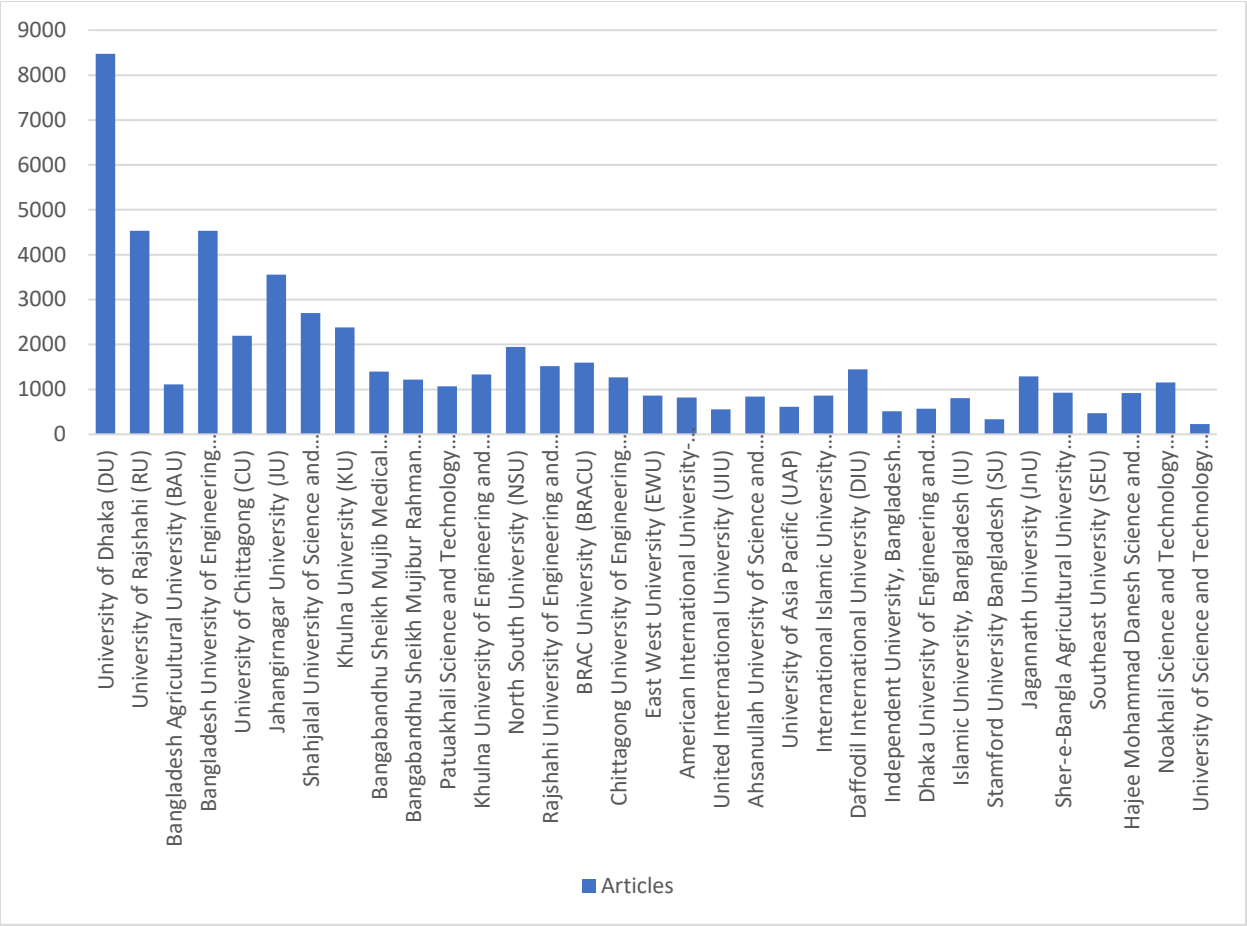
Table 4.5.2 exhibited various universities on the left, while each university's total number of articles from 2012 to 2021 on the right. These statistics effectively illustrated the article production across diverse universities.

Table 4.5.2: Number of articles in universities

Universities	**Articles**
University of Dhaka (DU)	8473
University of Rajshahi (RU)	4533
Bangladesh Agricultural University (BAU)	3645
Bangladesh University of Engineering and Technology	4530
University of Chittagong (CU)	2195
Jahangirnagar University (JU)	3559
Shahjalal University of Science and Technology (SUST)	2701
Khulna University (KU)	2377
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1397
Bangabandhu Sheikh Mujibur Rahman Agricultural	1219
Patuakhali Science and Technology University (PSTU)	1067
Khulna University of Engineering and Technology (KUET)	1331
North South University (NSU)	1948
Rajshahi University of Engineering and Technology (RUET)	1517
BRAC University (BRACU)	1597
Chittagong University of Engineering and Technology	1267
East West University (EWU)	860
American International University-Bangladesh (AIUB)	816
United International University (UIU)	556
Ahsanullah University of Science and Technology (AUST)	842
University of Asia Pacific (UAP)	609
International Islamic University Chittagong (IIUC)	860
Daffodil International University (DIU)	1443
Independent University, Bangladesh (IUB)	513
Dhaka University of Engineering and Technology,	567
Islamic University, Bangladesh (IU)	808
Stamford University Bangladesh (SU)	338
Jagannath University (JnU)	1288
Sher-e-Bangla Agricultural University (SAU)	925
Southeast University (SEU)	467
Hajee Mohammad Danesh Science and Technology	919
Noakhali Science and Technology University (NSTU)	1152
University of Science and Technology Chittagong (USTC)	230

Figure 4.5.2.1 visually represented Table 4.5.2. It displayed the universities on the X-axis. The Y-axis indicated the number of articles in universities. This Figure offered valuable insights into the extent and pattern of article production.

Figure 4.5.2.1: Number of articles in universities



The data revealed statistics on article production in universities. The University of Dhaka produced the highest number of articles (8473), followed by the University of Rajshahi (RU) with 4533 articles, Bangladesh Agricultural University (BAU) with 3645, and Bangladesh University of Engineering and Technology (BUET) with 4530 articles.

Down the list, the University of Chittagong (CU) produced 2195 articles, trailed by Jahangirnagar University (JU) with 3559 articles, Shahjalal University of Science and Technology (SUST) with 2701 articles, Khulna University (KU) with 2377 articles; Bangabandhu Sheikh Mujib Medical

University (BSMMU) with 1397 articles; Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) with 1219 articles; Patuakhali Science and Technology University (PSTU) with 1067 articles and Khulna University of Engineering and Technology (KUET) with 1331 articles.

However, private universities made a significant contribution to article production. For example, North South University (NSU) contributed 1948 articles, BRAC University (BRACU) 1597 articles, Chittagong University of Engineering and Technology (CUET) 1267 articles, East West University (EWU) 860 articles, American International University-Bangladesh (AIUB) 816 articles, and United International University (UIU) 556 articles, Independent University of Bangladesh (IUB) 513 articles, Southeast University (SEU) 467 articles, Stamford University Bangladesh (SU) 338 articles, and the University of Science and Technology Chittagong (USTC) 230 articles.

Patterns and trends:

1. **Article Counts:**

The University of Dhaka produced the highest number of articles (8,473) showing commitment to scholarly endeavors and generating intellectual property. University of Rajshahi (RU), Bangladesh University of Engineering and Technology (BUET), Bangladesh Agricultural University (BAU), and Jahangirnagar University (JU) trailed behind with 4533, 4530, 3645, and 3559 articles, respectively.

2. **Top Universities:**

Establishment and reputation made a significant impact on article productivity. For example, earlier established prominent universities such as the University of Dhaka (DU), the University of Rajshahi (RU), Bangladesh University of Engineering and Technology (BUET), and Jahangirnagar University (JU) were the key producers.

3. **Engineering and Technology Focus:**

   Engineering and technology-focused universities contributed significantly to article generation, such as Bangladesh University of Engineering and Technology BUET, Khulna University of Engineering and Technology KUET, and Chittagong University of Engineering and Technology CUET. This finding highlighted the distinctive nature of research in this domain.

4. **Medical and Agricultural Universities:**

   Bangladesh Agricultural University (BAU), Bangabandhu Sheikh Mujib Medical University (BSMMU), and Sher-e-Bangla Agricultural University (SAU) concentrated on agriculture and medical domains and produced a considerable amount of articles. This outcome denoted the dynamic nature of research production in these institutions.

5. **Private Universities:**

   North South University (NSU), BRAC University (BRACU), East West University (EWU), and Independent University, Bangladesh (IUB) exhibited significant article counts highlighting the emerging roles of private universities in the research domain.

6. **Diversity in Research Output:**

   The geographical distribution of article production from various universities of different domains indicated the diversity of research activities and intellectual attention. This observation highlighted the widespread focus on research and the importance of intellectual movement.

7. **Medium-sized Universities:**

   International Islamic University in Chittagong and Asia Pacific University produced a moderate number of articles highlighting an insignificant research movement in their fields.

8. **Lower Article Counts:**

   The University of Science and Technology Chittagong (USTC) and Southeast University (SEU) generated fewer articles, indicating either less emphasis on research or produced limited documents.

9. **Variation in Specializations:**

   The research outputs in Universities indicated various specializations such as agricultural sciences, medical research, engineering and Technology, etc. However, this finding highlighted a diversity of research interests in academia.

10. **Growing Institutions:**

    Regarding establishments, Daffodil International University (DIU) and Noakhali Science and Technology University (NSTU) were comparatively newer institutions that significantly contributed to article production, indicating their fascination and commitment to the intellectual movement.

These patterns and trends exhibited a pragmatic understanding of the distribution of research articles and the significance of research endeavors provided by Bangladesh's universities.

4.6 Comparative Analysis of Articles and Documents

The data on total documents were analyzed through the "Biblioshiny" tool. The number of documents and articles were retrieved through the analysis, and later, comparative analyses between these outputs were conducted based on disciplines and universities.

4.6.1 Comparative Analysis of Articles and Documents in Disciplines

Table 4.6.1 displayed the research outputs generated by 33 selected universities in Bangladesh between 2012 and 2021. Each row corresponded to a particular discipline, while each column represented the number of documents, number of articles, and percentage of articles in documents. Within this dataset, several interesting patterns and trends were observed, providing valuable perceptions of the research landscape of these institutions.

Table 4.6.1: Articles and Documents in Disciplines

Disciplines	**Documents**	**Articles**	**Percentage of Articles in documents**
Medicine	7642	5257	68.76%
Computer Science	15513	3171	20.44%
Engineering	15976	4834	30.26%
Social Sciences	4746	2895	60.99%
Environmental Science	5789	4478	77.36%
Biochemistry, Genetics and Molecular	4732	3893	82.26%
Physics and Astronomy	7666	4045	52.77%
Agricultural and Biological Sciences	6290	5453	86.72%
Materials Science	5152	3674	71.28%
Chemistry	3354	2760	82.28%
Pharmacology, Toxicology and	2513	2067	82.23%
Mathematics	4043	1776	43.94%
Business, Management and Accounting	2102	1473	70.05%
Chemical Engineering	2303	1750	75.97%
Earth and Planetary Sciences	1994	1467	73.59%
Economics, Econometrics and Finance	1438	1022	71.09%
Energy	4264	1238	29.01%
Immunology and Microbiology	1553	1280	82.48%
Multidisciplinary	1513	1393	92.08%
Decision Sciences	2003	454	22.66%
Arts and Humanities	699	406	58.08%
Psychology	491	356	72.50%

Table 4.6.1 Continued

Disciplines	Documents	Articles	Percentage of Articles in documents
Nursing	410	358	87.32%
Neuroscience	421	298	70.79%
Health Professions	218	168	77.06%
Veterinary	608	560	92.11%
Dentistry	26	23	88.46%

Figure 4.6.1.1 visually represented Table 4.6.1. It represented the disciplines on the X-axis. The Y-axis indicated the number of documents and articles in disciplines. This figure offered a comparative analysis of article and document production.

Figure 4.6.1.1: Articles and Documents in Disciplines

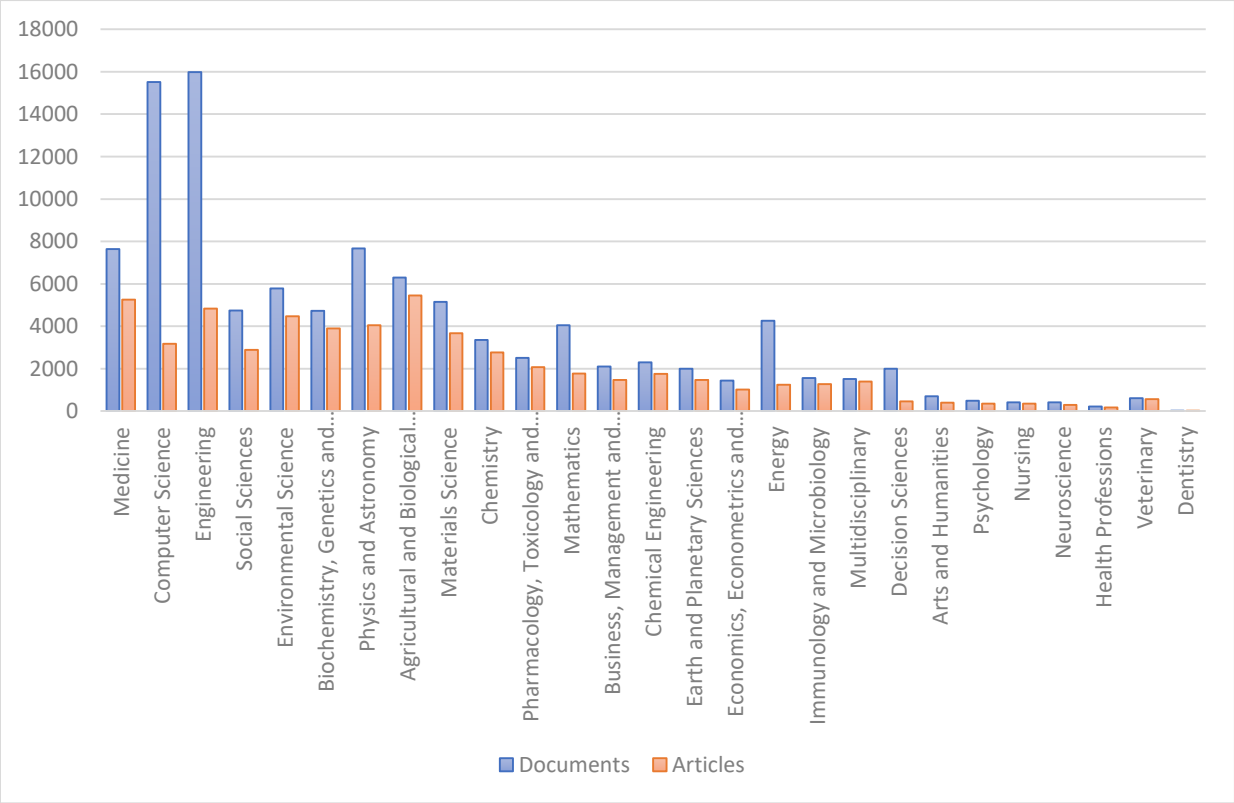
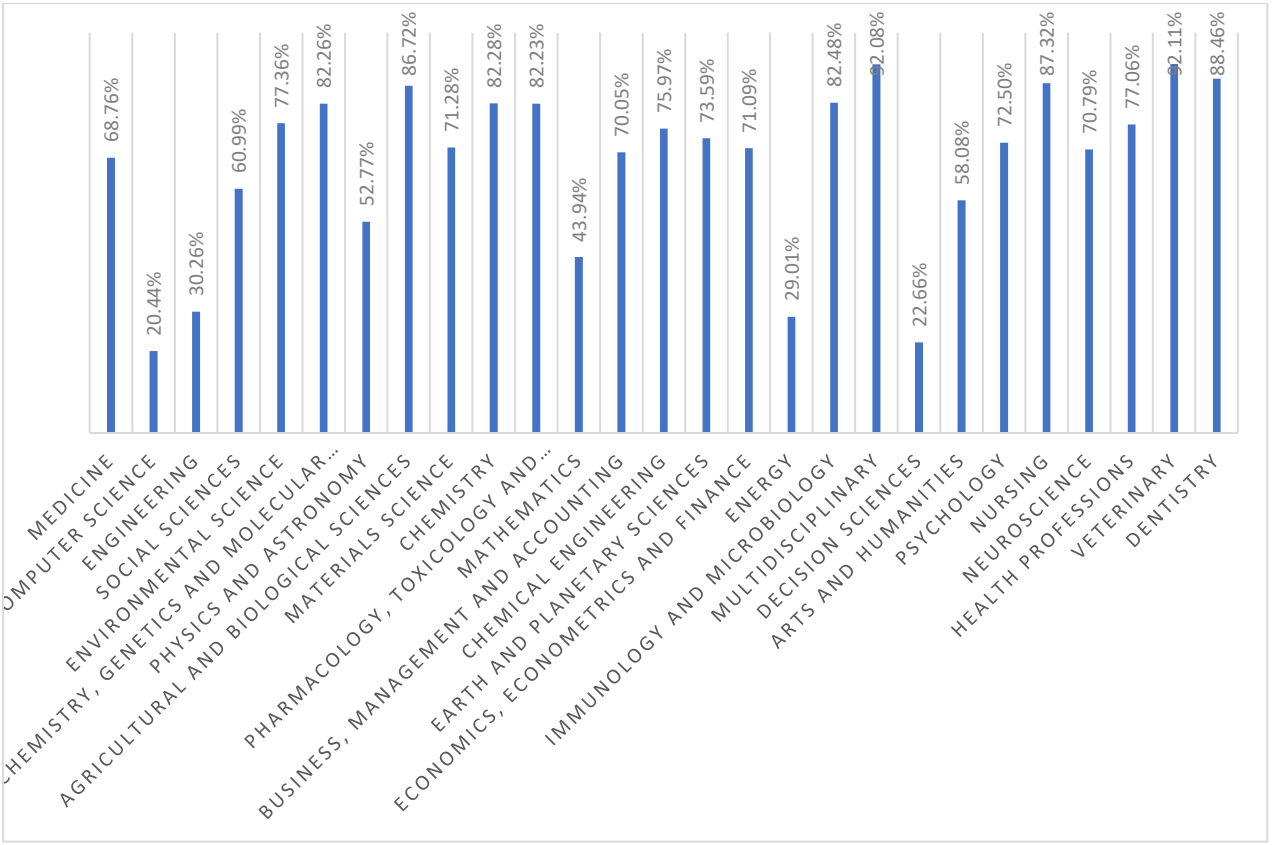


Figure 4.6.1.2 is a visual representation of Table 4.6.1. It represented the disciplines on the X-axis. The Y-axis indicates the percentage of articles within documents in disciplines. This figure portrayed valuable insights into the extent and pattern of article production.

Figure 4.6.1.2: Percentage of Articles within Documents in Disciplines



The available data comprehensively evaluated research impact in various academic disciplines, presenting the percentage of articles and corresponding document counts. A significant output of 608 documents was observed in the Veterinary field, with articles accounting for 92.11% (560) of the total. The Multidisciplinary field demonstrated strong performance, with 1513 documents, of which 92.08% (1393) were articles. Dentistry and Nursing also made noteworthy contributions, with 26 documents having 88.46% (23) as articles and 410 documents having 87.32% (358) as articles, respectively.

The Agricultural and Biological Sciences exhibited exemplary research output, comprising a total of 6290 documents. A substantial proportion of these documents were articles, making up 86.72%

(5453) of the total document count. Chemistry and Pharmacology, Toxicology, and Pharmaceutics also contributed significantly, with 3354 and 2513 documents, respectively. In these domains, articles constituted 82.28% (2760) and 82.23% (2067) of the total documents, respectively.

In scientific research, the domains of Biochemistry, Genetics, and Molecular Biology obtained an extensive collection of 4732 documents, with articles comprising 82.26% (3893) of the total. Conversely, immunology and microbiology contributed 1553 documents, of which articles comprised 82.48% (1280) of the overall count.

Regarding document count, Health Professions, Environmental Science, and Chemical Engineering owned 218, 5789, and 2303 documents, respectively. The percentage of articles in each field was 77.06% (168 articles) for Health Professions, 77.36% (4478 articles) for Environmental Science, and 75.97% (1750 articles) for Chemical Engineering. Moreover, Earth and Planetary Sciences generated 73.59% (1467 articles) of their total 1994 documents. Notably, Psychology contributed 72.50% (356 articles) to the overall output of 491 documents. Similarly, Materials Science accounted for 71.28% (3674 articles) of its 5152 documents.

Economics, Econometrics, and Finance projected a substantial publication volume of 1438 documents, of which 1022 constituted articles, comprising an impressive 71.09% of the total publications. With 421 documents analyzed, of which 298 are articles, Neuroscience demonstrated a considerable scholarly output, accounting for 70.79% of the total publications.

The Business, Management, and Accounting domain displayed a noteworthy scholarly presence, with 2102 documents analyzed, of which 1473 constituted articles, representing 70.05% of the total publications. With a staggering 7642 documents examined, Medicine emerged as a prolific field of research. Of these, 5257 were articles, comprising 68.76% of the total publications. In Social Sciences, considerable scholarly activity was observed, with 4746 documents analyzed, of which 2895 were articles, accounting for 60.99% of the total publications.

Although Arts and Humanities demonstrated scholarly engagement, the discipline exhibited a relatively lower publication rate than other fields. With 699 documents analyzed, of which 406 were articles, the percentage count was 58.08%.

Patterns and Trends

1. **Comparison within Categories:**

   In the realm of academic disciplines, the medical field is placed separately due to its notable abundance of documents compared to articles. This finding indicated a substantial presence of scholarly records within the field. Additionally, disciplines such as Computer Science, Engineering, Physics and Astronomy, and Environmental Science exhibited higher article counts, reflecting their dynamic research and productive publication activities. Conversely, disciplines like Chemistry, Economics, and Business demonstrated comparatively reduced article counts compared to their counterparts.

2. **Size of Fields:**

   The article counts on different fields representing their vast and diverse research landscape. Fields like Computer Science, Engineering, Biochemistry, Genetics, and Molecular Biology displayed significant disparities in article counts, suggesting the presence of diverse research communities. In contrast, Dentistry, Health Professions, and Neuroscience produced the lowest number of articles, indicating less emphasis on research.

3. **Document-to-Article Ratios:**

   The ratio of articles was lower than that of documents in all disciplines; however, variations were visible in ratios. For example, Medicine, Physics and Astronomy, and Environmental Sciences displayed a proportionally higher ratio of documents than articles. In contrast, Economics, Psychology, and Decision Sciences presented moderately less proportional variations between articles and documents.

4. **Variability in Ratios:**

   The differences in the ratio between articles and documents indicated identical research natures and precedencies in disciplines. For instance, Physics and Astronomy displayed a narrowly similar ratio, while Environmental Science revealed remarkable disparities. This finding denoted distinguished features and research nature within disciplines.

5. **Specialized Areas:**

   The proportional differences between articles and documents in Immunology and Microbiology, and Pharmacology, Toxicology, and Pharmaceutics highlighted the priorities for specialized research activities that resulting reduced article production or fewer documents.

6. **Interdisciplinary Nature:**

   Disciplines with an interdisciplinary nature, for example, Biochemistry, Genetics, Molecular Biology, Pharmacology, Toxicology, and Pharmaceutics, exhibited a dominance of documents compared to articles indicating a wide range of research projections in these fields.

7. **Emerging Disciplines:**

   Emerging disciplines, such as Environmental Science, exhibited a substantial number of documents compared to the articles. This observation highlighted the diversity of research outputs in this domain.

8. **Cross-Disciplinary Areas:**

   Decision Sciences, Business, Management, and Accounting fields emerged as cross-disciplinary focal points, displaying substantial article output. This amount highlighted the blending of research interests across various disciplines, showing a productive exchange of academic pursuits.

   A careful analysis of these trends revealed a comprehensive understanding of the diverse levels of research output in different disciplines. This observation enabled the recognition of evolving patterns and academic interests within each field.

4.6.2: Comparative Analysis of Articles and Documents in Universities

Table 4.6.2 displayed the research outputs generated by 33 selected universities in Bangladesh between 2012 and 2021. Each row represented a particular university, while each column signified the number of documents, number of articles, and percentage of articles in documents. Several interesting patterns and trends were identified within this dataset, signifying valuable perceptions of the research landscape of these institutions.

Table 4.6.2: Comparative Analysis of Articles and Documents in Universities

Universities	Documents	Articles	Percentage of Articles in documents
University of Dhaka (DU)	12018	8473	70.51%
University of Rajshahi (RU)	7161	4533	63.33%
Bangladesh Agricultural University (BAU)	4331	3645	84.12%
Bangladesh University of Engineering and Technology (BUET)	11903	4530	38.08%
University of Chittagong (CU)	3541	2195	61.97%
Jahangirnagar University (JU)	5221	3559	68.17%
Shahjalal University of Science and Technology (SUST)	3622	2701	74.54%
Khulna University (KU)	3557	2377	66.87%
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1689	1397	82.72%
Bangabandhu Sheikh Mujibur Rahman Agricultural University	1507	1219	80.94%
Patuakhali Science and Technology University (PSTU)	1396	1067	76.47%
Khulna University of Engineering and Technology (KUET)	4769	1331	27.90%
North South University (NSU)	4185	1948	46.57%
Rajshahi University of Engineering and Technology (RUET)	3840	1517	39.49%
BRAC University (BRACU)	3802	1597	42.02%
Chittagong University of Engineering and Technology (CUET)	3138	1267	40.39%
East West University (EWU)	1731	860	49.57%
American International University-Bangladesh (AIUB)	3146	816	25.93%
United International University (UIU)	1496	556	37.17%
Ahsanullah University of Science and Technology (AUST)	2109	842	39.95%
University of Asia Pacific (UAP)	1348	609	45.16%
International Islamic University Chittagong (IIUC)	2238	860	38.44%
Daffodil International University (DIU)	3810	1443	37.87%
Independent University, Bangladesh (IUB)	1451	513	35.35%
Dhaka University of Engineering and Technology,	1566	567	36.20%
Islamic University, Bangladesh (IU)	1013	808	79.70%
Stamford University Bangladesh (SU)	494	338	68.22%
Jagannath University (JnU)	1813	1288	71.09%
Sher-e-Bangla Agricultural University (SAU)	1347	925	68.72%
Southeast University (SEU)	991	467	47.12%
Hajee Mohammad Danesh Science and Technology University (HSTU)	1218	919	75.50%
Noakhali Science and Technology University (NSTU)	1508	1152	76.45%
University of Science and Technology Chittagong (USTC)	500	230	46.00%

Figure 4.6.2.1 visually outlined table 4.6.2. It represented the universities on the X-axis. The Y-axis indicated the percentage of articles within documents in universities. This figure offered valuable insights into the extent and pattern of article and document production.

Figure 4.6.2.1: Comparative Analysis of Articles and Documents in Universities

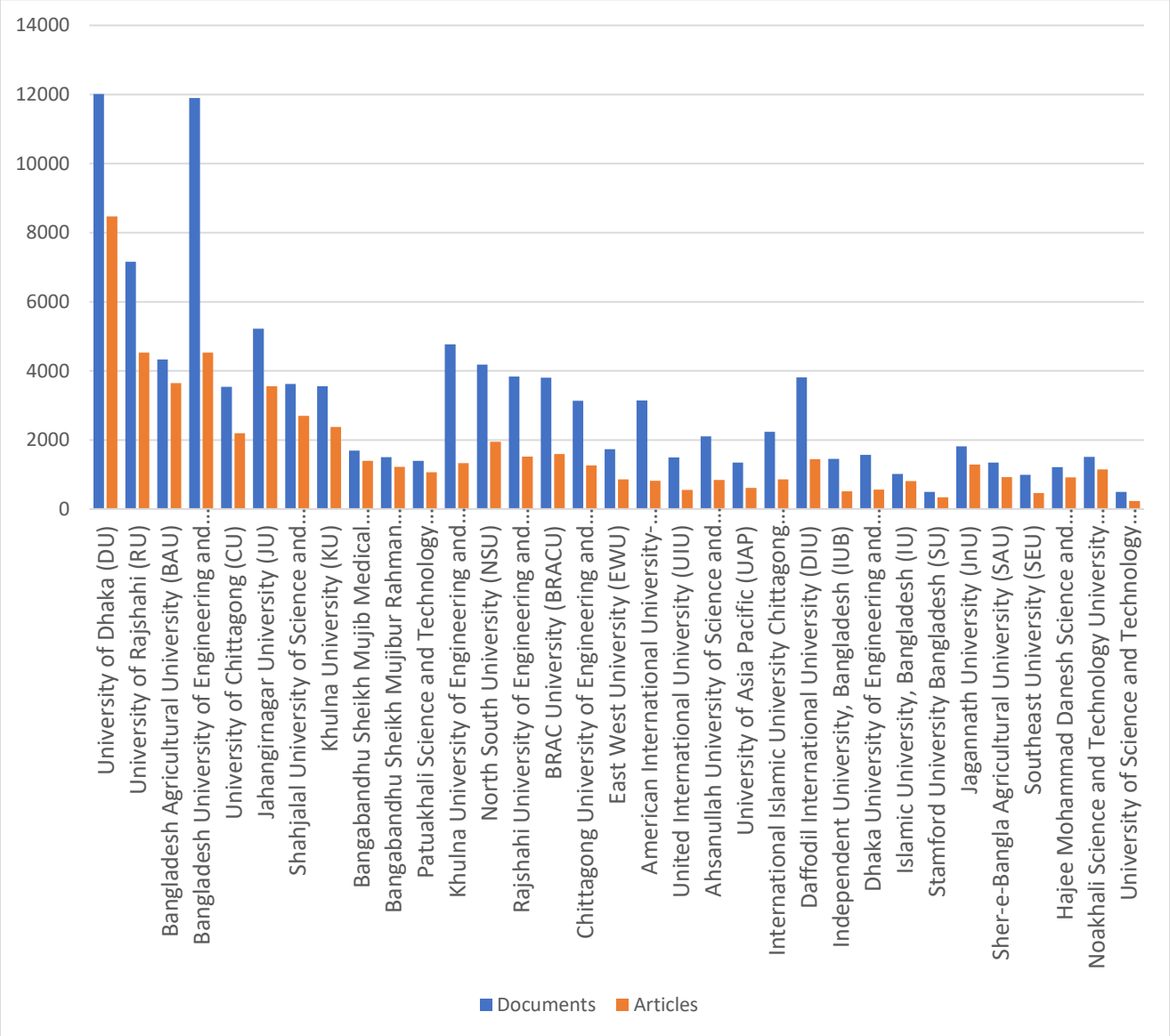
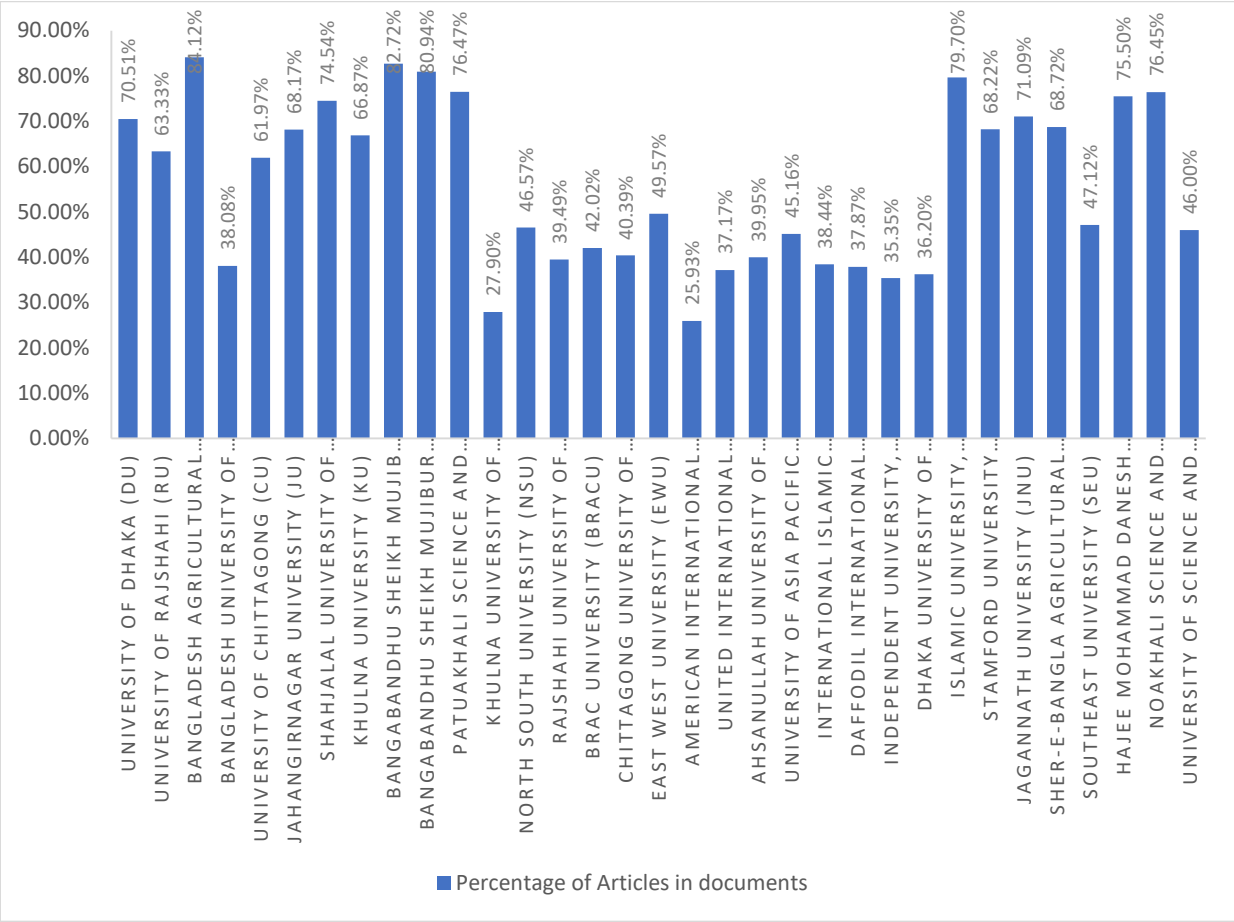


Figure 4.6.2.2 visually represented the table 4.6.1. It highlighted the universities on the X-axis. The Y-axis indicated the percentage of articles within documents in universities. This figure projected valuable insights into the extent and pattern of article production.

Figure 4.6.2.2: Percentage of Articles within Documents in Universities



The University of Dhaka (DU) produced 12,018 documents. Among these documents, articles represented the majority, constituting 8,473, accounting for 70.51% of the documents. Similarly, the University of Rajshahi (RU) generated 7,161 documents, of which 4,533 articles comprised a significant portion, constituting 63.33% of the documents.

Bangladesh Agricultural University (BAU) possessed 4,331 documents, including 3,645 articles, comprising 84.12% of the total documents. Conversely, the Bangladesh University of Engineering and Technology (BUET) generated 11,903 documents. Articles represented a smaller proportion, accounting for 4,530, or 38.08% of the documents.

The University of Chittagong (CU) produced 3,541 documents, with articles comprising 2,195, constituting 61.97% of the total documents. Jahangirnagar University (JU) obtained a robust academic repository with 5,221 documents, of which 3,559 were articles, accounting for 68.17% of the total documents.

Shahjalal University of Science and Technology (SUST) exhibited a significant academic presence with 3,622 documents, among which 2,701 were articles, making up 74.54% of the total documents. Khulna University (KU) displayed a comprehensive academic collection comprising 3,557 documents, with 2,377 articles representing 66.87% of the total documents.

Bangabandhu Sheikh Mujib Medical University (BSMMU) produced 1,689 documents. Notably, articles constituted the majority, accounting for 1,397, or 82.72% of the documents. Similarly, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) generated 1,507 documents. Articles were significant, comprising 1,219, or 80.94% of the total documents.

Patuakhali Science and Technology University (PSTU) revealed a significant academic presence with 1,396 documents. Among these, articles represented a notable portion, comprising 1,067, or 76.47% of the total documents. Khulna University of Engineering and Technology (KUET) portrayed a comprehensive academic collection with 4,769 documents. However, articles constituted a smaller proportion, comprising 1,331, or 27.90% of the documents.

North South University (NSU) generated 4,185 documents, of which articles constituted a significant portion, comprising 1,948, or 46.57% of the total documents. Rajshahi University of Engineering and Technology (RUET) exhibited a distinctive profile with 3,840 documents. However, articles obtained a smaller proportion, comprising 1,517, or 39.49% of the documents.

BRAC University (BRACU) produced 3,802 documents. Articles represented a notable portion, comprising 1,597, or 42.02% of the total documents. Chittagong University of Engineering and Technology (CUET) exhibited a significant academic presence with 3,138 documents. However, articles grasped a smaller proportion, comprising 1,267, or 40.39% of the documents.

East West University (EWU) generated 1,731 documents. Among these, articles represented a notable portion, comprising 860, or 49.57% of the total documents. American International University-Bangladesh (AIUB) produced 3,146 documents. Articles represented a remarkable percentage, comprising 816, or 25.93% of the documents.

United International University (UIU) generated 1,496 documents. Articles obtained a noteworthy portion, comprising 556, or 37.17% of the total documents. Ahsanullah University of Science and Technology (AUST) produced 2,109 documents. However, articles constituted a smaller proportion, comprising 842, or 39.95% of the total documents.

University of Asia Pacific (UAP) produced 1,348 documents. Among these, articles represented a significant portion, comprising 609, or 45.16%, of the total documents. International Islamic University Chittagong (IIUC) exhibited a substantial academic presence with 2,238 documents. However, articles constituted a smaller proportion, comprising 860, or 38.44% of the total documents.

Daffodil International University (DIU) maintained a substantial academic repository with 3,810 documents. Articles obtained a trivial portion, comprising 1,443, or 37.87% of the documents. Independent University, Bangladesh (IUB) showed a distinctive profile with 1,451 documents. However, articles constituted a smaller proportion, comprising 513, or 35.35% of the total documents.

Dhaka University of Engineering and Technology exhibited a significant academic presence with 1,566 documents, of which articles obtained a smaller proportion, comprising 567, or 36.20% of the total documents. Islamic University, Bangladesh (IU) generated 1,013 documents. Articles, including 808, or 79.70% of the total documents, represented an outstanding portion.

Stamford University Bangladesh (SU) produced 494 documents, including 338 articles, and obtained 68.22% of the documents. Jagannath University (JnU) generated 1,813 documents. Articles represented a notable portion, comprising 1,288, or 71.09% of the documents.

Sher-e-Bangla Agricultural University (SAU) exhibited a significant academic presence with 1,347 documents. Articles signified a notable portion, comprising 925, or 68.72% of the documents. Southeast University (SEU) produced 991 documents. Articles acquired a notable portion, comprising 467, or 47.12% of the total documents.

Hajee Mohammad Danesh Science and Technology University (HSTU) presented 1,218 documents. However, articles constituted a greater amount, comprising 919, or 75.50% of the total documents. Noakhali Science and Technology University (NSTU) generated 1,508 documents, including 1,152 articles obtained 76.45% of the documents.

University of Science and Technology Chittagong (USTC) exhibited 500 documents. However, articles constituted a smaller proportion, comprising 230, or 46.00% of the documents.

Patterns and Trends:

Following patterns and trends were observed in the Articles and Documents in Universities:

1. **High Percentage of Articles:**

   Bangladesh Agricultural University (BAU) exhibited the highest percentage of articles in documents (84.12%). Bangabandhu Sheikh Mujib Medical University (BSMMU) and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) also displayed notably high percentages (82.72% and 80.94% respectively).

2. **Moderate to High Percentage of Articles:**

   Universities like the University of Dhaka (DU), Jahangirnagar University (JU), Shahjalal University of Science and Technology (SUST), and others obtained percentages ranging from 60% to 75%, indicating a significant presence of articles in their documents.

3. **Moderate to Low Percentage of Articles:**

   Some universities, like North South University (NSU), BRAC University (BRACU), and East-West University (EWU), acquired moderate percentages ranging from 40% to 50%.

4. **Low Percentage of Articles:**

   Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), and American International University-Bangladesh (AIUB) exhibited a low percentage of articles ranging from 25% to 40%.

5. **Variability among Engineering and Technology Universities**

   Bangladesh University of Engineering and Technology BUET, Khulna University of Engineering and Technology KUET, and Chittagong University of Engineering and Technology CUET exhibited a lower percentage of articles than other universities, indicating distinguished research focus or publication tradition.

6. **Consistency in Medical and Agricultural Universities**

   Bangladesh Agricultural University BAU, Bangabandhu Sheikh Mujibur Rahman Medical University BSMMU, and Bangabandhu Sheikh Mujibur Rahman Agricultural University BSMRAU exhibited higher percentages of articles, signifying a consistent presence of research production.

7. **Variability among Private Universities:**

   Private universities, in general, exhibited a variable range of articles. For example, American International University AIUB showed a lower percentage, whereas Independent University, Bangladesh (IUB) revealed moderate percentages of article production.

8. **Diversity of Research Interests:**

   The diversity of research capacities and skills was evidenced within the higher education institutions in Bangladesh with various specializations, such as agricultural, medical, engineering, and general academic fields.

9. **Islamic University (IU) Exception:** Islamic University, Bangladesh (IU) distinguished itself with a high percentage (79.70%), possibly indicating less diversity in research publications.

Overall, the analysis suggested variability in research output across different universities, with factors like field of study, institutional focus, and research culture influencing the percentages of articles in documents.

4.6.3 Impact of collaboration on article production in disciplines

Table 4.6.3 was extracted from Table 4.3.1(Collaborative Author Documents in Disciplines) and Table 4.6.1(Comparative Analysis of Articles and Documents in Disciplines). It displayed the Universities on the left, while data on Total Documents, Single author documents, Collaborative author documents, Articles, and Percentage of Articles in documents on the right.

A comparative analysis between the Percentage of Collaborative Author Documents and the Percentage of Articles in Documents may reveal the relationship between article production and research collaboration in disciplines.

Table 4.6.3 Collaboration on article production in disciplines

Discipline	**Total Document**	**Single Author Document**	**Collaborative Author Document**	**Articles**	**Percentage of Articles in documents**
Medicine	7642	192	7450	3171	20.44%
Computer Science	15513	424	15089	454	22.66%
Engineering	15976	469	15507	1238	29.01%
Social Sciences	4746	842	3904	4834	30.26%
Environmental Science	5789	208	5581	1776	43.94%
Biochemistry, Genetics and Molecular Biology	4732	81	4651	4045	52.77%
Physics and Astronomy	7666	223	7443	406	58.08%
Agricultural and Biological Sciences	6290	102	6188	2895	60.99%
Materials Science	5152	162	4990	5257	68.76%
Chemistry	3354	35	3319	1473	70.05%
Pharmacology, Toxicology and Pharmaceutics	2513	46	2467	298	70.79%
Mathematics	4043	142	3901	1022	71.09%
Business, Management and Accounting	2102	258	1844	3674	71.28%
Chemical Engineering	2303	50	2253	356	72.50%
Earth and Planetary Sciences	1994	93	1901	1467	73.59%
Economics, Econometrics and Finance	1438	212	1226	1750	75.97%
Energy	4264	150	4114	168	77.06%
Immunology and Microbiology	1553	17	1536	4478	77.36%
Multidisciplinary	1513	16	1497	2067	82.23%
Decision Sciences	2003	61	1942	3893	82.26%
Arts and Humanities	699	215	484	2760	82.28%
Psychology	491	40	451	1280	82.48%
Nursing	410	12	398	5453	86.72%
Neuroscience	421	7	414	358	87.32%
Health Professions	218	7	211	23	88.46%
Veterinary	608	3	605	1393	92.08%
Dentistry	26	1	25	560	92.11%

Analysis:

Step 1: Calculating Percentage of Collaborative Authored Documents in disciplines:

Percentage of Collaborative Author Documents= (Collaborative Author Document/ Total Document) X 100

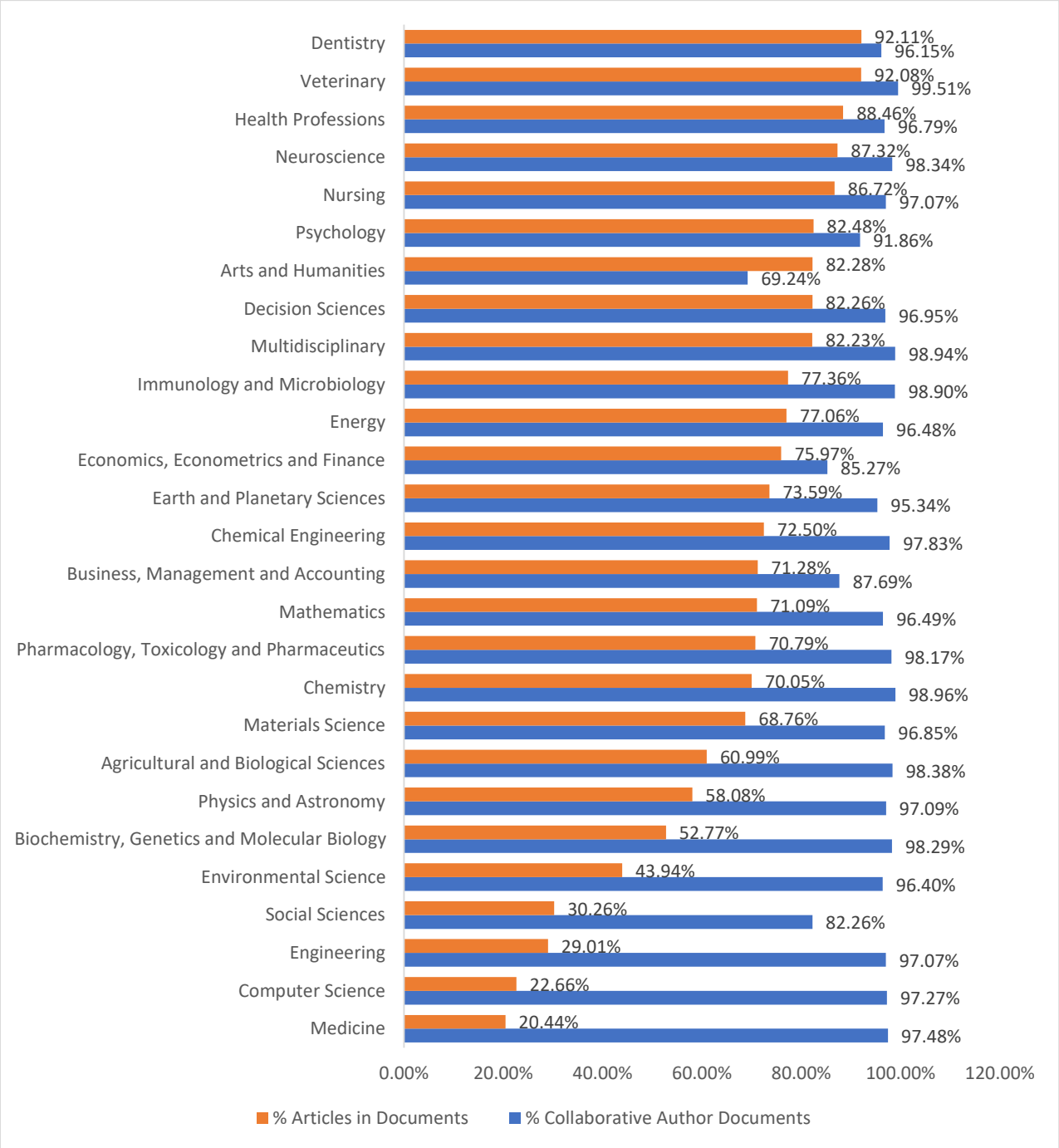
Step 2: Comparing with Percentage of Articles in Documents

Step 3: Interpreting the results

Table 4.6.3.1 Summary Table

Discipline	**% Collaborative Author Documents**	**% Articles in Documents**
Medicine	97.48%	20.44%
Computer Science	97.27%	22.66%
Engineering	97.07%	29.01%
Social Sciences	82.26%	30.26%
Environmental Science	96.40%	43.94%
Biochemistry, Genetics and Molecular Biology	98.29%	52.77%
Physics and Astronomy	97.09%	58.08%
Agricultural and Biological Sciences	98.38%	60.99%
Materials Science	96.85%	68.76%
Chemistry	98.96%	70.05%
Pharmacology, Toxicology and Pharmaceutics	98.17%	70.79%
Mathematics	96.49%	71.09%
Business, Management and Accounting	87.69%	71.28%
Chemical Engineering	97.83%	72.50%
Earth and Planetary Sciences	95.34%	73.59%
Economics, Econometrics and Finance	85.27%	75.97%
Energy	96.48%	77.06%
Immunology and Microbiology	98.90%	77.36%
Multidisciplinary	98.94%	82.23%
Decision Sciences	96.95%	82.26%
Arts and Humanities	69.24%	82.28%
Psychology	91.86%	82.48%
Nursing	97.07%	86.72%
Neuroscience	98.34%	87.32%
Health Professions	96.79%	88.46%
Veterinary	99.51%	92.08%
Dentistry	96.15%	92.11%

Figure 4.6.3.2: Visualization of Summary Table



Interpretation

- **High Collaboration, Low Article Proportion**: Disciplines like Medicine, Computer Science, and Engineering exhibited a high percentage of collaborative documents, but a lower percentage of these documents were articles.
- **High Collaboration, High Article Proportion**: Disciplines like Veterinary, Dentistry, and Neuroscience demonstrated high collaboration and a high proportion of articles.
- **Moderate Collaboration, Moderate to High Article Proportion**: Disciplines such as Social Sciences and Business, Management and Accounting displayed moderate levels of collaboration and a higher percentage of articles.

The data proved a positive relationship between the Percentage of Collaborative Author Documents and the Percentage of Articles in Documents with minor variations across different disciplines.

4.6.4 Impact of collaboration on article production in Universities

Table 4.6.4 was extracted from Table 4.3.2 (Collaborative Author Documents in Universities) and Table 4.6.2 (Comparative Analysis of Articles and Documents in Universities.) It displayed the Universities on the left, while data on Total Documents, Single author documents, Collaborative author documents, Articles, and Percentage of Articles in documents on the right.

A comparative analysis between the Percentage of Collaborative Author Documents and the Percentage of Articles in Documents may reveal the relationship between article production and research collaboration in disciplines.

Table 4.6.4: collaboration and article production in Universities

Universities	**Total Document**	**Single author document**	**Collaborative author document**	**Articles**	**Percentage of Articles in documents**
University of Dhaka (DU)	12018	750	11268	816	25.93%
University of Rajshahi (RU)	7161	304	6857	1331	27.90%
Bangladesh Agricultural University (BAU)	4331	45	4286	513	35.35%
Bangladesh University of Engineering and Technology (BUET)	11903	349	11554	567	36.20%
University of Chittagong (CU)	3541	298	3243	556	37.17%
Jahangirnagar University (JU)	5221	207	5014	1443	37.87%
Shahjalal University of Science and Technology (SUST)	3622	139	3483	4530	38.08%
Khulna University (KU)	3557	96	3461	860	38.44%
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1689	45	1644	1517	39.49%
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	1507	23	1484	842	39.95%
Patuakhali Science and Technology University (PSTU)	1396	17	1379	1267	40.39%
Khulna University of Engineering and Technology (KUET)	4769	95	4674	1597	42.02%
North South University (NSU)	4185	220	3965	609	45.16%
Rajshahi University of Engineering and Technology (RUET)	3840	99	3741	230	46.00%
BRAC University (BRACU)	3802	250	3552	1948	46.57%
Chittagong University of Engineering and Technology (CUET)	3138	104	3034	467	47.12%
East West University (EWU)	1731	140	1591	860	49.57%

Table 4.6.4 Continued

Universities	Total Document	Single author document	Collaborative author document	Articles	Percentage of Articles in documents
American International University-Bangladesh (AIUB)	3146	98	3048	2195	61.97%
United International University (UIU)	1496	55	1441	4533	63.33%
Ahsanullah University of Science and Technology (AUST)	2109	111	1998	2377	66.87%
University of Asia Pacific (UAP)	1348	53	1295	3559	68.17%
International Islamic University Chittagong (IIUC)	2238	118	2120	338	68.22%
Daffodil International University (DIU)	3810	109	3701	925	68.72%
Independent University, Bangladesh (IUB)	1451	68	1383	8473	70.51%
Dhaka University of Engineering and Technology, Gazipur (DUET)	1566	54	1512	1288	71.09%
Islamic University, Bangladesh (IU)	1013	31	982	2701	74.54%
Stamford University Bangladesh (SU)	494	34	460	919	75.50%
Jagannath University (JnU)	1813	52	1761	1152	76.45%
Sher-e-Bangla Agricultural University (SAU)	1347	11	1336	1067	76.47%
Southeast University (SEU)	991	53	938	808	79.70%
Hajee Mohammad Danesh Science and Technology University (HSTU)	1218	12	1206	1219	80.94%
Noakhali Science and Technology University (NSTU)	1508	10	1498	1397	82.72%
University of Science and Technology Chittagong (USTC)	500	18	482	3645	84.12%

Analysis:

Step 1: Calculating Percentage of Collaborative Author Documents in Universities:

Percentage of Collaborative Author Documents= (Collaborative Author Document/ Total Document) X 100

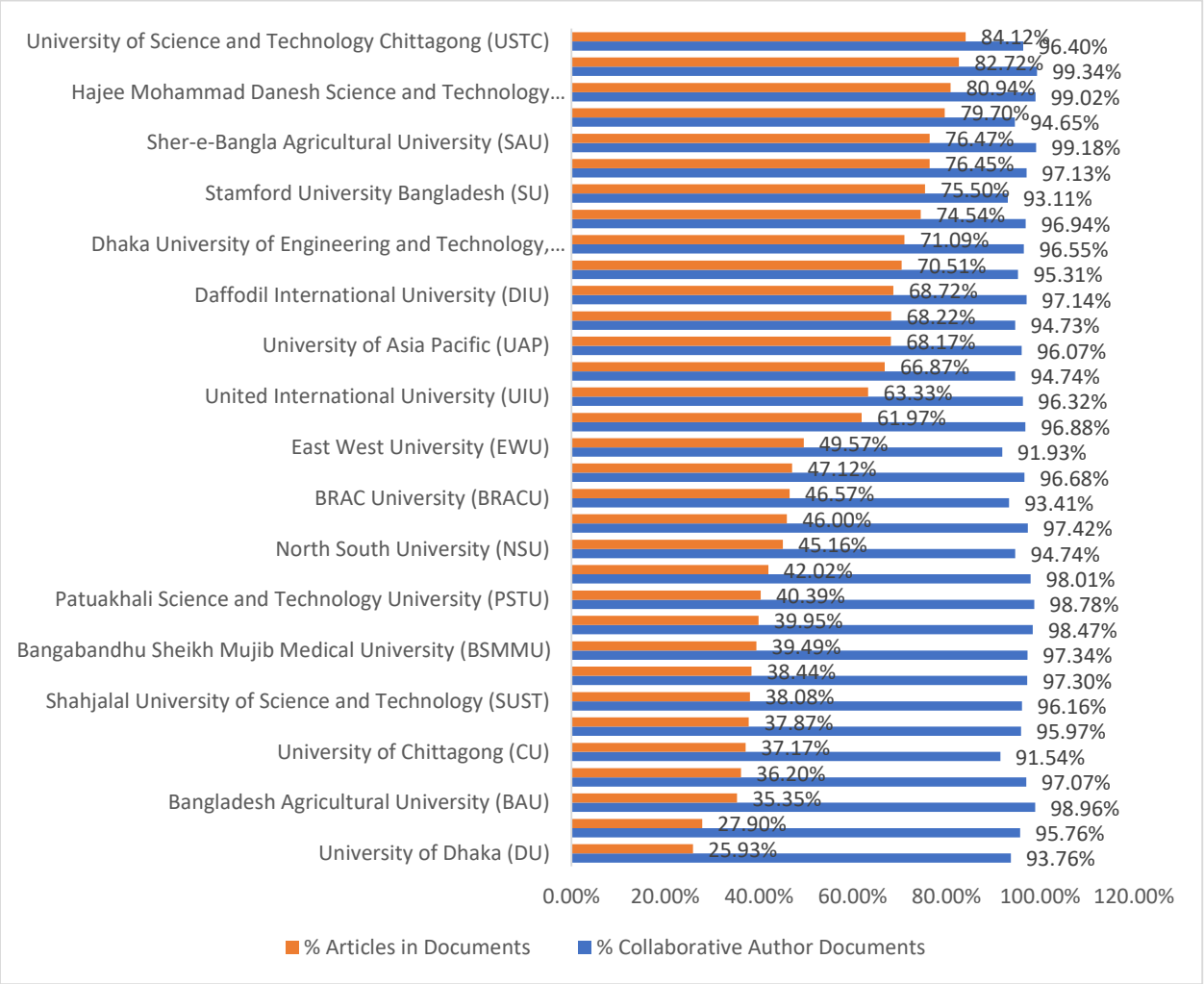
Step 2: Comparing with Percentage of Articles in Documents

Step 3: Interpreting the results

Table 4.6.4.1: Summary Table

University	% Collaborative Author Documents	% Articles in Documents
University of Dhaka (DU)	93.76%	25.93%
University of Rajshahi (RU)	95.76%	27.90%
Bangladesh Agricultural University (BAU)	98.96%	35.35%
Bangladesh University of Engineering and Technology (BUET)	97.07%	36.20%
University of Chittagong (CU)	91.54%	37.17%
Jahangirnagar University (JU)	95.97%	37.87%
Shahjalal University of Science and Technology (SUST)	96.16%	38.08%
Khulna University (KU)	97.30%	38.44%
Bangabandhu Sheikh Mujib Medical University (BSMMU)	97.34%	39.49%
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	98.47%	39.95%
Patuakhali Science and Technology University (PSTU)	98.78%	40.39%
Khulna University of Engineering and Technology (KUET)	98.01%	42.02%
North South University (NSU)	94.74%	45.16%
Rajshahi University of Engineering and Technology (RUET)	97.42%	46.00%
BRAC University (BRACU)	93.41%	46.57%
Chittagong University of Engineering and Technology (CUET)	96.68%	47.12%
East West University (EWU)	91.93%	49.57%
American International University-Bangladesh (AIUB)	96.88%	61.97%
United International University (UIU)	96.32%	63.33%
Ahsanullah University of Science and Technology (AUST)	94.74%	66.87%
University of Asia Pacific (UAP)	96.07%	68.17%
International Islamic University Chittagong (IIUC)	94.73%	68.22%
Daffodil International University (DIU)	97.14%	68.72%
Independent University, Bangladesh (IUB)	95.31%	70.51%
Dhaka University of Engineering and Technology, Gazipur (DUET)	96.55%	71.09%
Islamic University, Bangladesh (IU)	96.94%	74.54%
Stamford University Bangladesh (SU)	93.11%	75.50%
Jagannath University (JnU)	97.13%	76.45%
Sher-e-Bangla Agricultural University (SAU)	99.18%	76.47%
Southeast University (SEU)	94.65%	79.70%
Hajee Mohammad Danesh Science and Technology University (HSTU)	99.02%	80.94%
Noakhali Science and Technology University (NSTU)	99.34%	82.72%
University of Science and Technology Chittagong (USTC)	96.40%	84.12%

Figure 4.6.4.2: Visualization of Summary Table



Interpretation

- **High Collaboration, Low Article Proportion**: Universities like the University of Dhaka (DU), University of Rajshahi (RU), and Bangladesh Agricultural University (BAU) exhibited high percentages of collaborative author documents but a lower proportion of articles.
- **High Collaboration, High Article Proportion**: Universities like the University of Science and Technology Chittagong (USTC), Noakhali Science and Technology University (NSTU), and Hajee Mohammad Danesh Science and Technology University (HSTU) displayed high collaboration and a high proportion of articles.

- **Moderate Collaboration, Moderate to High Article Proportion**: Universities such as East-West University (EWU), United International University (UIU), and American International University-Bangladesh (AIUB) demonstrated moderate levels of collaboration with higher percentages of articles.

The data proved a positive relationship between the Percentage of Collaborative Author Documents and the Percentage of Articles in Documents with minor variations across different universities.

4.7 Annual Growth Rate

The data on total documents were analyzed through the “Biblioshiny” tool. The annual growth rate of documents was retrieved through the analysis and divided according to disciplines and universities.

Table 4.7.1: Annual growth rate of documents in disciplines

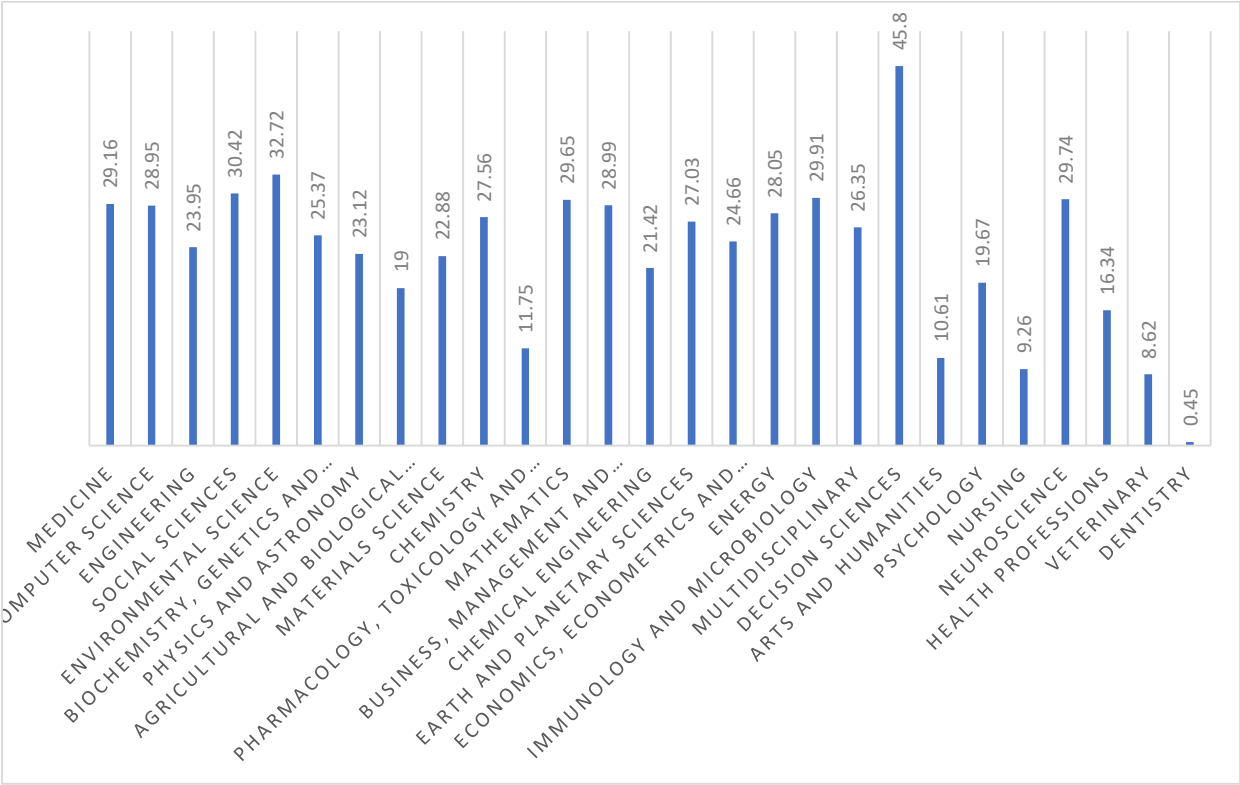
Table 4.7.2 was extracted from Appendix 5. This table offered specific disciplines on the left, while the right side illustrated the annual growth rate in each discipline from 2012 to 2021. These statistics effectively represented the research outputs in various fields.

Table 4.7.1: Annual growth rate of documents in disciplines

Disciplines	**Annual Growth Rate %**
Medicine	29.16
Computer Science	28.95
Engineering	23.95
Social Sciences	30.42
Environmental Science	32.72
Biochemistry, Genetics and Molecular Biology	25.37
Physics and Astronomy	23.12
Agricultural and Biological Sciences	19.00
Materials Science	22.88
Chemistry	27.56
Pharmacology, Toxicology and Pharmaceutics	11.75
Mathematics	29.65
Business, Management and Accounting	28.99
Chemical Engineering	21.42
Earth and Planetary Sciences	27.03
Economics, Econometrics and Finance	24.66
Energy	28.05
Immunology and Microbiology	29.91
Multidisciplinary	26.35
Decision Sciences	45.80
Arts and Humanities	10.61
Psychology	19.67
Nursing	9.26
Neuroscience	29.74
Health Professions	16.34
Veterinary	8.62
Dentistry	0.45

Figure 4.7.1.1 visually represented the table 4.7.1. It signified the disciplines on the X-axis. The Y-axis indicated the annual growth rate of documents in different disciplines. This Figure offered valuable insights into the extent and pattern of article production.

Figure 4.7.1.1: Annual growth rate of documents in disciplines



The academic landscape included various disciplines with annual growth rates, indicating growing interests and dynamic trends. Notably, Decision Sciences exhibited a remarkable growth rate of 45.80%, followed by Environmental Science, with a growth rate of 32.72%. Social Sciences and Immunology and Microbiology showed 30.42% and 29.91% growth rates, respectively. Significant contributions to the expansion of knowledge arose from Neuroscience, Mathematics, and Medicine, with growth rates of 29.74%, 29.65%, and 29.16%, respectively.

Additionally, the energy sector demonstrated a growth rate of 28.05%, and Mathematics, Business, Management, and Accounting maintained robust growth rates of 29.65% and 28.99%,

respectively. Further essential fields included Computer Science, Chemistry, and Earth and Planetary Sciences, exhibiting growth rates of 28.95%, 27.56%, and 27.03%, respectively.

Multidisciplinary studies, with a growth rate of 26.35%, underscored the increasing interconnectedness of knowledge across disciplines. Biochemistry, Genetics, and Molecular Biology possessed a growth rate of 25.37%. On the other hand, Economics, Econometrics, and Finance significantly contribute, showing a growth rate of 24.66%.

Sustained interest was also evident in Materials Science, Physics and Astronomy, and Engineering, with 22.88%, 23.12%, and 23.95% growth rates. These rates highlighted the existing interest and pursuit of knowledge in these fields. Psychology displayed a growth rate of 19.67%. Agricultural and Biological Sciences followed closely with a growth rate of 19.00%. Health Professions also demonstrated substantial growth at 16.34%.

Pharmacology, Toxicology, and Pharmaceutics, Arts and Humanities, Nursing and Veterinary disciplines exhibited moderate growth rates of 11.75%, 10.61%, 9.26%, and 8.62%, respectively. At the bottom of the list, Dentistry displayed the lowest growth rate at 0.45%, suggesting a further investment of attention in this field.

In conclusion, the diverse growth rates of various disciplines indicated their emphasis on research and the future direction of research progress and contributions to knowledge and innovation.

Patterns and trends:

The analysis of the annual growth rate of various disciplines provided the inherent dynamics of research trends and patterns. Thus, this analysis sheded light on the evolutionary landscape of academic endeavors.

1. **High Growth Disciplines**

   Decision Sciences, Environmental Science, Social Sciences, Immunology and Microbiology, Neuroscience, and Medicine exhibited higher annual growth rates ranging from 29% to 45.8%. This finding highlighted a tremendous focus on research with a futuristic approach.

2. **Moderate Growth Disciplines**

   Disciplines such as Energy, Mathematics, Business, Management and Accounting, Computer Science, Chemistry, Earth and Planetary Sciences, Multidisciplinary, Biochemistry, Genetics and Molecular Biology, Economics, Econometrics and Finance, Materials Science, Physics and Astronomy, Engineering areas demonstrated moderate growth rates ranging from 22% to 29%. Notably, these fields made remarkable progress and attracted considerable interest, although they had not reached the levels observed in high-growth areas.

3. **Low Growth or Declining Disciplines**

   Chemical Engineering, Agricultural and Biological Sciences, Psychology, Health Professions, Pharmacology, Toxicology and Pharmaceutics, Arts and Humanities, Veterinary, Nursing, and Dentistry disciplines displayed notably lower growth rates, with Dentistry exhibiting a highly minimal rate of 0.45%. These statistics suggested a slower pace of progress or a potential decline in research interest and activity within these fields.

4. **Diverse Growth Rates in Health-Related Disciplines**

   The growth rates of health-related disciplines differed due to variations in research focus, funding, and social demands. Notably, Medicine, Immunology and Microbiology, and Neuroscience experienced significant growth, whereas Nursing and Health Professions observed comparatively lower rates.

5. **Interdisciplinary Fields**

   The significant growth rates in Multidisciplinary disciplines and Decision Sciences highlighted a positive shift towards interdisciplinary research, collaboration, and the integration of knowledge from diverse domains.

6. **Stability in Physical Sciences**

   Physics and Astronomy, Materials Science, and Chemical Engineering demonstrated a steady growth rate, indicating a remarkable and robust research endeavor, though not equal to a higher level.

7. **Humanities and Social Sciences Diversity**

   Arts and Humanities, Psychology, and Economics, Econometrics, and Finance displayed varied growth rates, indicating diverse research interests and approaches within these disciplines.

8. **Biological and Environmental Sciences Dominance**

   Environmental Science, Biochemistry, Genetics, Molecular Biology, and Agricultural and Biological Sciences exhibited a remarkable growth rate, highlighting commitments to intellectual endeavors in the biological and environmental fields.

9. **Technological Advancements in Computer Science**

   Computer Science and Mathematics demonstrated significant growth rates, representing the increasing importance of research activities, technological advancements, and their interdisciplinary nature in these domains.

10. **Economic and Business Growth**

    Business, Management, Accounting, Economics, Econometrics, Finance, and Energy exhibited substantial growth rates. This observation highlighted the significance of research in these fields for economic development, sustainability in businesses, and the expansion of energy solutions.

    These patterns and trends underscored the interdisciplinary nature of disciplines, latent challenges, and ranges of quick expansion.

4.7.2: Annual growth rate of documents in Universities

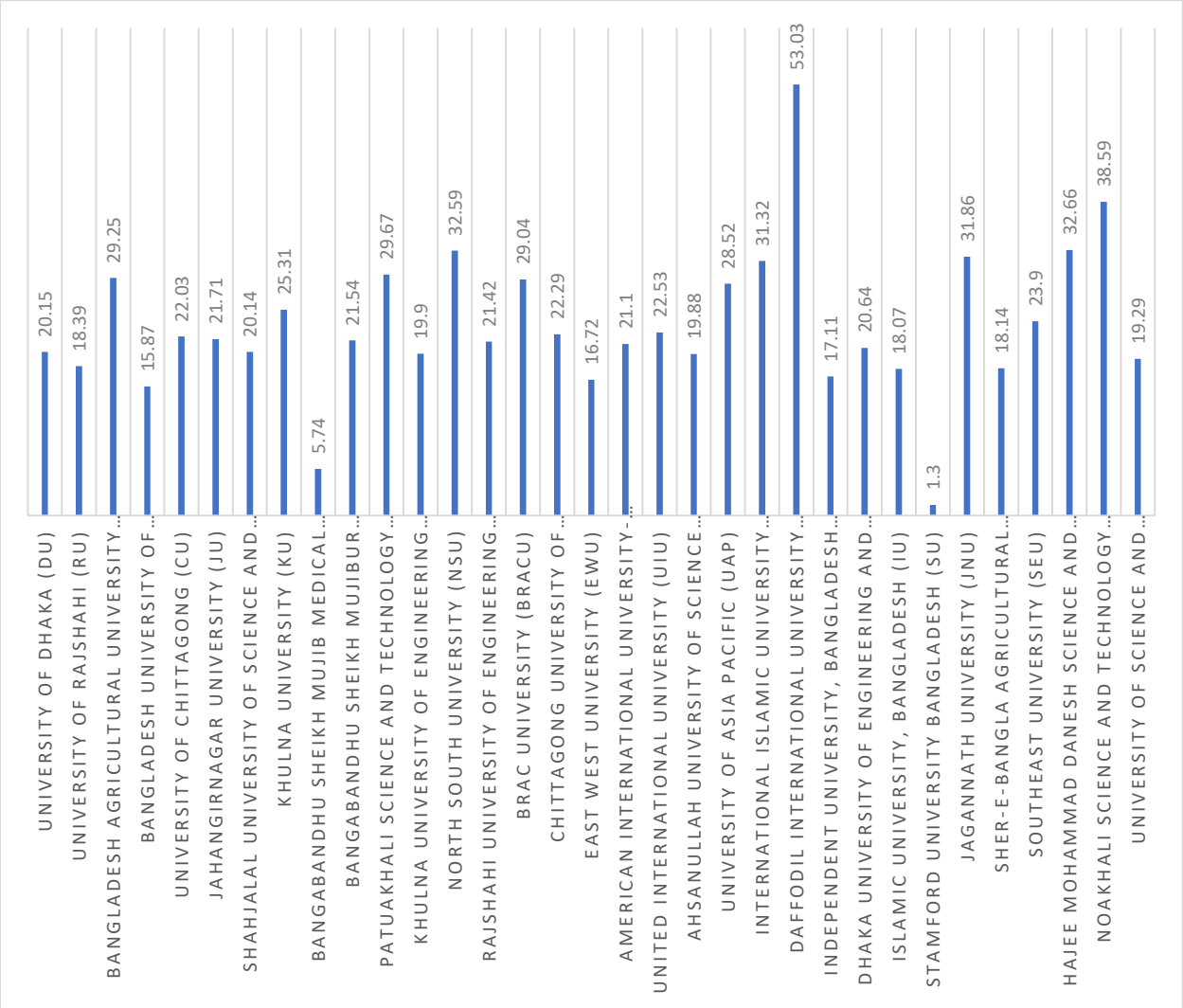
Table 4.7.2 was extracted from the Appendix 5. It offered specific universities on the left, while the right side illustrated the annual growth rate of each university from 2012 to 2021. These statistics effectively represented the research outputs in various Universities.

Table 4.7.2: Annual growth rate of documents in Universities

Universities	**Annual Growth Rate (%)**
University of Dhaka (DU)	20.15
University of Rajshahi (RU)	18.39
Bangladesh Agricultural University (BAU)	29.25
Bangladesh University of Engineering and Technology (BUET)	15.87
University of Chittagong (CU)	22.03
Jahangirnagar University (JU)	21.71
Shahjalal University of Science and Technology (SUST)	20.14
Khulna University (KU)	25.31
Bangabandhu Sheikh Mujib Medical University (BSMMU)	5.74
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	21.54
Patuakhali Science and Technology University (PSTU)	29.67
Khulna University of Engineering and Technology (KUET)	19.90
North South University (NSU)	32.59
Rajshahi University of Engineering and Technology (RUET)	21.42
BRAC University (BRACU)	29.04
Chittagong University of Engineering and Technology (CUET)	22.29
East West University (EWU)	16.72
American International University-Bangladesh (AIUB)	21.10
United International University (UIU)	22.53
Ahsanullah University of Science and Technology (AUST)	19.88
University of Asia Pacific (UAP)	28.52
International Islamic University Chittagong (IIUC)	31.32
Daffodil International University (DIU)	53.03
Independent University, Bangladesh (IUB)	17.11
Dhaka University of Engineering and Technology, Gazipur (DUET)	20.64
Islamic University, Bangladesh (IU)	18.07
Stamford University Bangladesh (SU)	1.30
Jagannath University (JnU)	31.86
Sher-e-Bangla Agricultural University (SAU)	18.14
Southeast University (SEU)	23.90
Hajee Mohammad Danesh Science and Technology University (HSTU)	32.66
Noakhali Science and Technology University (NSTU)	38.59
University of Science and Technology Chittagong (USTC)	19.29

Figure 4.7.2.1 visually represented the table 4.7.2. It highlighted the universities on the X-axis. The Y-axis indicated the Annual Growth Rate of documents in universities.

Figure 4.7.2.1: Annual growth rate of documents in universities



The universities in Bangladesh exhibited a significant growth rate and diversity in research outputs. This study assessed the growth rates of universities and provided valuable insights into the research endeavors of educational institutions. Among the universities, Bangladesh Agricultural University (BAU) and the University of Dhaka (DU) displayed significant growth rates of 29.25% and 20.15%, closely followed by the University of Rajshahi (RU) with an 18.39% growth rate.

The Bangladesh University of Engineering and Technology (BUET), the University of Chittagong (CU), and Jahangirnagar University (JU) obtained 15.87%, 22.03%, and 21.71% growth rates respectively. Down the list, Shahjalal University of Science and Technology (SUST), Khulna University (KU), and Sheikh Mujibur Rahman Agricultural University (BSMRAU) exhibited substantial growth rates of 20.14%, 25.31%, and 21.54% correspondingly.

Bangabandhu Sheikh Mujib Medical University (BSMMU) displayed a lower growth rate of 5.74%, while Patuakhali Science and Technology University (PSTU) demonstrated 29.67%. Khulna University of Engineering and Technology (KUET), Chittagong University of Engineering and Technology (CUET), and Rajshahi University of Engineering and Technology (RUET) proved noteworthy growth with rates of 19.90%, 22.29%, and 21.42%, respectively.

Among the private universities, North South University (NSU), BRAC University (BRACU), East West University (EWU), American International University-Bangladesh (AIUB), United International University (UIU), Ahsanullah University of Science and Technology (AUST), and the University of Asia Pacific (UAP) acquired growth rates of 32.59%, 29.04%, 16.72%, 21.10%, 22.53%, 19.88%, and 28.52%, respectively.

Further down the list, International Islamic University Chittagong (IIUC) and Daffodil International University (DIU) distinguished themselves with impressive growth rates of 31.32% and 53.03%, respectively. Independent University, Bangladesh (IUB) maintained a steady growth rate of 17.11%, confirming its position in the private education sector. Dhaka University of Engineering and Technology, Gazipur (DUET) and Islamic University, Bangladesh (IU) exhibited growth rates of 20.64% and 18.07%, respectively, contributing to the diversity of educational offerings in engineering and general disciplines.

Stamford University Bangladesh (SU) demonstrated a more conservative growth rate of 1.30%, highlighting the variations in growth patterns among educational institutions. Jagannath University (JnU) presented a significant growth rate of 31.86%, confirming its increasing influence in higher education.

At the bottom of the list, Sher-e-Bangla Agricultural University (SAU), Southeast University (SEU), Hajee Mohammad Danesh Science and Technology University (HSTU), Noakhali Science

and Technology University (NSTU), and the University of Science and Technology Chittagong (USTC) exhibited growth rates of 18.14%, 23.90%, 32.66%, 38.59%, and 19.29%, respectively.

Patterns and Trends:

1. **Variability in Growth Rates:**

   The universities displayed growth rates ranging from 1% to 54%, indicating divergences in the evolution of research pursuits practiced by these educational institutions.

2. **High Growth Cluster:**

   Daffodil International University (DIU), Noakhali Science and Technology University (NSTU), Hajee Mohammad Danesh Science and Technology University (HSTU), North South University (NSU), and Jagannath University (JnU) exhibited outstanding growth rates of 53.03%, 38.59%, 32.66%, 32.59%, and 31.86%, respectively. This finding highlighted the institutions' rapid growth or successful strategic implementation of research initiatives.

3. **Consistent Growth:**

   Khulna University (KU), Southeast University (SEU), United International University (UIU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Chittagong University of Engineering and Technology (CUET), Rajshahi University of Engineering and Technology (RUET), University of Chittagong (CU), Jahangirnagar University (JU), American International University-Bangladesh (AIUB), University of Science and Technology Chittagong, Ahsanullah University of Science and Technology (AUST), Dhaka University of Engineering and Technology, Gazipur (DUET), Bangladesh Agricultural University (BAU, University of Dhaka (DU) exhibited more than 20% growth rate. This trend highlighted the continuous efforts the universities employed to ensure research outputs.

4. **Below Average Growth:**

   Stamford University Bangladesh (SU) and Bangabandhu Sheikh Mujib Medical University (BSMMU) exhibited below-average growth rates of 1.30% and 5.74%, respectively. This finding highlighted insufficient research activities in these institutions.

5. **Clustering of Growth Rates:**

   The University of Dhaka (DU), Shahjalal University of Science and Technology (SUST), Jahangirnagar University (JU), and Rajshahi University of Engineering and Technology (RUET) displayed similar growth rates ranging from 20-22%. This observation indicated common characteristics of research endeavors in these universities.

6. **Engineering and Technology Focus:**

   Bangladesh University of Engineering and Technology BUET, Khulna University of Engineering and Technology KUET, Chittagong University of Engineering and Technology CUET and Ahsanullah University of Science and Technology AUST demonstrated growth rates ranging from 15.87% to 22.29%, indicating growing demand for technical education.

7. **Geographical Distribution:**

   The geographical distribution of growth rates varied, spreading over regional areas such as Dhaka, Chittagong, Rajshahi, Khulna, Gazipur, etc. This finding highlighted extensive research movement across the nation.

8. **Role of Private Universities:**

   North South University (NSU), BRAC University (BRACU), and Daffodil International University (DIU) exhibited outstanding growth rates, indicating a strong commitment by private universities to research production.

9. **Consideration of Outliers:**

   Daffodil International University (DIU) displayed an exceptionally high growth rate of 53.03%. This observation highlighted the institute's advanced strategies and initiatives to escalate research production.

10. **Potential Areas for Further Research:**

    A further investigation may reveal a more philosophical sense of patterns and trends in growth rates. Analyzing academic programs, research initiatives, faculty development, and research strategies may extract a deeper understanding of factors contributing to growth rates.

4.7.3: Impact of collaboration on annual growth rate in Disciplines

The disciplines of selected universities exhibited the impact of collaboration on annual growth rates. This study revealed the prevalence of collaboration in publishing research outputs by collaborative authorship.

Table 4.7.3: Impact of collaboration on annual growth rate in Disciplines

Discipline	**Total Document**	**Single Author Document**	**Collaborative Author Document**	**Percentage single-authored Documents (%)**	**Percentage Collaborative Documents (%)**	**Annual Growth Rate (%)**	**Annual Growth Rate for Single Author Documents (%)**	**Annual Growth Rate for Collaborative Author Documents (%)**
Medicine	7642	192	7450	2.51%	97.49	29.16	0.73	28.43
Computer Science	15513	424	15089	2.73%	97.27	28.95	0.79	28.16
Engineering	15976	469	15507	2.94%	97.06	23.95	0.70	23.24
Social Sciences	4746	842	3904	17.74%	82.26	30.42	5.40	25.02
Environmental Science	5789	208	5581	3.59%	96.41	32.72	1.18	31.55
Biochemistry, Genetics and Molecular Biology	4732	81	4651	1.71%	98.29	25.37	0.43	24.93
Physics and Astronomy	7666	223	7443	2.91%	97.09	23.12	0.67	22.45
Agricultural and Biological Sciences	6290	102	6188	1.62%	98.38	19.00	0.31	18.69
Materials Science	5152	162	4990	3.14%	96.86	22.88	0.72	22.16
Chemistry	3354	35	3319	1.04%	98.96	27.56	3.26	27.28

Table 4.7.3 Continued

Discipline	Total Document	Single Author Document	Collaborative Author Document	Percentage single-authored Documents (%)	Percentage Collaborative Documents (%)	Annual Growth Rate (%)	Annual Growth Rate for Single Author Documents (%)	Annual Growth Rate for Collaborative Author Documents (%)
Pharmacology, Toxicology and Pharmaceutics	2513	46	2467	1.83%	98.17	11.75	1.60	11.53
Mathematics	4043	142	3901	3.51%	96.49	29.65	0.27	28.60
Business, Management and Accounting	2102	258	1844	12.27%	87.73	28.99	0.49	25.43
Chemical Engineering	2303	50	2253	2.17%	97.83	21.42	0.52	20.95
Earth and Planetary Sciences	1994	93	1901	4.66%	95.34	27.03	0.04	25.77
Economics, Econometrics and Finance	1438	212	1226	14.74%	85.26	24.66	0.02	21.02
Energy	4264	150	4114	3.52%	96.48	28.05	0.70	27.07
Immunology and Microbiology	1553	17	1536	1.09%	98.91	29.91	0.49	29.58
Multidisciplinary	1513	16	1497	1.06%	98.94	26.35	0.43	26.07
Decision Sciences	2003	61	1942	3.05%	96.95	45.80	0.27	44.41
Arts and Humanities	699	215	484	30.76%	69.24	10.61	1.18	31.55
Psychology	491	40	451	8.15%	91.85	19.67	1.60	27.28
Nursing	410	12	398	2.93%	97.07	9.26	0.72	22.16
Neuroscience	421	7	414	1.66%	98.34	29.74	3.26	28.60
Health Professions	218	7	211	3.21%	96.79	16.34	1.60	11.53
Veterinary	608	3	605	0.49%	99.51	8.62	1.18	29.58
Dentistry	26	1	25	3.85%	96.15	0.45	0.49	25.43

The data indicated that Medicine, Computer Science, and Engineering earned outstanding annual growth rates due to their substantial collaborative endeavors. For example, Medicine produced 97.49% collaborative outputs of its total document production while producing only 2.51% single-authored documents. However, Medicine earned a 29.16% growth rate for this remarkable collaborative output. Computer Science and Engineering followed similar trends of higher growth rates reinforced by collaboration.

On the other hand, Social Sciences, Environmental Science, and Mathematics displayed higher annual growth rates, which emerged mainly from collaborative efforts. For instance, Social Sciences generated 82.26% collaborative documents among total outputs, impacting 30.42% yearly growth rates. Environmental Science and Mathematics exhibited similar patterns and trends, representing a substantial influence of collaboration to espouse increasing annual growth.

Physics and Astronomy, Agricultural and Biological Sciences, and Materials Science exhibited over 95% collaborative outputs, contributing to more than 18% of annual growth rates. Chemistry and Neuroscience, on the other hand, displayed higher annual growth rates for single-author documents compared to other disciplines. However, the percentage of collaborative–authored documents was predominant in these disciplines.

In summary, collaboration influenced the annual growth rates of research outputs, encouraged interdisciplinary research, and drove a more substantial research impact and vigorous progress of the intellectual movement in each discipline.

4.7.4: Impact of collaboration on annual growth rate in Universities

The differences between the growth rates of single-authored and collaborative-authored documents across various institutions indicated the impact of collaboration on the annual growth rate of publications.

Table 4.7.4: Impact of collaboration on annual growth rate in universities

Universities	**Total Document**	**Single Author Document**	**Collaborative Author Document**	**Percentage of Single-authored Documents (%)**	**Percentage of Collaborative-authored (%)**	**Annual Growth Rate (%)**	**Annual Growth Rate for Single Author Documents (%)**	**Annual Growth Rate for Collaborative Author Documents (%)**
University of Dhaka (DU)	12018	750	11268	6.24	93.76	20.15	1.26	18.90
University of Rajshahi (RU)	7161	304	6857	4.25	95.75	18.39	0.78	17.60
Bangladesh Agricultural University (BAU)	4331	45	4286	1.04	98.96	29.25	0.30	28.95
Bangladesh University of Engineering and Technology (BUET)	11903	349	11554	2.93	97.07	15.87	0.46	15.41
University of Chittagong (CU)	3541	298	3243	8.41	91.59	22.03	1.85	20.18
Jahangirnagar University (JU)	5221	207	5014	3.97	96.03	21.71	0.86	20.85
Shahjalal University of Science and Technology (SUST)	3622	139	3483	3.84	96.16	20.14	0.77	19.36
Khulna University (KU)	3557	96	3461	2.70	97.30	25.31	0.68	24.63
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1689	45	1644	2.67	97.33	5.74	0.15	5.58
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	1507	23	1484	1.53	98.47	21.54	0.33	21.21
Patuakhali Science and Technology University (PSTU)	1396	17	1379	1.22	98.78	29.67	0.36	29.31
Khulna University of Engineering and Technology (KUET)	4769	95	4674	1.99	98.01	19.90	0.40	19.50
North South University (NSU)	4185	220	3965	5.26	94.74	32.59	1.71	30.88
Rajshahi University of Engineering and Technology (RUET)	3840	99	3741	2.58	97.42	21.42	0.55	20.86
BRAC University (BRACU)	3802	250	3552	6.57	93.43	29.04	1.91	27.13

Table 4.7.4 Continued

Universities	Total Document	Single Author Document	Collaborative Author Document	Percentage of Single-authored Documents (%)	Percentage of Collaborative-authored (%)	Annual Growth Rate (%)	Annual Growth Rate for Single Author Documents (%)	Annual Growth Rate for Collaborative Author Documents (%)
Chittagong University of Engineering and Technology (CUET)	3138	104	3034	3.31	96.69	22.29	0.74	21.56
East West University (EWU)	1731	140	1591	8.08	91.92	16.72	1.35	15.37
American International University-Bangladesh (AIUB)	3146	98	3048	3.11	96.89	21.10	0.66	20.45
United International University (UIU)	1496	55	1441	3.68	96.32	22.53	0.83	21.70
Ahsanullah University of Science and Technology (AUST)	2109	111	1998	5.27	94.73	19.88	1.05	18.84
University of Asia Pacific (UAP)	1348	53	1295	3.93	96.07	28.52	1.12	27.39
International Islamic University Chittagong (IIUC)	2238	118	2120	5.27	94.73	31.32	1.65	29.67
Daffodil International University (DIU)	3810	109	3701	2.86	97.14	53.03	1.52	51.51
Independent University, Bangladesh (IUB)	1451	68	1383	4.68	95.32	17.11	0.80	16.31
Dhaka University of Engineering and Technology, Gazipur (DUET)	1566	54	1512	3.45	96.55	20.64	0.71	19.93
Islamic University, Bangladesh (IU)	1013	31	982	3.06	96.94	18.07	0.55	17.51
Stamford University Bangladesh (SU)	494	34	460	6.88	93.12	1.30	0.09	1.21
Jagannath University (JnU)	1813	52	1761	2.87	97.13	31.86	0.91	30.94
Sher-e-Bangla Agricultural University (SAU)	1347	11	1336	0.82	99.18	18.14	0.15	17.99
Southeast University (SEU)	991	53	938	5.35	94.65	23.90	1.28	22.62
Hajee Mohammad Danesh Science and Technology University (HSTU)	1218	12	1206	0.98	99.02	32.66	0.32	32.34
Noakhali Science and Technology University (NSTU)	1508	10	1498	0.66	99.34	38.59	0.25	38.34
University of Science and Technology Chittagong (USTC)	500	18	482	3.60	96.40	19.29	0.69	18.59

The data revealed the following key observations and analyses:

1. **Higher Growth Rates with Collaboration:** The annual growth rate for collaborative-authored documents was substantially higher than single-authored documents among all universities, indicating that collaborative efforts drive overall publication growth.
2. **Universities with High Collaboration Percentage:**
    - **Bangladesh Agricultural University (BAU):** Bangladesh Agricultural University (BAU) possessed 98.96% collaborative authored documents among the total. The university exhibited an annual growth rate of 29.25%, with collaborative documents growing at 28.95% compared to just 0.30% for single-authored documents.
    - **Patuakhali Science and Technology University (PSTU):** Patuakhali Science and Technology University (PSTU) obtained 98.78% of collaborative documents, showing an overall growth rate of 29.67%. Here, collaborative documents grew at 29.31%, while single-authored documents produced at 0.36%.
3. **Impact of Low Single-Authored Document Percentage:**
    - **Hajee Mohammad Danesh Science and Technology University (HSTU):** Hajee Mohammad Danesh Science and Technology University (HSTU) displayed an annual growth rate of 32.66%, including a 32.34% collaborative documents growth rate and a 0.32% single-authored documents growth rate.
    - **Noakhali Science and Technology University (NSTU):** Noakhali Science and Technology University (NSTU) exhibited an annual growth rate of 38.59%, comprising a 38.34% collaborative documents growth rate and a 0.25% single-authored documents growth rate.
4. **Relative Contribution of Single-Authored Documents:**
    - **University of Dhaka (DU):** The University of Dhaka (DU) possessed 6.24% of single-authored documents, with a 20.15% overall growth rate. The growth rate for single-authored documents was 1.26%, while collaborative documents grew at 18.90%.
    - **University of Rajshahi (RU):** The University of Rajshahi (RU) produced 4.25% of single-authored documents, with an 18.39% overall growth rate. The growth rate

for single-authored documents was 0.78%, while collaborative documents grew at 17.60%.

5. **Universities with Lower Overall Growth Rates but Still High Collaboration:**
    - **Bangabandhu Sheikh Mujib Medical University (BSMMU):** Bangabandhu Sheikh Mujib Medical University (BSMMU) generated 97.33% collaborative documents, with a 5.74% total growth rate. The growth rate for collaborative documents was 5.58%, whereas single-authored documents grew at 0.15%.
    - **Stamford University Bangladesh (SU):** Stamford University Bangladesh (SU) produced 93.12% collaborative documents, with a 1.30% total growth rate. The growth rate for collaborative documents was 1.21%, whereas single-authored documents grew at 0.09%.

The analysis highlighted that collaboration enhanced the annual growth rate of university publications. Universities with a higher percentage of collaborative-authored documents demonstrated significantly higher growth rates, emphasizing the importance of collaborative research endeavors in research productivity and impact.

4.8 Average Citation per Document

The data on total documents were analyzed through the "Biblioshiny" tool. The average citation per document was retrieved through analysis and divided according to discipline and university.

4.8.1: Average Citation per Document in Disciplines

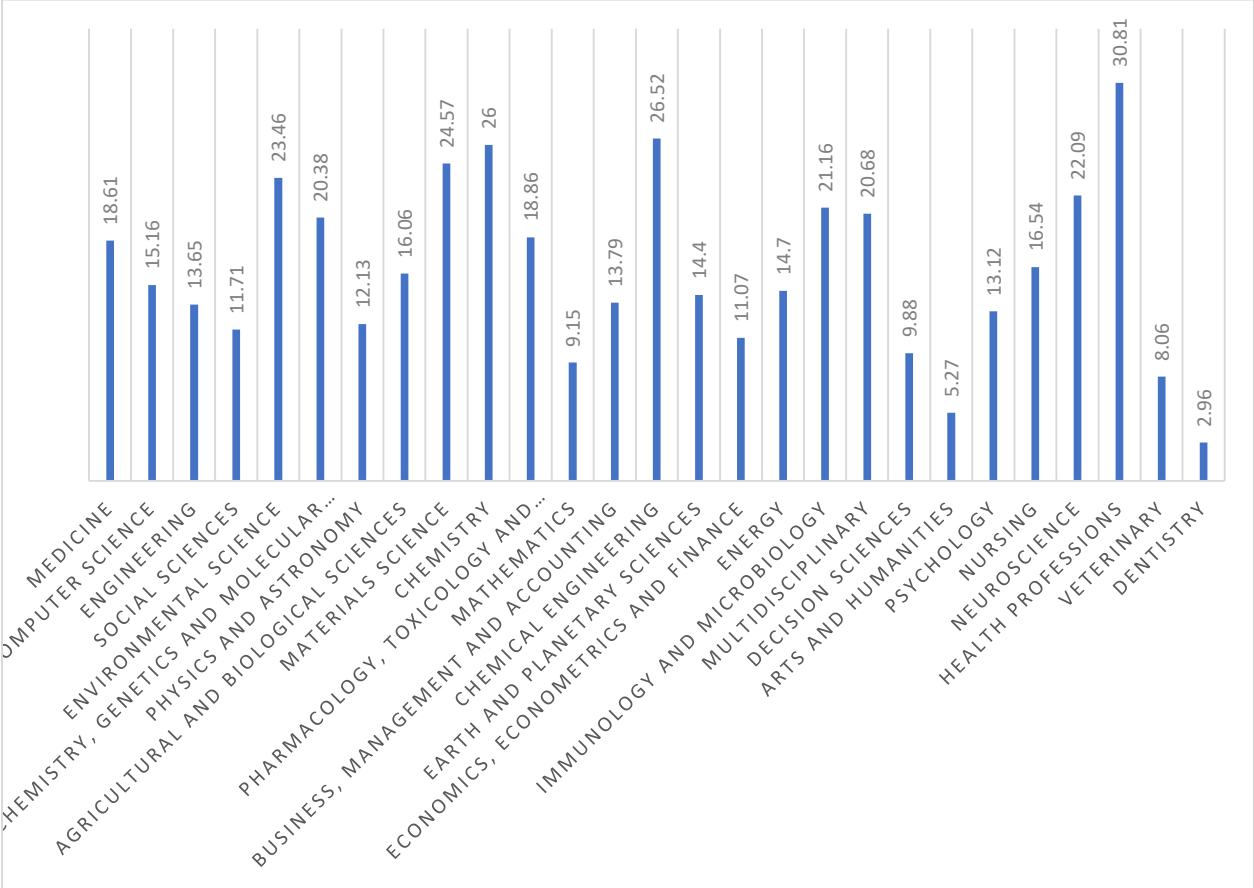
Table 4.8.1 was extracted from Appendix 6. It represented different disciplines on the left, while the average citation per document in each discipline from 2012 to 2021 on the right. These figures functioned as an illustration of research outputs and the level of research capability across various disciplines.

Table 4.8.1: Average Citation per Document in Disciplines

Disciplines	**Average Citation per Document**
Medicine	18.61
Computer Science	15.16
Engineering	13.65
Social Sciences	11.71
Environmental Science	23.46
Biochemistry, Genetics and Molecular Biology	20.38
Physics and Astronomy	12.13
Agricultural and Biological Sciences	16.06
Materials Science	24.57
Chemistry	26.00
Pharmacology, Toxicology and Pharmaceutics	18.86
Mathematics	9.15
Business, Management and Accounting	13.79
Chemical Engineering	26.52
Earth and Planetary Sciences	14.40
Economics, Econometrics and Finance	11.07
Energy	14.70
Immunology and Microbiology	21.16
Multidisciplinary	20.68
Decision Sciences	9.88
Arts and Humanities	5.27
Psychology	13.12
Nursing	16.54
Neuroscience	22.09
Health Professions	30.81
Veterinary	8.06
Dentistry	2.96

Figure 4.8.1.1 visually represented Table 4.8.1. It displayed the disciplines on the X-axis. The Y-axis indicated the Average Citation per Document in disciplines. This Figure demonstrated valuable insights into the extent and pattern of average citation of documents and the value of research outputs.

Figure 4.8.1.1: Average Citation per Document in Disciplines



Exploring the average citation per document in disciplines demonstrated notable insights into the impact and visibility of research. Medicine and Computer Science exhibited 18.61 and 15.16 average citations, respectively. Engineering and Social Sciences, on the other hand, displayed citation rates of 13.65 and 11.71, respectively.

Environmental Science showed 23.46 average citations, indicating the importance of ecological issues. Similarly, Biochemistry, Genetics, and Molecular Biology had a citation rate of 20.38, underscoring the relevance of research in these life sciences fields.

Materials Science and Chemistry were at the forefront of research, with citation rates of 24.57 and 26.00, respectively. The fields of Pharmacology, Toxicology, Pharmaceutics, Mathematics, and Business, Management, and Accounting exhibited citation rates of 18.86, 9.15, and 13.79, respectively. In contrast, with an average citation per document rate of 26.52, Chemical Engineering highlighted its critical contributions to industrial processes and advancements.

Earth and Planetary Sciences and Economics, Econometrics, and Finance presented citation rates of 14.40 and 11.07, respectively. On the other hand, Energy and Immunology and Microbiology had citation rates of 14.70 and 21.16, respectively.

Multidisciplinary research exhibited a citation rate of 20.68. In contrast, Arts and Humanities had a lower citation rate of 5.27. Psychology, Nursing, and Neuroscience demonstrated citation rates of 13.12, 16.54, and 22.09, respectively.

However, Health Professions had the highest average citation per document rate at 30.81, indicating the field's critical role in health care and its significant impact on practice and policy.

Veterinary and Dentistry have lower citation rates of 8.06 and 2.96, respectively. These rates may reflect the smaller research communities in these fields and their more focused research scope.

Patterns and Trends:

1. **High Citation Disciplines:**
   Health Professions, Chemistry, Materials Science, and Environmental Science were leaders in research impact, displaying the highest average citation counts. This trend highlighted the significant attention and acknowledgment these disciplines received within the scientific community, emphasizing their extensive contributions and significance.
2. **Science and Medicine Dominance:**
   The reputation of disciplines like Medicine, Biochemistry, Genetics and Molecular Biology, Immunology and Microbiology, and Neuroscience characterized the academic landscape for their substantial citations. The prevalence of biomedical and health-related research indicated

the popularity of these disciplines, underscoring the social and scientific impact of advancements in these fields.

3. **Engineering and Technology Impact:**
   Chemical Engineering, Materials Science, and Engineering distinguished themselves with high average citation counts. The substantial impact of advancement in technology and engineering research was revealed from this observation, highlighting the importance and growth of these fields.

4. **Low Citation Disciplines:**
   A minor impact of Dentistry, Arts and Humanities, and Decision Sciences was evidenced in the scholarly community by their lower average citation counts. This finding highlighted the limited attention paid to research endeavors in these domains or the existence of any specialization in research.

5. **Interdisciplinary Impact:**
   Multidisciplinary discipline exhibited a high average citation count, indicating an extensive impact of this field beyond disciplinary boundaries. This observation revealed the increasing value of interdisciplinary approaches in various academic fields.

6. **Variability in Mathematics and Economics:**
   Economics, Econometrics, and Finance demonstrated a moderate range of citation count. In contrast, Mathematics showed a comparatively lower count. This variance indicated the identical differences in research interest and citation methodologies within these disciplines.

7. **Social Sciences and Psychology:**
   Social Sciences, Psychology, Business, Management, and Accounting demonstrated similarity in citation counts. These disciplines exhibited comparatively lower impact on the scholastic domain.

8. **Specialized Disciplines:**
   Dentistry obtained the lowest average citation count, indicating a comparatively limited impact on the research domain. This finding highlighted the specialization and limited outreach within the scholarly community.

This analysis highlighted the impact of research outputs on disciplines through citation counts. However, impact analysis should include the scope of the field, research methodologies, and publication standards.

4.8.2: Average Citation per Document in Universities

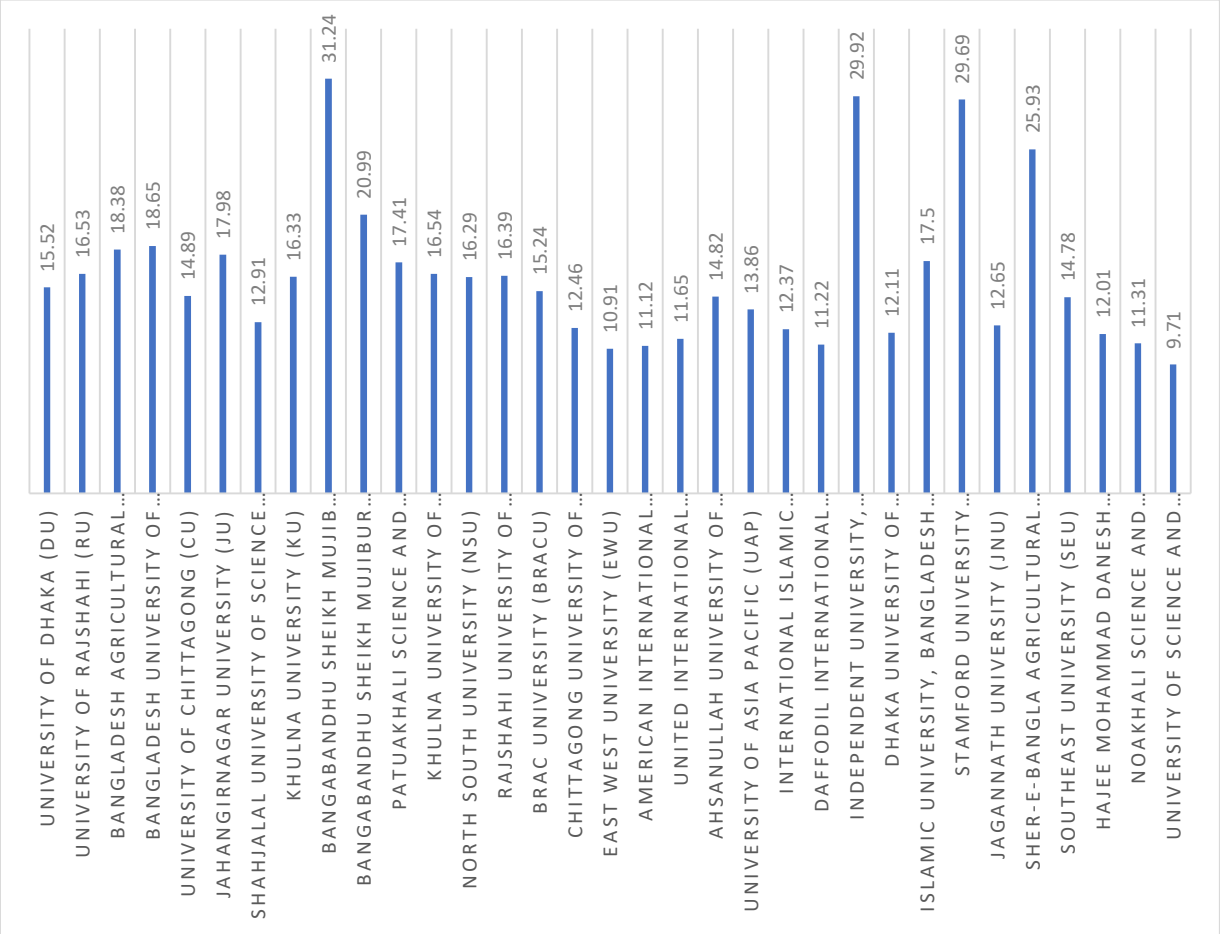
Table 4.8.2 was extracted from Appendix 6. It represented different universities on the left and each discipline's average citation per document from 2012 to 2021 on the right. These figures served as a representation of research outputs and the level of research expertise across various universities.

Table 4.8.2: Average Citation per Document in Universities

Universities	**Average Citation per Document**
University of Dhaka (DU)	15.52
University of Rajshahi (RU)	16.53
Bangladesh Agricultural University (BAU)	18.38
Bangladesh University of Engineering and Technology (BUET)	18.65
University of Chittagong (CU)	14.89
Jahangirnagar University (JU)	17.98
Shahjalal University of Science and Technology (SUST)	12.91
Khulna University (KU)	16.33
Bangabandhu Sheikh Mujib Medical University (BSMMU)	31.24
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	20.99
Patuakhali Science and Technology University (PSTU)	17.41
Khulna University of Engineering and Technology (KUET)	16.54
North South University (NSU)	16.29
Rajshahi University of Engineering and Technology (RUET)	16.39
BRAC University (BRACU)	15.24
Chittagong University of Engineering and Technology (CUET)	12.46
East West University (EWU)	10.91
American International University-Bangladesh (AIUB)	11.12
United International University (UIU)	11.65
Ahsanullah University of Science and Technology (AUST)	14.82
University of Asia Pacific (UAP)	13.86
International Islamic University Chittagong (IIUC)	12.37
Daffodil International University (DIU)	11.22
Independent University, Bangladesh (IUB)	29.92
Dhaka University of Engineering and Technology, Gazipur (DUET)	12.11
Islamic University, Bangladesh (IU)	17.50
Stamford University Bangladesh (SU)	29.69
Jagannath University (JnU)	12.65
Sher-e-Bangla Agricultural University (SAU)	25.93
Southeast University (SEU)	14.78
Hajee Mohammad Danesh Science and Technology University (HSTU)	12.01
Noakhali Science and Technology University (NSTU)	11.31
University of Science and Technology Chittagong (USTC)	9.71

Figure 4.8.3.1 visually represented Table 4.8.3. It exhibited the universities on the X-axis. The Y-axis specified the Average Citation per Document in universities. This Figure offered valuable insights into the extent and pattern of average citation of documents and the value of research outputs.

Figure 4.8.2.1: Average Citation per Document in Universities



The data revealed a wide range of divergences in citation metrics, indicating universities' varied intellectual effects and research output.

The University of Dhaka (DU) and the University of Rajshahi (RU) earned 15.52 and 16.53 average citations per document, respectively. The Bangladesh Agricultural University (BAU) displayed 18.38 average citations, indicating an outstanding impact.

The Bangladesh University of Engineering and Technology (BUET) exhibited a high average citation per document of 18.65, while The University of Chittagong (CU) and Jahangirnagar University (JU) displayed 14.89 and 17.98, respectively.

On the other hand, the Shahjalal University of Science and Technology (SUST) and Khulna University (KU) demonstrated 12.91 and 16.33 average citation counts, individually.

Bangabandhu Sheikh Mujib Medical University (BSMMU) and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) exhibited significant impact with remarkable citation rates of 31.24 and 20.99, respectively.

Conversely, Patuakhali Science and Technology University (PSTU), Khulna University of Engineering and Technology (KUET), and North South University (NSU) demonstrated 17.41, 16.54, and 16.29 average citations, individually.

Among the private universities, Independent University, Bangladesh (IUB) and Stamford University Bangladesh (SU) earned significant and similar average citations of 29.92 and 29.69, respectively.

The analysis indicated the varied levels of research impact of the several universities in Bangladesh, illustrating the diversity of the research impact.

Patterns and Trends

The average citation per document for the selected universities showed a distinct range of patterns and trends, representing the following insights into the impact of these institutions on research:

1. **High Citations:**

   Bangabandhu Sheikh Mujib Medical University (BSMMU), BRAC University (BRACU), Stamford University Bangladesh (SU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), and Sher-e-Bangla Agricultural University (SAU) exhibited significantly high average citations, underscoring their substantial impact and dominance on

respective research domains. However, Bangabandhu Sheikh Mujib Medical University (BSMMU) emphasized Medicine and health-related issues, and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Sher-e-Bangla Agricultural University (SAU) in Agriculture.

2. **Moderate Citations:**

   Bangladesh University of Engineering and Technology (BUET), Jahangirnagar University (JU), University of Rajshahi (RU), Khulna University of Engineering and Technology (KUET), and North South University (NSU) received moderate citations; however, their contribution and impact on research were substantial.

3. **Below Average Citations:**

   Some private universities, for instance, East West University (EWU), American International University Bangladesh (AIUB), United International University (UIU), and Ahsanullah University of Science and Technology (AUST) gained lower citations, demonstrating a comparatively limited research impact.

4. **High Variability Among Universities:**

   A remarkable disparity in citation rates was visible among universities, even in the same research area. For example, the health sector presented a wide range of variations in citation rates from 11.2 to 64.28 across different institutions.

5. **Specialized Focus:**

   The University of Science and Technology, Chittagong (USTC), received lower citation counts, emphasizing particular research areas or reduced scholastic production. In contrast, Daffodil International University (DIU) and Islamic University, Bangladesh (IU) gained a moderate citation count, representing a balanced research impact.

6. **Potential Growth:**

   The International Islamic University Chittagong IIUC, Hajee Mohammad Danesh Science and Technology University HSTU, and Noakhali Science and Technology University NSTU

exhibited lower citation counts, representing the possibility of growth and improved research impact.

7. **University-Specific Characteristics:**

   Universities set priorities advancing specific research domains. Some universities emphasized Medicine, while others focused on Computer Science or Engineering, signifying the diversity of research outputs' strengths in academia.

8. **Interdisciplinary Nature:**

   BRAC University distinguished itself for its interdisciplinary research outputs, highlighting its strong dedication to diversity in research.

9. **Outliers and Anomalies:**

   The disparities in citation rates within universities professed that significant outliers emerged from particular fields or institutions.

10. **Potential Research Impact:**

    Higher citation counts across various university disciplines indicated more extensive research contributions and values in the scholarly domains.

Citation count usually indicates the impact of research outputs. However, it included the university's size, various disciplines, and extensive research environment.

4.8.3 Impact of Collaboration on Citation in Disciplines

The comparative analysis of the average citations per document between single-author and collaborative-author documents underlined the impact of collaboration on citations across various disciplines.

Table 4.8.3: Impact of Collaboration on Citation in Disciplines

Discipline	**Total Document**	**Single Author Document**	**Collaborative Author Document**	**Percentage single-authored Documents (%)**	**Percentage Collaborative Documents (%)**	**Average Citation per Document**	**Average Citation per Single-Author Document**	**Average Citation per Collaborative-Author Document**
Medicine	7642	192	7450	2.51%	97.49	18.61	0.47	18.14
Computer Science	15513	424	15089	2.73%	97.27	15.16	0.41	14.75
Engineering	15976	469	15507	2.94%	97.06	13.65	0.40	13.25
Social Sciences	4746	842	3904	17.74%	82.26	11.71	2.08	9.63
Environmental Science	5789	208	5581	3.59%	96.41	23.46	0.84	22.62
Biochemistry, Genetics and Molecular Biology	4732	81	4651	1.71%	98.29	20.38	0.35	20.03
Physics and Astronomy	7666	223	7443	2.91%	97.09	12.13	0.35	11.78
Agricultural and Biological Sciences	6290	102	6188	1.62%	98.38	16.06	0.26	15.80
Materials Science	5152	162	4990	3.14%	96.86	24.57	0.77	23.80
Chemistry	3354	35	3319	1.04%	98.96	26.00	0.27	25.73
Pharmacology, Toxicology and Pharmaceutics	2513	46	2467	1.83%	98.17	18.86	0.22	18.51
Mathematics	4043	142	3901	3.51%	96.49	9.15	0.21	8.83
Business, Management and Accounting	2102	258	1844	12.27%	87.73	13.79	0.62	12.10
Chemical Engineering	2303	50	2253	2.17%	97.83	26.52	0.25	25.94

Table 4.8.3 Continued

Discipline	Total Document	Single Author Document	Collaborative Author Document	Percentage single-authored Documents (%)	Percentage Collaborative Documents (%)	Average Citation per Document	Average Citation per Single-Author Document	Average Citation per Collaborative-Author Document
Earth and Planetary Sciences	1994	93	1901	4.66%	95.34	14.40	0.55	13.73
Economics, Econometrics and Finance	1438	212	1226	14.74%	85.26	11.07	0.48	9.44
Energy	4264	150	4114	3.52%	96.48	14.70	0.52	14.18
Immunology and Microbiology	1553	17	1536	1.09%	98.91	21.16	0.37	20.93
Multidisciplinary	1513	16	1497	1.06%	98.94	20.68	0.35	20.46
Decision Sciences	2003	61	1942	3.05%	96.95	9.88	0.30	9.58
Arts and Humanities	699	215	484	30.76%	69.24	5.27	1.62	3.65
Psychology	491	40	451	8.15%	91.85	13.12	1.07	12.05
Nursing	410	12	398	2.93%	97.07	16.54	0.48	16.06
Neuroscience	421	7	414	1.66%	98.34	22.09	0.37	21.72
Health Professions	218	7	211	3.21%	96.79	30.81	0.99	29.82
Veterinary	608	3	605	0.49%	99.51	8.06	0.04	8.02
Dentistry	26	1	25	3.85%	96.15	2.96	0.11	2.85

Key Observations:

1. **Higher Citations for Collaborative Work:**
    - Collaborative-author documents obtained more citations than single-author documents in all disciplines.
    - In Medicine, for example, collaborative papers got 18.14 average citations compared to 0.47 for single-author papers.

2. **Discipline-Specific Trends:**
    - **Medicine:** Collaborative documents gathered 38.6 times more average citations than single-author documents.
    - **Computer Science:** Collaborative documents received 36 times more average citations than single-author documents.
    - **Social Sciences:** On average, collaborative papers received 4.63 times more citations than those written by a single author.
    - **Arts and Humanities:** Collaborative documents received more citations than single-authored documents, which is minor compared to sciences.
3. **Highest Citation Counts:**
    - **Health Professions:** Collaborative documents received the highest average citations (29.82) compared to single-author documents (0.99), a 30.12 times more average citations.
    - **Chemistry:** Collaborative documents gained an average of 25.73 citations compared to 0.27 for single-author, almost 95.3 times more.

Statistical Summary:

The following table illustrated the trends more clearly by calculating the percentage increase in citations using the formula:

Percentage Increase= (Avg. Citation per Collaborative Author Doc−Avg. Citation per Single-Author Doc/ Avg. Citation per Single-Author Doc) ×100

Table 4.8.3.1: Statistical Summary

Discipline	Avg. Citation per Single-Author Doc	Avg. Citation per Collaborative-Author Doc	% Increase in Citations (Single vs. Collaborative)
Medicine	0.47	18.14	3759.57
Computer Science	0.41	14.75	3497.56
Engineering	0.40	13.25	3212.50
Social Sciences	2.08	9.63	362.98
Environmental Science	0.84	22.62	2592.86
Biochemistry, Genetics and Molecular Biology	0.35	20.03	5622.86
Physics and Astronomy	0.35	11.78	3265.71
Agricultural and Biological Sciences	0.26	15.80	5976.92
Materials Science	0.77	23.80	2990.91
Chemistry	0.27	25.73	9429.63
Pharmacology, Toxicology and Pharmaceutics	0.22	18.51	8313.64
Mathematics	0.21	8.83	4104.76
Business, Management and Accounting	0.62	12.10	1851.61
Chemical Engineering	0.25	25.94	10276.00
Earth and Planetary Sciences	0.55	13.73	2396.36
Economics, Econometrics and Finance	0.48	9.44	1866.67
Energy	0.52	14.18	2626.92
Immunology and Microbiology	0.37	20.93	5556.76
Multidisciplinary	0.35	20.46	5745.71
Decision Sciences	0.30	9.58	3093.33
Arts and Humanities	1.62	3.65	125.31
Psychology	1.07	12.05	1026.17
Nursing	0.48	16.06	3245.83
Neuroscience	0.37	21.72	5770.27
Health Professions	0.99	29.82	2912.12
Veterinary	0.04	8.02	19950.00
Dentistry	0.11	2.85	2490.91

Conclusion:

This finding highlighted that the collaborative research generated higher citation rates in all disciplines. For example, Chemistry, Health Professions, and Veterinary earned higher citation rates from collaborative endeavors, indicating the importance of collaborative research for the impact of research outputs.

4.8.4 Impact of Collaboration on Citation in University

The impact of collaboration on citations across various Universities can be identified through a threadbare analysis of average citations per document between single-author and collaborative-author documents. The following table exhibited the impact by presenting the specific data.

Table 4.8.4 Impact of Collaboration on Citation in University

Universities	**Total Document**	**Single author document**	**Collaborative author document**	**Percentage of Single-authored documents (%)**	**Percentage of Collaborative-authored (%)**	**Average Citation per Document**	**Average Citations per Document for Single-authored Documents**	**Citations per Document for Collaborative-author**
University of Dhaka (DU)	12018	750	11268	6.24	93.76	15.52	0.97	14.55
University of Rajshahi (RU)	7161	304	6857	4.25	95.75	16.53	0.70	15.83
Bangladesh Agricultural University (BAU)	4331	45	4286	1.04	98.96	18.38	0.19	18.20
Bangladesh University of Engineering and Technology (BUET)	11903	349	11554	2.93	97.07	18.65	0.55	18.09
University of Chittagong (CU)	3541	298	3243	8.41	91.59	14.89	1.25	13.64
Jahangirnagar University (JU)	5221	207	5014	3.97	96.03	17.98	0.71	17.28
Shahjalal University of Science and Technology (SUST)	3622	139	3483	3.84	96.16	12.91	0.50	12.40
Khulna University (KU)	3557	96	3461	2.70	97.30	16.33	0.44	15.89
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1689	45	1644	2.67	97.33	31.24	0.83	30.40
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	1507	23	1484	1.53	98.47	20.99	0.32	20.65
Patuakhali Science and Technology University (PSTU)	1396	17	1379	1.22	98.78	17.41	0.21	17.21
Khulna University of Engineering and Technology (KUET)	4769	95	4674	1.99	98.01	16.54	0.33	16.22
North South University (NSU)	4185	220	3965	5.26	94.74	16.29	0.86	15.43

Table 4.8.4 Continued

Universities	Total Document	Single author document	Collaborative author document	Percentage of Single-authored documents (%)	Percentage of Collaborative-authored (%)	Average Citation per Document	Average Citations per Document for Single-authored Documents	Citations per Document for Collaborative-author
Rajshahi University of Engineering and Technology (RUET)	3840	99	3741	2.58	97.42	16.39	0.42	15.98
BRAC University (BRACU)	3802	250	3552	6.57	93.43	15.24	1.00	14.24
Chittagong University of Engineering and Technology (CUET)	3138	104	3034	3.31	96.69	12.46	0.41	12.05
East West University (EWU)	1731	140	1591	8.08	91.92	10.91	0.88	10.03
American International University-Bangladesh (AIUB)	3146	98	3048	3.11	96.89	11.12	0.35	10.79
United International University (UIU)	1496	55	1441	3.68	96.32	11.65	0.43	11.22
Ahsanullah University of Science and Technology (AUST)	2109	111	1998	5.27	94.73	14.82	0.78	14.03
University of Asia Pacific (UAP)	1348	53	1295	3.93	96.07	13.86	0.54	13.31
International Islamic University Chittagong (IIUC)	2238	118	2120	5.27	94.73	12.37	0.65	11.72
Daffodil International University (DIU)	3810	109	3701	2.86	97.14	11.22	0.32	10.90
Independent University, Bangladesh (IUB)	1451	68	1383	4.68	95.32	29.92	2.06	29.67
Dhaka University of Engineering and Technology, Gazipur (DUET)	1566	54	1512	3.45	96.55	12.11	0.35	11.47
Islamic University, Bangladesh (IU)	1013	31	982	3.06	96.94	17.50	0.14	17.32
Stamford University Bangladesh (SU)	494	34	460	6.88	93.12	29.69	1.59	29.51
Jagannath University (JnU)	1813	52	1761	2.87	97.13	12.65	0.12	12.21
Sher-e-Bangla Agricultural University (SAU)	1347	11	1336	0.82	99.18	25.93	0.17	24.12
Southeast University (SEU)	991	53	938	5.35	94.65	14.78	0.53	14.34
Hajee Mohammad Danesh Science and Technology University (HSTU)	1218	12	1206	0.98	99.02	12.01	0.41	11.89
Noakhali Science and Technology University (NSTU)	1508	10	1498	0.66	99.34	11.31	0.35	10.70
University of Science and Technology Chittagong (USTC)	500	18	482	3.60	96.40	9.71	0.67	9.60

Key Observations:

1. **Higher Citations for Collaborative Work:**
    - Universities received more citations from collaborative documents compared to single-authored documents.
    - An exemplary citation count was visible at Dhaka University (DU). The University received 14.55 citations for collaborative-authored documents and 0.97 for single-authored papers.
2. **University-Specific Trends:**
    - **University of Dhaka (DU):** The University of Dhaka (DU) acquired 15 times more citations from collaborative documents than single-author documents.
    - **University of Rajshahi (RU):** The University of Rajshahi (RU) achieved 22.5 times higher average citations from collaborative documents compared to single-authored documents.
    - **Bangladesh Agricultural University (BAU):** On average, Bangladesh Agricultural University (BAU) received 95.3 times more citations from collaborative documents than single-authored documents.
    - **BRAC University (BRACU):** BRAC University (BRACU) achieved 14.2 times more average citations from Collaborative documents compared to single-author documents.
3. **Highest Citation Counts:**
    - **Bangabandhu Sheikh Mujib Medical University (BSMMU):**

      Bangabandhu Sheikh Mujib Medical University (BSMMU) received 36.5 times more average citations from Collaborative documents (Average citation 30.40) than single-authored documents (Average citation 0.83).
    - **Independent University, Bangladesh (IUB):**

      Collaborative documents acquired 14.4 times more average citations compared to single-author documents in Independent University, Bangladesh (IUB). However, the

average citation for Collaborative documents was 29.67, and for single-author documents was 2.06.

- **Sher-e-Bangla Agricultural University (SAU):**

  The average citations for collaborative documents were 24.12 compared with 0.17 for individual authors, 141.0 times more.

Statistical Summary:

The following table explained the patterns more evidently by calculating the percentage increase in citations using the formula:

Percentage Increase= (Avg. Citation per Collaborative Author Doc−Avg. Citation per Single-Author Doc/ Avg. Citation per Single-Author Doc) ×100

Table 4.8.4.1: Statistical Summary

University	Avg. Citation per Single-Author Doc	Avg. Citation per Collaborative-Author Doc	% Increase in Citations (single vs. Collaborative)
University of Dhaka (DU)	0.97	14.55	1400
University of Rajshahi (RU)	0.70	15.83	2161.43
Bangladesh Agricultural University (BAU)	0.19	18.20	9478.95
Bangladesh University of Engineering and Technology (BUET)	0.55	18.09	3189.09
University of Chittagong (CU)	1.25	13.64	991.20
Jahangirnagar University (JU)	0.71	17.28	2333.80
Shahjalal University of Science and Technology (SUST)	0.50	12.40	2380
Khulna University (KU)	0.44	15.89	3511.36
Bangabandhu Sheikh Mujib Medical University (BSMMU)	0.83	30.40	3562.65
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	0.32	20.65	6353.13
Patuakhali Science and Technology University (PSTU)	0.21	17.21	8095.24
Khulna University of Engineering and Technology (KUET)	0.33	16.22	4815.15
North South University (NSU)	0.86	15.43	1694.19
Rajshahi University of Engineering and Technology (RUET)	0.42	15.98	3704.76
BRAC University (BRACU)	1.00	14.24	1324

Table 4.8.4.1 Continued

University	Avg. Citation per Single-Author Doc	Avg. Citation per Collaborative-Author Doc	% Increase in Citations (single vs. Collaborative)
Chittagong University of Engineering and Technology (CUET)	0.41	12.05	2839.02
East West University (EWU)	0.88	10.03	1039.77
American International University-Bangladesh (AIUB)	0.35	10.79	2982.86
United International University (UIU)	0.43	11.22	2509.30
Ahsanullah University of Science and Technology (AUST)	0.78	14.03	1698.72
University of Asia Pacific (UAP)	0.54	13.31	2364.82
International Islamic University Chittagong (IIUC)	0.65	11.72	1703.08
Daffodil International University (DIU)	0.32	10.90	3306.25
Independent University, Bangladesh (IUB)	2.06	29.67	1340.29
Dhaka University of Engineering and Technology, Gazipur (DUET)	0.35	11.47	3177.14
Islamic University, Bangladesh (IU)	0.14	17.32	12271.43
Stamford University Bangladesh (SU)	1.59	29.51	1755.98
Jagannath University (JnU)	0.12	12.21	10075
Sher-e-Bangla Agricultural University (SAU)	0.17	24.12	14088.24
Southeast University (SEU)	0.53	14.34	2605.66
Hajee Mohammad Danesh Science and Technology University (HSTU)	0.41	11.89	2800
Noakhali Science and Technology University (NSTU)	0.35	10.70	2957.14
University of Science and Technology Chittagong (USTC)	0.67	9.60	1332.84

Conclusion:

The data exhibited that collaborative research earned higher citation rates across all universities. This trend was visible predominantly in Bangladesh Agricultural University (BAU), Patuakhali Science and Technology University (PSTU), Sher-e-Bangla Agricultural University (SAU), and Islamic University, Bangladesh (IU), where collaborative work received more citations than single-author work. This finding indicated the importance of collaboration in enhancing the visibility and impact of academic research.

Chapter 5

Author Analysis and Findings

5.1 Total Author

The data on total documents were analyzed through the "Biblioshiny" tool. The total number of authors was retrieved through the analysis and divided according to discipline and university.

5.1.1: Authors in disciplines

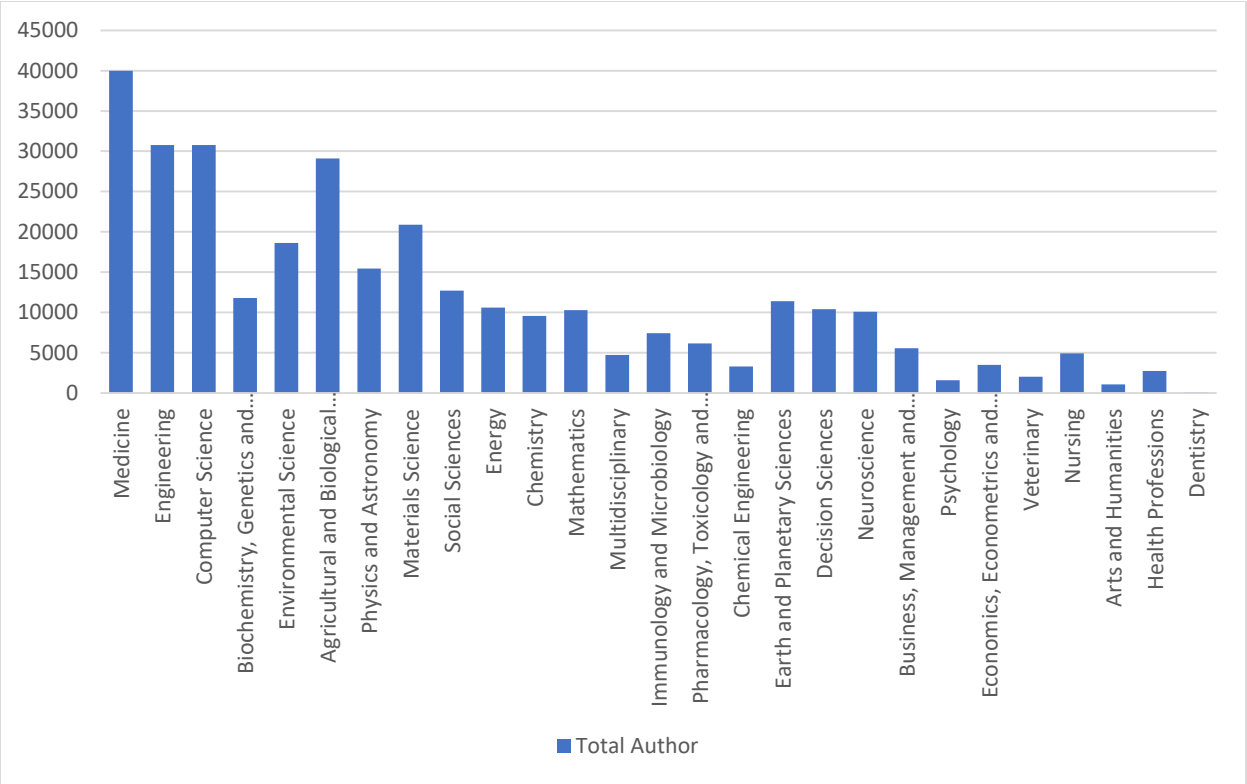
Table 5.1.1 was prepared from the Appendix 7. It showcased different disciplines on the left, while the total number of authors in each discipline from 2012 to 2021 on the right. These figures served as a representation of participant authors across various disciplines.

Table 5.1.1: Authors in disciplines

Disciplines	**Total no. of Authors**
Medicine	39993
Engineering	30760
Computer Science	30757
Biochemistry, Genetics and Molecular Biology	11789
Environmental Science	18637
Agricultural and Biological Sciences	29109
Physics and Astronomy	15430
Materials Science	20879
Social Sciences	12718
Energy	10596
Chemistry	9587
Mathematics	10281
Multidisciplinary	4711
Immunology and Microbiology	7406
Pharmacology, Toxicology and Pharmaceutics	6157
Chemical Engineering	3277
Earth and Planetary Sciences	11378
Decision Sciences	10402
Neuroscience	10088
Business, Management and Accounting	5567
Psychology	1603
Economics, Econometrics and Finance	3504
Veterinary	2015
Nursing	4911
Arts and Humanities	1054
Health Professions	2739
Dentistry	122

Figure 5.1.1.1 represented the disciplines on the X-axis while the number of authors in disciplines on the Y-axis.

Figure 5.1.1.1: authors in disciplines



Among the disciplines, Medicine ensured the highest participation, with 39993 authors, followed by Engineering (30757), Computer Science (30760), and Biochemistry, Genetics, and Molecular Biology (29109). Environmental Science (18637) and Agricultural and Biological Sciences (20879) also exhibited substantial authorship. Physics and Astronomy (15430) followed closely in terms of participation.

The field of Materials Science (12718) included noteworthy contributors from Social Sciences (11789), Energy (11378), Chemistry (10596), Mathematics (10281), and Multidisciplinary studies (10088).

Another tier of active participation was confirmed by Immunology and Microbiology (10402), Pharmacology, Toxicology, and Pharmaceutics (9587), and Chemical Engineering (7406).

Down the list, the number of authors was seen in Earth and Planetary Sciences (6157), Decision Sciences (5567), Neuroscience (4911), Business, Management, and Accounting (4711), Psychology (3504), and Economics, Econometrics, and Finance (3277).

On the other hand, disciplines like Veterinary, Nursing, Arts and Humanities, Health Professions, and Dentistry exhibited the lowest authorship counts, with 2739, 2015, 1,603, 1054, and 122, respectively. These statistics emphasized the variations in research participation across different academic areas.

Patterns and trends:

The data offered insights into the number of authors within diverse disciplines. Following patterns and trends can be identified based on this data.

1. **Medical Dominance:** Medicine involved the highest number of authors, highlighting its immense importance and popularity among researchers. The wide variety and diversity of medical subjects contributed to this participation.

2. **STEM Fields Leading:** Science, Technology, Engineering, and Mathematics **(**STEM) disciplines, including Engineering, Computer Science, Biochemistry, Genetics and Molecular Biology, Environmental Science, Agricultural and Biological Sciences, and Mathematics, displayed a significant number of authors that demonstrated the priority to research and innovation in these areas.

3. **Interdisciplinary Research:**
   Multidisciplinary exhibited remarkable authorship, highlighting a growing research interest in this discipline. As a nature, the discipline promoted interconnectedness and interdependence among various scientific fields.

4. **Environmental Focus:**
   A significant number of authors were enrolled in Environmental Science, representing the prominence of environmental issues such as climate change, pollution, and the necessity for sustainability etc.

5. **Energy Research:**
   A substantial number of authors were involved in Energy, highlighting the importance of burning issues regarding renewable Energy and environmental changes.

6. **Physics and Materials Science:**
   Physics and Astronomy, and Materials Science exhibited a noteworthy number of authors indicating the importance of these domains.

7. **Social Sciences Impact:** Social sciences did not receive the same degree of prominence as STEM fields, but they included many authors. This discovery emphasized the importance of exploring human behavior, societies, and cultures.

8. **Health Professions and Nursing:** Health-related disciplines exhibited a substantial number of authors, suggesting a continuous flow of research in these disciplines.

9. **Low Representation in Arts and Humanities:** The disciplines like Arts and Humanities, Dentistry, and Veterinary demonstrated a relatively lower number of authors. This observation indicated a shortage of active researchers in these fields or a comparatively lower volume of research output compared to other disciplines.

10. **Niche Fields:** Several specialized disciplines, including Decision Sciences, Neuroscience, Business, Management and Accounting, Psychology, Economics, Econometrics and Finance, drew the attention of a moderate number of authors. These fields represented specific areas of study within the wider academic domain.

These patterns highlighted valuable perceptions of the author's involvement in the current academic research landscape, thereby assisting in identifying areas of growth and significance across disciplines.

5.1.2 Authors in Universities

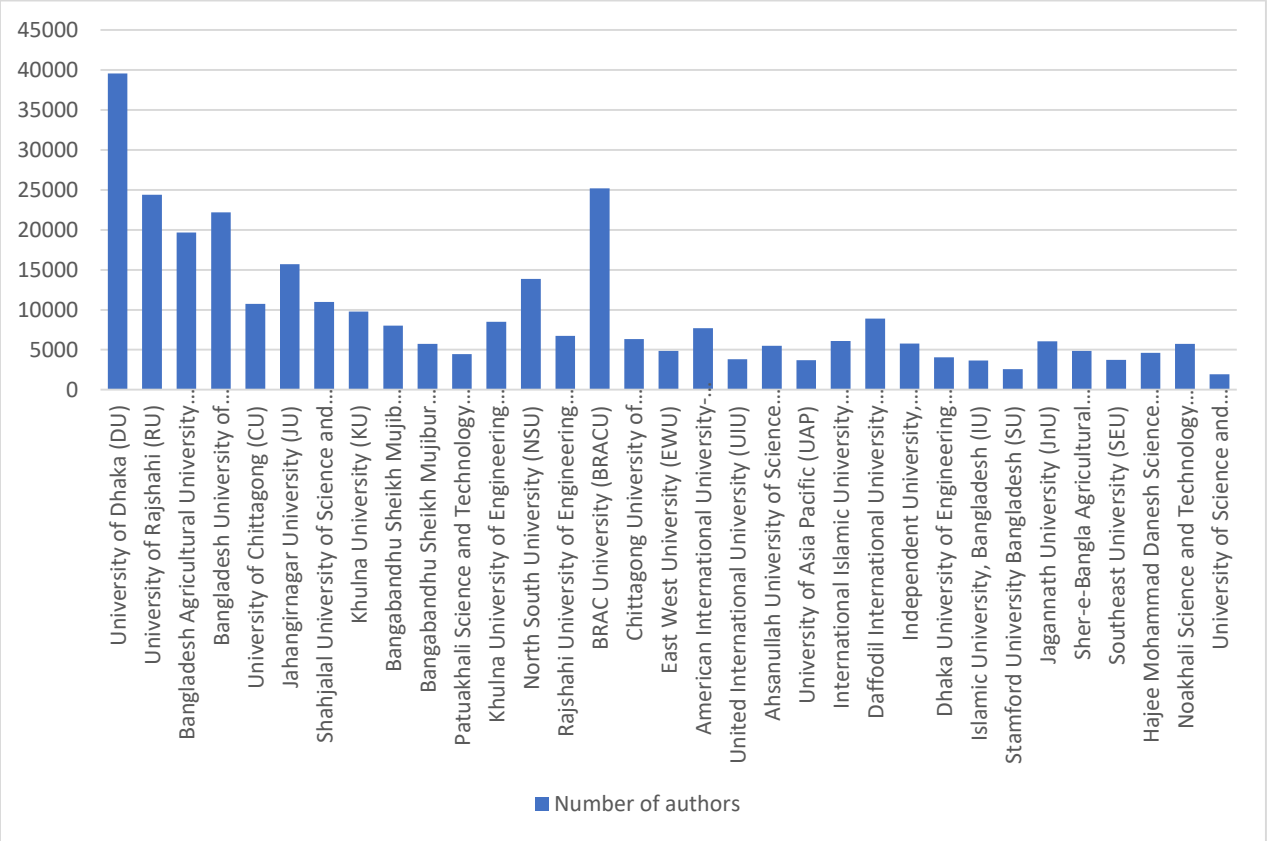
Table 5.1.2 was prepared from Appendix 7. It showcased the total number of authors by each university from 2012 to 2021.

Table 5.1.2: Authors in Universities

Universities	**Number of authors**
University of Dhaka (DU)	39557
University of Rajshahi (RU)	24386
Bangladesh Agricultural University (BAU)	19667
Bangladesh University of Engineering and Technology (BUET)	22184
University of Chittagong (CU)	10727
Jahangirnagar University (JU)	15686
Shahjalal University of Science and Technology (SUST)	10975
Khulna University (KU)	9775
Bangabandhu Sheikh Mujib Medical University (BSMMU)	8005
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	5752
Patuakhali Science and Technology University (PSTU)	4476
Khulna University of Engineering and Technology (KUET)	8514
North South University (NSU)	13871
Rajshahi University of Engineering and Technology (RUET)	6733
BRAC University (BRACU)	25197
Chittagong University of Engineering and Technology (CUET)	6346
East West University (EWU)	4839
American International University-Bangladesh (AIUB)	7718
United International University (UIU)	3827
Ahsanullah University of Science and Technology (AUST)	5500
University of Asia Pacific (UAP)	3697
International Islamic University Chittagong (IIUC)	6104
Daffodil International University (DIU)	8915
Independent University, Bangladesh (IUB)	5786
Dhaka University of Engineering and Technology, Gazipur (DUET)	4056
Islamic University, Bangladesh (IU)	3657
Stamford University Bangladesh (SU)	2588
Jagannath University (JnU)	6040
Sher-e-Bangla Agricultural University (SAU)	4844
Southeast University (SEU)	3736
Hajee Mohammad Danesh Science and Technology University (HSTU)	4615
Noakhali Science and Technology University (NSTU)	5753
University of Science and Technology Chittagong (USTC)	1944

Figure 5.1.2.1 visually represented the universities on the X-axis, and the Y-axis indicated the number of authors in universities.

Figure 5.1.2.1: Authors in Universities



The analysis of authors by universities revealed different levels of authorship, offering valuable information about the research involvement in institutions. University of Dhaka (DU) included 39,557 authors, closely followed by BRAC University (BRACU) with 25,197 authors. University of Rajshahi (RU), Bangladesh University of Engineering and Technology (BUET), and Bangladesh Agricultural University (BAU) also demonstrated substantial involvement, displaying 24386, 22184, and 19667 authors, respectively.

Jahangirnagar University (JU) possessed a prominent position in authorship involvement with 15,686 authors, following closely behind the North South University (NSU) and Shahjalal University of Science and Technology (SUST) retains 13,871 and 10,975 authors, respectively. On

the other hand, the University of Chittagong (CU) and Khulna University (KU) exhibited considerable authorship, with 10,727 and 9,775 authors, separately.

Daffodil International University (DIU) and Khulna University of Engineering and Technology (KUET) appeared as prominent academic institutions in their scholarly output, with a remarkable number of 8,915 and 8,514 authors, respectively. Similarly, Bangabandhu Sheikh Mujib Medical University (BSMMU) and American International University-Bangladesh (AIUB) made notable contributions by producing significant research and publications with 8,005 and 7,718 authors individually.

Rajshahi University of Engineering and Technology (RUET) and Chittagong University of Engineering and Technology (CUET) maintained a critical status in the lower range, with 6,733 and 6,346 authors, respectively. On the contrary, the International Islamic University Chittagong (IIUC) and Jagannath University (JnU) played a significant role by contributing 6,104 and 6,040 authors individually.

Independent University, Bangladesh (IUB) was a notable institution in the middle tier with 5,786 authors. Following closely behind, Noakhali Science and Technology University (NSTU) and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) each obtained 5,753 and 5,752 authors, individually.

Down the list, Ahsanullah University of Science and Technology (AUST) and Sher-e-Bangla Agricultural University (SAU) contributed to the research, with 5,500 and 4,844 authors, separately. Conversely, East West University (EWU) and Hajee Mohammad Danesh Science and Technology University (HSTU) demonstrated significant participation, respectively, with 4,839 and 4,615 authors.

At the bottom of the list, Patuakhali Science and Technology University (PSTU) and Dhaka University of Engineering and Technology (DUET) enrolled 4,476 and 4,056 authors, respectively followed by United International University (UIU) with 3,827, Southeast University (SEU) with 3,736 authors, University of Asia Pacific (UAP) with 3,697 authors, Islamic University, Bangladesh (IU) with 3,657 authors, Stamford University Bangladesh (SU) with 2,588 authors, and University of Science and Technology Chittagong (USTC) with the lowest count of 1,944 authors.

Patterns and Trends:

The breakdown of authors across universities in Bangladesh showed the following interesting patterns:

1. **High Contributor Universities:**

In the research output landscape of Bangladesh, the University of Dhaka (DU) emerged as the frontrunner, with an impressive count of 39,557 authors. BRAC University (BRACU) and the University of Rajshahi (RU) also significantly contributed to the scholarly community, with 25,197 and 24,386 authors, respectively. These institutions turned into toppers by these statistics.

2. **Engineering and Technology Focus:**

Bangladesh University of Engineering and Technology (BUET), Shahjalal University of Science and Technology (SUST), and Khulna University of Engineering and Technology (KUET) led the Engineering and technology research and ensured the highest participation in these domains.

3. **Medical Universities:**

Bangabandhu Sheikh Mujib Medical University (BSMMU) involved extreme participation in medical research. Its contributing authors ensured progress and innovation in advancing the research landscape.

4. **Private Universities:**

Private universities such as North South University (NSU), Daffodil International University (DIU), American International University-Bangladesh (AIUB), and Independent University, Bangladesh (IUB) exhibited remarkable authorship in their research outputs, indicating significant contributions of private universities in the academia.

5. **Agricultural Focus:**

A substantial number of authors were enrolled at Bangladesh Agricultural University (BAU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), and Sher-e-

Bangla Agricultural University (SAU). Their research made an impact on agricultural issues and promoted creativity.

6. Variety of Specializations:

The variety of specializations was evidenced in the universities' research outputs reflecting intellectual communities' inclusive nature. Universities exhibited an encouraging environment to ensure the participation of authors in collaborative efforts in Science and Technology, Engineering, Medicine and Agriculture etc..

7. Size of Universities vs. Research Participation:

Large populated universities such as the University of Dhaka, BRAC University, and the University of Rajshahi exhibited a higher number of authors, indicating a correlation between the population size of the institution and the research participation. Conversely, smaller universities such as Stamford University Bangladesh and the University of Science and Technology Chittagong proved the antithesis, suggesting that population size merely made an impact on participation in research.

8. Potential for Collaboration:

Some universities exhibited a limited number of authors in research production, indicating the potential to enhance research endeavors through collaboration, knowledge, and research sharing, leading to innovations and collective research effects.

These patterns and trends indicated the authorship formations of selected universities in Bangladesh. Usually, higher authorship highlighted the collaborative effects, whereas lower participation indicated individual research. However, authorship does not mean the quality of research. A more comprehensive study is required to identify the quality measures.

5.2 Single Authors

The data on total documents were analyzed through the “Biblioshiny” tool. The number of single authors was retrieved through the analysis, and results were divided according to discipline and university.

5.2.1: Single authors in disciplines

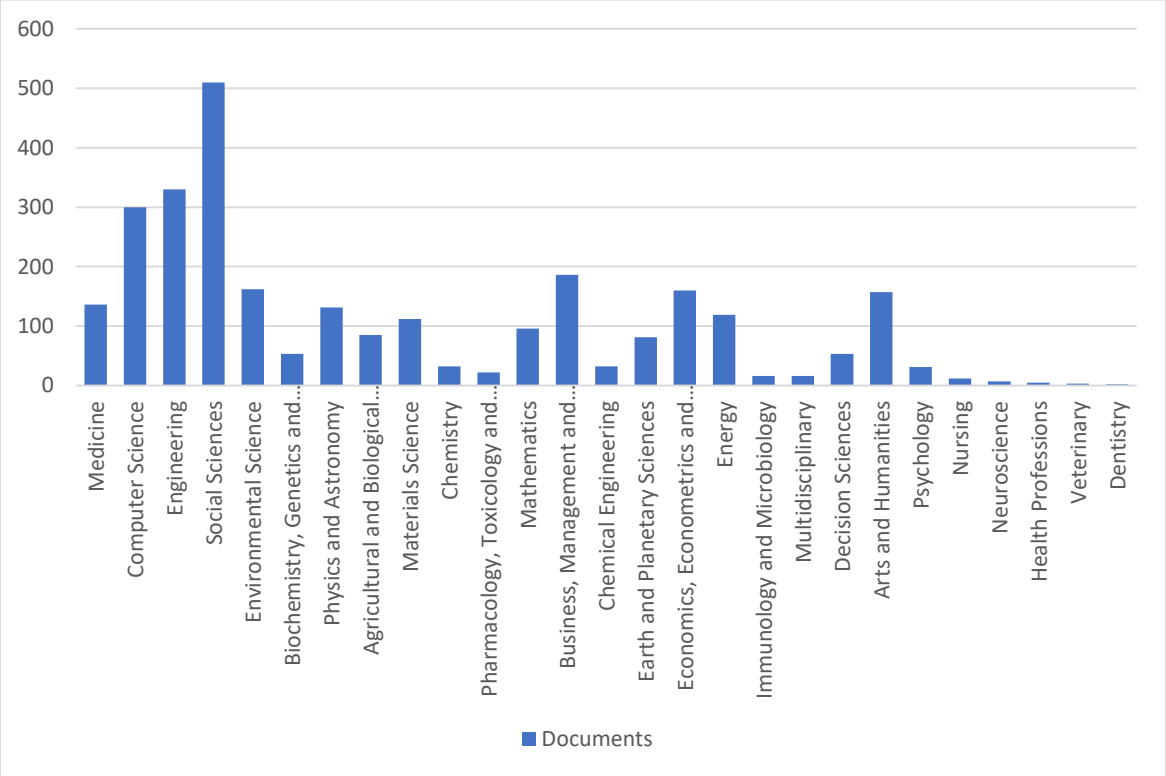
Table 5.2.1 was prepared from Appendix 8. It exhibited different disciplines on the left, while the number of single authors in each discipline from 2012 to 2021 on the right. These figures served as a representation of participant single authors across various disciplines.

Table 5.2.1: Single authors in disciplines

Disciplines	**Authors**
Medicine	136
Computer Science	300
Engineering	330
Social Sciences	510
Environmental Science	162
Biochemistry, Genetics and Molecular Biology	53
Physics and Astronomy	131
Agricultural and Biological Sciences	85
Materials Science	112
Chemistry	32
Pharmacology, Toxicology and Pharmaceutics	22
Mathematics	96
Business, Management and Accounting	186
Chemical Engineering	32
Earth and Planetary Sciences	81
Economics, Econometrics and Finance	160
Energy	119
Immunology and Microbiology	16
Multidisciplinary	16
Decision Sciences	53
Arts and Humanities	157
Psychology	31
Nursing	12
Neuroscience	7
Health Professions	5
Veterinary	3
Dentistry	2

Figure 5.2.1.1 visually represented Table 5.2.1. It denoted the disciplines on the X-axis. The Y-axis indicated the number of single authors in disciplines. Generally, a significant rise in the chart displayed the growth of participant authors, whereas a decline suggested a reduced number of authors. This chart offered valuable insights into the extent and pattern of authorship.

Figure 5.2.1.1: Single authors in disciplines



A thorough examination of disciplines revealed a remarkable distribution of individual authors across various disciplines.

Among the disciplines, Social Science took the lead, with an impressive count of 510 single authors, followed by Engineering with 330 authors, and Computer Science with 300 authors. On the other hand, Business, Management, and Accounting exhibited 186 single authors, trailed by Environmental Science with 162 authors and Economics, Econometrics, and Finance with 160 authors. Additionally, Arts and Humanities exhibited 157 single authors, Medicine 136, Physics and Astronomy 131, Energy 119, and Materials Science 112 single authors.

A significant number of (96) single authors was observed within mathematics. Agricultural and Biological Sciences followed by 85 single authors, while Earth and Planetary Sciences had 81 authors. Decision Sciences trailed behind with 53 single authors. Biochemistry, Genetics, and Molecular Biology recorded 53 single authors, whereas Chemical Engineering and Chemistry both had 32 single authors. Psychology was not far behind, with 31 single authors.

The fields of Pharmacology, Toxicology, and Pharmaceutics, as well as Immunology and Microbiology, Multidisciplinary fields, and Nursing, experienced a decline in the number of authors (22, 16, 16, and 12, respectively).

At the bottom, Neuroscience exhibited the number of single authors at 7, followed by Health Professions at 5, Veterinary at 3, and Dentistry at 2. This comprehensive breakdown highlighted the diverse landscape of solo authorship across various disciplines.

Patterns and trends:

Author distribution across different disciplines allowed the investigation of following patterns and trends.

1. **Disciplinary Trends:**

   Notably, disciplines often considered trendy demonstrated the highest examples of single authorship. Social Sciences led with 510 single authors, highlighting their substantial individual contributions. Closely followed by Engineering with 320 single authors, while Computer Science and Business, Management, and Accounting lagged behind with 300 and 186 single authors, respectively.

   This pattern remained consistent in different domains, as indicated by the number of individual authors in Economics, Econometrics and Finance 160, Arts and Humanities 157, Environmental Science 162, and Medicine 136.

2. **STEM Dominance:**

   STEM disciplines, including Engineering, Computer Science, Physics and Astronomy, Materials Science, Mathematics, Earth and Planetary Sciences, and Chemistry,

significantly contributed to the number of single authors indicating the importance of individual research output in these domains.

3. **Health and Medicine:**

   Health and medical disciplines included a range of fields, including Medicine, Pharmacology, Toxicology and Pharmaceutics, Nursing, Health Professions, and Dentistry. Among these disciplines, Medicine distinguished itself with a significant number of single authors; however, other disciplines produced a considerably lower number of single authors, indicating the popularity of collaborative efforts.

4. **Specialized Fields:**

   Compared to larger disciplines, Decision Sciences, Energy, and Neuroscience were more specialized or interdisciplinary, with fewer single authors, indicating low productivity or appeal of collaborative research.

5. **Low Representation:**

   Regarding authorship, Veterinary and Dentistry had the lowest number of single authors, indicating a relatively reduced amount of individual research output in these areas.

6. **Authorship comparison:** Interesting patterns emerged when examining the distribution of single authors in different fields. The total number of authors in Medicine was 39993, of which 136 were single authors. Similarly, within Computer Science, the total author count was 30760, of which only 300 were single.

   Engineering encompassed 330 single authors, with a total of 30757 authors. In social science, the overall number of authors is 11789, with 510 being single authors. Within the Environmental Science domain, there were 18637 authors, with only 162 single authors. The total number of authors in biochemistry, genetics, and molecular biology was 29109, with surprisingly only 53 single authors.

The results highlighted the amount of research conducted by individual authors in these areas, indicating the presence of personal research interests. The existence of single authorship in these fields inspired a deeper investigation into the factors contributing to this pattern and its potential impact on research endeavors.

5.2.2: Single authors in universities

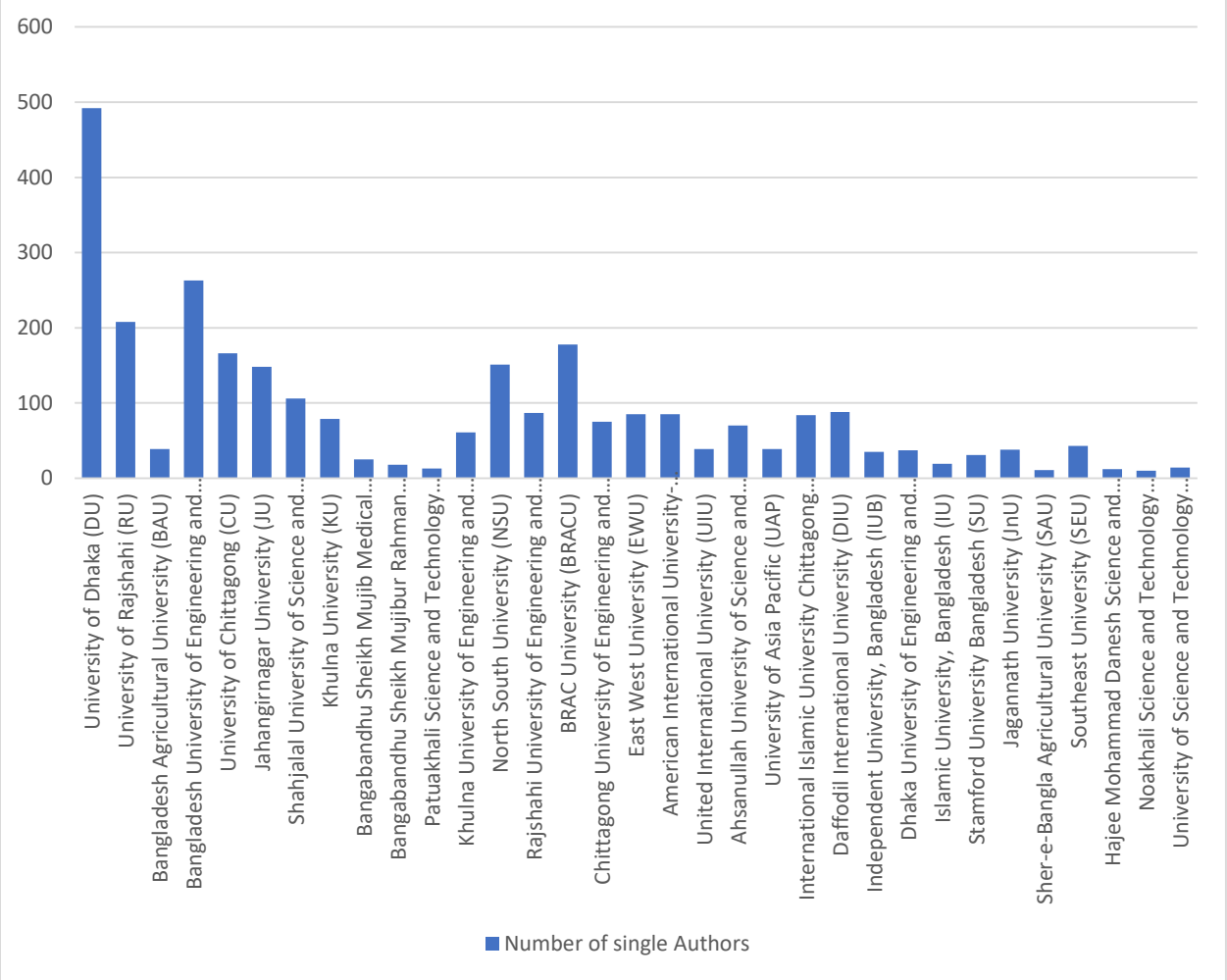
Table 5.2.2 was extracted from Appendix 8. It showcased different universities on the left, while the total number of single authors in each university from 2012 to 2021 on the right. These figures served as a representation of participant single authors across various universities.

Table 5.2.2: Single authors in universities

Universities	**Number of single Authors**
University of Dhaka (DU)	492
University of Rajshahi (RU)	208
Bangladesh Agricultural University (BAU)	39
Bangladesh University of Engineering and Technology (BUET)	263
University of Chittagong (CU)	166
Jahangirnagar University (JU)	148
Shahjalal University of Science and Technology (SUST)	106
Khulna University (KU)	79
Bangabandhu Sheikh Mujib Medical University (BSMMU)	25
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	18
Patuakhali Science and Technology University (PSTU)	13
Khulna University of Engineering and Technology (KUET)	61
North South University (NSU)	151
Rajshahi University of Engineering and Technology (RUET)	87
BRAC University (BRACU)	178
Chittagong University of Engineering and Technology (CUET)	75
East West University (EWU)	85
American International University-Bangladesh (AIUB)	85
United International University (UIU)	39
Ahsanullah University of Science and Technology (AUST)	70
University of Asia Pacific (UAP)	39
International Islamic University Chittagong (IIUC)	84
Daffodil International University (DIU)	88
Independent University, Bangladesh (IUB)	35
Dhaka University of Engineering and Technology (DUET)	37
Islamic University, Bangladesh (IU)	19
Stamford University Bangladesh (SU)	31
Jagannath University (JnU)	38
Sher-e-Bangla Agricultural University (SAU)	11
Southeast University (SEU)	43
Hajee Mohammad Danesh Science and Technology University (HSTU)	12
Noakhali Science and Technology University (NSTU)	10
University of Science and Technology Chittagong (USTC)	14

Figure 5.2.2.1 visually represented Table 5.2.2. It displayed the universities on the X-axis. The Y-axis indicated the number of single authors in universities.

Figure 5.2.2.1: Single authors in universities



A comprehensive study of universities revealed that the University of Dhaka distinguished itself with 492 single authors. The Bangladesh University of Engineering and Technology (BUET) followed by 263 authors, and the University of Rajshahi (RU) 208 authors. The BRAC University of Bangladesh (BRACU) and Chittagong University of Bangladesh (CU) exhibited 178 and 166 authors, respectively.

North South University (NSU) contributed significantly, with 151 authors, followed by Shahjalal University of Science and Technology (SUST), with 106 authors.

Daffodil International University (DIU) made a remarkable contribution with 88 authors, followed by Rajshahi University of Engineering and Technology (RUET) with 87 authors, East West University (EWU) and American International University-Bangladesh (AIUB) with 85 authors, International Islamic University Chittagong (IIUC) with 84 authors.

Down the list, Bangladesh Agricultural University (BAU), the United International University (UIU), and the University of Asia Pacific (UAP) exhibited 39 authors each. Jagannath University (JnU) followed with 38 authors, and Dhaka University of Engineering and Technology (DUET) with 37 authors.

Independent University, Bangladesh (IUB) contributed substantially with 35 authors, followed by Stamford University Bangladesh (SU) with 31 authors, and Bangabandhu Sheikh Mujib Medical University (BSMMU) with 25 authors.

Among the remaining universities, Islamic University, Bangladesh (IU) enrolled 19 authors; Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) 18 authors; University of Science and Technology Chittagong (USTC) 14 authors, Patuakhali Science and Technology University (PSTU) both 13 authors, Hajee Mohammad Danesh Science and Technology University (HSTU) 12 authors, Sher-e-Bangla Agricultural University (SAU) 11 authors, and Noakhali Science and Technology University (NSTU) 10 authors.

Trends and Patterns

1. **Top Universities by Number of Authors:**

   With an impressive count of 492 authors, the University of Dhaka (DU) led the individual research. Trailing this rank, the Bangladesh University of Engineering and Technology (BUET) and the University of Rajshahi (RU) secured second and third place with 263 and 208 single authors, respectively.

2. **Distribution of Authors:**

   A decline in the number of authors was evidenced by moving down from the top universities, with a substantial drop occurring after the first three institutions. Furthermore,

several universities exhibited a moderate number of authors, followed by a long tail of institutions with fewer authors.

3. **Mid-tier Universities:**

   A notable number of authors were observed within the mid-tier group consisting of BRAC University (BRACU), University of Chittagong (CU), and North South University (NSU).

4. **Emerging Universities:**

   Daffodil International University (DIU), Rajshahi University of Engineering and Technology (RUET), and East-West University (EWU) presented a significant number of single authors, demonstrating the prominence of individual research.

5. **Similar Author Numbers:**

   East West University (EWU), American International University-Bangladesh (AIUB) and, Bangladesh Agricultural University (BAU), United International University (UIU), University of Asia Pacific (UAP) enrolled a similar number of single authors, indicating the same extent of individual efforts in research production.

6. **Lower Author Numbers:**

   Some universities, such as the University of Science and Technology Chittagong (USTC), Patuakhali Science and Technology University (PSTU), Hajee Mohammad Danesh Science and Technology University (HSTU), Sher-e-Bangla Agricultural University (SAU), Noakhali Science and Technology University (NSTU), exhibited relatively lower single-author numbers.

7. **Specialized Universities:**

   Bangabandhu Sheikh Mujib Medical University (BSMMU) and Islamic University, Bangladesh (IU) were specialized institutions with fewer single authors, indicating their dedication to specific areas of study.

8. **Authorship proportion in universities:**

   The proportion of single authors in universities is significantly lower compared to the total number of authors. For instance, at the University of Dhaka (DU), there were a total of

39,557 authors, out of which only 492 were single. Similarly, the University of Rajshahi (RU) had 24,386 authors in total, with 208 single authors.

The Bangladesh Agricultural University (BAU) enrolled an impressive number of 19667 authors, of which 39 were single. In contrast, the Bangladesh University of Engineering and Technology (BUET) included 22,184 authors, with 263 single. The University of Chittagong (CU) encompassed 10,727 authors, with 166 single authors.

Jahangirnagar University (JU) recorded 15,686 authors, with 148 single authors. On the contrary, the Shahjalal University of Science and Technology (SUST) enlisted a significant number of 10,975 authors, of whom 106 were single.

Khulna University (KU) boasted an impressive count of 9,775 authors, of which 79 were single. Similarly, Bangabandhu Sheikh Mujib Medical University (BSMMU) possessed 8,005 authors, with 25 single authors.

The data highlighted the lack of singular research and indicated a strong emphasis on collaboration within these institutions, with most authors contributing to publications as part of a team rather than working individually.

9. **Correlation between Total Authors and Single Authors:**

The universities that produced the highest number of authors also exhibited a significant presence of single authors. For instance, the University of Dhaka (DU) distinguished itself with a total of 39,557 authors, out of which 492 were single. Similarly, BRAC University (BRACU) generated 25,197 authors, with 178 single authors.

The University of Rajshahi (RU) contributed 24,386 authors, of which 208 were single. The Bangladesh University of Engineering and Technology (BUET) had a remarkable total of 22,184 authors, of which 263 were single. Bangladesh Agricultural University (BAU) enrolled19667 authors, of which 39 were single. Jahangirnagar University (JU) documented 15,686 authors, with 492 single authors. The North South University (NSU) showcased 13,871 authors, with 151 single authors.

10. **Public vs. Private Universities:**

The proportions of single authors in private and public universities showed significant variations in their distribution. Private universities like BRAC University (BRACU) had 25,197 authors, of which 178 were single, and North South University (NSU) had 13,871 authors, with 151 single authors. On the other hand, Daffodil International University (DIU) had 8,915 authors, of which 88 were single.

Other notable examples included East West University (EWU), with 4,839 authors, counting 85 single authors, and American International University-Bangladesh (AIUB), with 7,718 authors, including 85 single authors.

Public universities, on the other hand, demonstrated distinct variations. The University of Dhaka (DU) distinguished itself by having 39,557 authors, of which 492 were single. Bangladesh University of Engineering and Technology (BUET) included 22,184 authors, with 263 being single; the University of Rajshahi (RU) enrolled 24,386 authors, including 208 single authors; Bangladesh Agricultural University (BAU) had 19667 total authors with only 39 single authors, and the University of Chittagong (CU) enrolled a total of 10,727 authors, of which 166 were single.

Similarly, Jahangirnagar University (JU) had 15,686 authors, with 148 being single. Shahjalal University of Science and Technology (SUST) and Rajshahi University of Engineering and Technology (RUET) also presented distinct figures, with 10,975 and 6,733 total authors, including 106 and 87 single authors, respectively. The data highlighted the significant disparities in the prevalence of single authors between private and public universities in Bangladesh.

12. **Engineering and Technological Universities:**

The information showed a notable trend in Engineering and Technological universities where single authorship is significant. For example, the Bangladesh University of Engineering and Technology (BUET) distinguished itself with 22,184 authors, of which 263 were single.

Shahjalal University of Science and Technology (SUST) possessed 10,975 authors, of which 106 were single. Rajshahi University of Engineering and Technology (RUET) mirrored this trend with 6,733 authors and 87 single authors.

Chittagong University of Engineering and Technology (CUET), Ahsanullah University of Science and Technology (AUST), and Khulna University of Engineering and Technology (KUET) enrolled 6346, 5500, and 8514 authors, of which 75, 70, and 61 single authors. These patterns indicated the prevalence of collaboration in Engineering and Technological Universities.

13. **Single Authors in Public Universities:**

The University of Dhaka (DU), the University of Rajshahi (RU), the University of Chittagong (CU), Jahangirnagar University (JU), and Khulna University (KU) enlisted 492, 208, 166, 148, and 79 single authors, respectively.

On the other hand, North South University (NSU), BRAC University (BRACU), East West University (EWU), American International University-Bangladesh (AIUB), United International University (UIU), Ahsanullah University of Science and Technology (AUST), University of Asia Pacific (UAP), International Islamic University Chittagong (IIUC), Daffodil International University (DIU) and Independent University, Bangladesh (IUB) signed up 151, 178, 85, 85, 39, 70, 39, 84, 88 and 35 single authors, respectively, indicated the less concentration of enlisting single authors in private universities.

These observations highlighted the single authorship patterns among universities, summarizing the correlation between the single authorship and collaboration. Proportionally, higher single authorship meant less production of collaborative outputs, whereas lower single authorship predicted more collaborative production.

5.3 Collaborative Authors

The data on total documents were analyzed through the "Biblioshiny" tool. The total number of authors and the number of single authors were retrieved through the analysis; later, Collaborative authors were calculated following the equation: *Collaborative Authors=Total Authors-Single Authors*. Finally, the results were divided according to discipline and university.

5.3.1: Collaborative authors in disciplines

Table 5.3.1 was extracted from Appendix 9. It showcased different disciplines on the left, while the total number of collaborative authors in each discipline from 2012 to 2021 on the right. These figures served as a representation of participant collaborative authors across various disciplines. A higher numerical value generally signified a greater emphasis on collaborative research within a particular discipline, whereas a lower value indicated a weaker focus on collaborative research.

Table 5.3.1: Collaborative authors in disciplines

Discipline	**Collaborative authors**
Medicine	39857
Computer Science	30460
Engineering	30427
Social Sciences	11279
Environmental Science	18475
Biochemistry, Genetics and Molecular Biology	29056
Physics and Astronomy	15299
Agricultural and Biological Sciences	20794
Materials Science	12606
Chemistry	10564
Pharmacology, Toxicology and Pharmaceutics	9565
Mathematics	10185
Business, Management and Accounting	4525
Chemical Engineering	7374
Earth and Planetary Sciences	6076
Economics, Econometrics and Finance	3117
Energy	11259
Immunology and Microbiology	10386
Multidisciplinary	10072
Decision Sciences	5514
Arts and Humanities	1446
Psychology	3473

Table 5.3.1 Continued

Discipline	Collaborative authors
Nursing	2003
Neuroscience	4904
Health Professions	1049
Veterinary	2736
Dentistry	120

Figure 5.3.1.1 visually represented Table 5.3.1. It denoted the disciplines on the X-axis. The Y-axis indicated the number of collaborative authors in disciplines. This figure offered valuable insights into the extent and pattern of authorship.

Figure 5.3. 1.1: Collaborative authors in disciplines

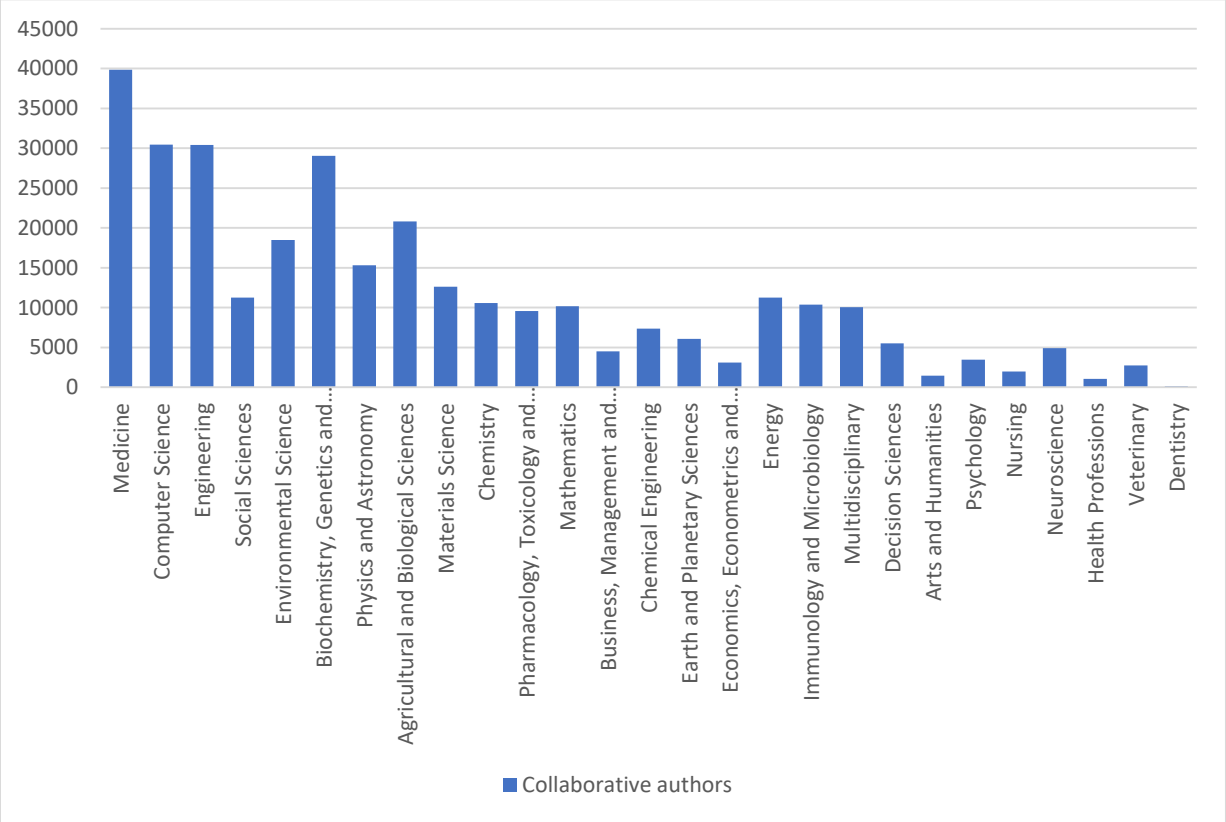


Table 5.3.1 signified the collaborative authors in various disciplines from 2012 to 2021 among 33 sample universities. Medicine led among the disciplines with an impressive count of 39857 collaborative authors, making it the highest number of contributors. Computer Science closely

followed with 30460 authors, while Engineering distinguished itself with 30427 authors. Biochemistry, Genetics, and Molecular Biology also exhibited a significant impact, with 29056 collaborative authors. Notable author counts were also observed in Agricultural and Biological Sciences with 20794; Environmental Science with 18475; Physics and Astronomy with 15299; Materials Science with 12606; Social Sciences with 11279; and Energy with 11,259.

However, a moderate number of collaborative authors was observed in fields such as Chemistry (10564), Mathematics (10185), Multidisciplinary studies (10072), Immunology and Microbiology (10386), and Pharmacology, Toxicology, and Pharmaceutics (9565).

A noteworthy number of collaborative authors included in different domains such as Chemical Engineering (7374), Earth and Planetary Sciences (6076), Decision Sciences (5514), Neuroscience (4904), and Business, Management, and Accounting (4525).

In contrast, a comparatively lower number of collaborative authors enrolled in Psychology (3473), Economics, Econometrics, and Finance (3117), Veterinary studies (2736), Nursing (2003), Arts and Humanities (1446), Health Professions (1049), and Dentistry (120).

Patterns and Trends:

The data illustrated the number of authors collaborating in various disciplines. Several patterns and trends were identified from this information.

1. **Overview of Collaboration in Various Disciplines:**

   A consistent trend emerged when analyzing the collaboration patterns among authors in various disciplines. It was evident that the disciplines with the highest number of authors also exhibited a significant inclination to collaborative efforts. Medicine, for example, enrolled an impressive number of 39993 authors, of which 39857 were collaborative. This trend was also observed in Engineering, Computer Science, Biochemistry, Genetics, Molecular Biology, Environmental Science, Agricultural and Biological Sciences, Physics and Astronomy. The collaborative dynamics within these fields emphasized the important role of partnership in advancing research.

2. **Collaboration in Health-Related Fields:**

   Collaboration in health-related fields, excluding Medicine, was typically restricted. However, Medicine distinguished itself with 39857 authors engaging in collaborative works, whereas other health-related disciplines like Neuroscience, Psychology, Veterinary, Nursing, Health Professions, and Dentistry exhibited a relatively lower number of collaborative authors. This finding highlighted the exceptional collaborative atmosphere within health-related disciplines.

3. **Thriving Collaboration in Trendsetting Fields:**

   The leading fields in current trends showed a growing collaboration, demonstrated by the extensive collaborative authorship across diverse disciplines, including Medicine, Engineering, Computer Science, Biochemistry, Genetics and Molecular Biology, Environmental Science, Agricultural and Biological Sciences, and Physics and Astronomy. This correlation suggested the significance of collaboration in advancing research in these innovative domains.

4. **The prominence of Computer Science:**

   Computer Science enlisted the third-highest number of collaborative authors, with a count of 30460. This statistic highlighted the predominance of a collaborative approach in the research and development activities within the computer science discipline.

5. **Biological and Environmental Sciences Collaboration:**

   Biochemistry, Genetics and Molecular Biology, and Agricultural and Biological Sciences showed substantial collaboration with 29056 and 20794 collaborative authors, respectively. This finding indicated a trend of interdisciplinary collaboration in biological and Agricultural research.

6. **Physical Sciences and Materials Science Collaboration:**

   Physics, Astronomy, and Materials Science collaborated with 15299 and 12606 collaborative authors, respectively. This finding emphasized the shared nature of research within these disciplines.

7. **Social Sciences Collaboration:**

   Social Sciences exhibited a collaborative nature in their research endeavors by enrolling 11279 collaborative authors. This observation indicated that collaboration became an integral part of research in Social Sciences.

8. **Emerging Trends in Energy Research:**

   The energy discipline demonstrated a high inclination toward collaboration by enlisting 11259 collaborative authors. This observation highlighted the impact of collaboration in advancing Energy research.

9. **Cross-disciplinary Collaboration:**

   The Multidisciplinary discipline engaged 10072 collaborative authors, indicating that a growing research trend emerged above traditional disciplinary boundaries.

10. **Health Professions and Dentistry with Lower Collaboration:**

    Health Professions and Dentistry exhibited comparatively lower collaboration by engaging 1049 and 120 collaborative authors, respectively. This finding highlighted these disciplines' distinct nature, indicating more individualized or specialized research.

11. **Low Collaboration in Arts and Humanities:**

    The Arts and Humanities discipline enlisted 1,446 collaborative authors, indicating a lower level of collaboration in this domain. This discovery specified a tendency towards individual or specialized contributions within this discipline.

The collaborative nature of research across different disciplines was revealed through these patterns and trends, highlighting varying levels of partnership in various fields.

5.3.2: Collaborative authors in universities

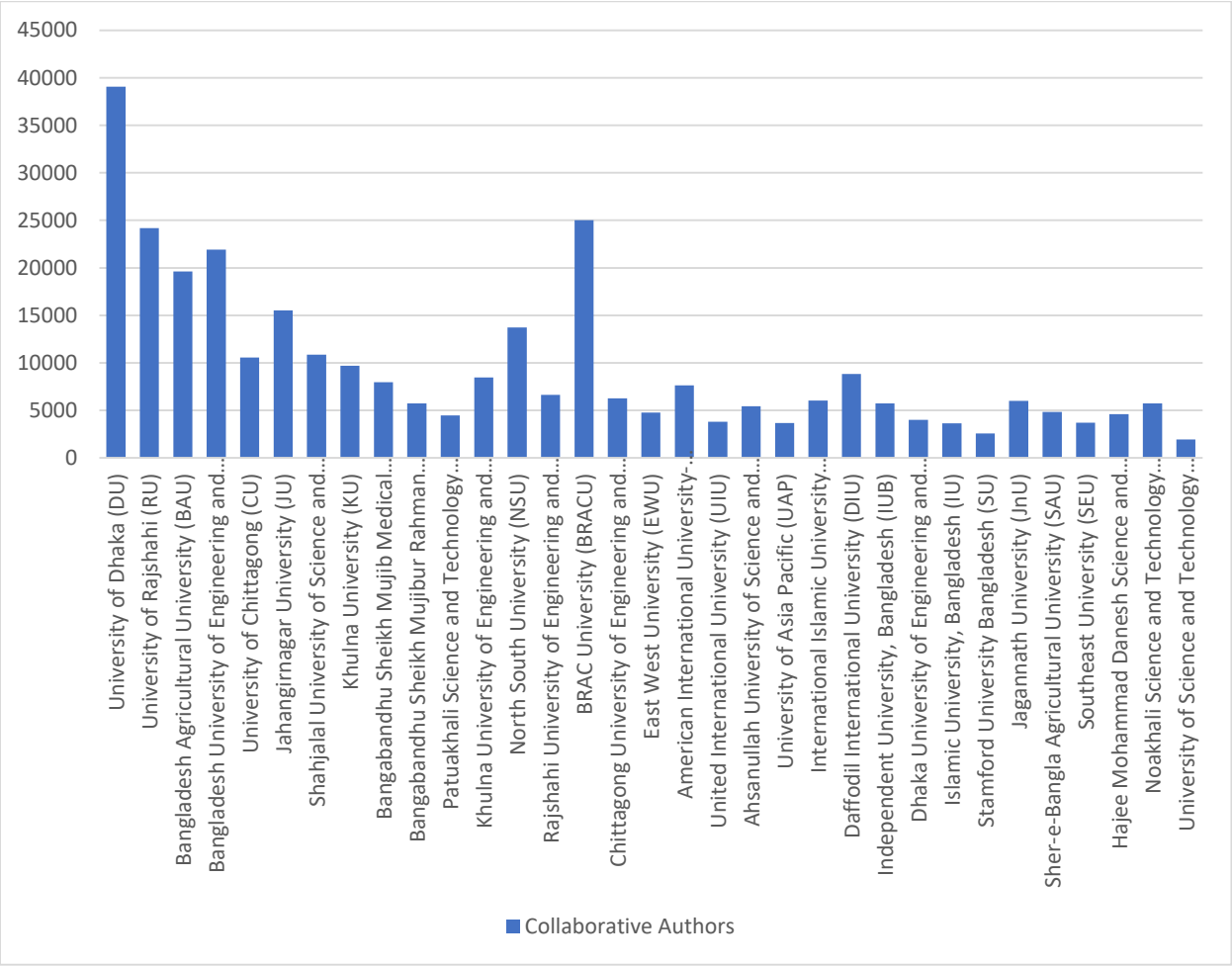
Table 5.3.2 was obtained from Appendix 9. It represented different universities on the left, while the total number of collaborative authors in each university from 2012 to 2021 on the right. These figures served as a representation of participant collaborative authors across universities.

Table 5.3.2: Collaborative authors in universities

Universities	**Collaborative Authors**
University of Dhaka (DU)	39065
University of Rajshahi (RU)	24178
Bangladesh Agricultural University (BAU)	19628
Bangladesh University of Engineering and Technology (BUET)	21921
University of Chittagong (CU)	10561
Jahangirnagar University (JU)	15538
Shahjalal University of Science and Technology (SUST)	10869
Khulna University (KU)	9696
Bangabandhu Sheikh Mujib Medical University (BSMMU)	7980
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	5734
Patuakhali Science and Technology University (PSTU)	4463
Khulna University of Engineering and Technology (KUET)	8453
North South University (NSU)	13720
Rajshahi University of Engineering and Technology (RUET)	6646
BRAC University (BRACU)	25019
Chittagong University of Engineering and Technology (CUET)	6271
East West University (EWU)	4754
American International University-Bangladesh (AIUB)	7633
United International University (UIU)	3789
Ahsanullah University of Science and Technology (AUST)	5430
University of Asia Pacific (UAP)	3658
International Islamic University Chittagong (IIUC)	6020
Daffodil International University (DIU)	8827
Independent University, Bangladesh (IUB)	5751
Dhaka University of Engineering and Technology (DUET)	4019
Islamic University, Bangladesh (IU)	3638
Stamford University Bangladesh (SU)	2557
Jagannath University (JnU)	6002
Sher-e-Bangla Agricultural University (SAU)	4833
Southeast University (SEU)	3693
Hajee Mohammad Danesh Science and Technology University (HSTU)	4603
Noakhali Science and Technology University (NSTU)	5743
University of Science and Technology Chittagong (USTC)	1930

Figure 5.3.2.1 visually represented Table 5.3.2. It displayed the universities on the X-axis. The Y-axis indicated the number of collaborative authors in universities. This figure offered valuable insights into the extent and pattern of authorship.

Figure 5.3.2.1: Collaborative authors in universities



Among universities, the University of Dhaka (DU) led in enrolling collaborative authors, with a remarkable count of 39,065. BRAC University (BRACU), followed by 25,019 authors. The University of Rajshahi (RU) secured the third position with 24,178 authors, while the Bangladesh University of Engineering and Technology (BUET) ranked fourth with 21,921 authors.

Down the list, Bangladesh Agricultural University (BAU), Jahangirnagar University (JU), North South University (NSU), Shahjalal University of Science and Technology (SUST), and the University of Chittagong (CU) enlisted 19628, 15,538, 13,720, 10,869 and 10,561 authors, respectively.

Further down the list, Khulna University (KU), Daffodil International University (DIU), Khulna University of Engineering and Technology (KUET), Bangabandhu Sheikh Mujib Medical University (BSMMU), and American International University-Bangladesh (AIUB) signed up 9696, 8827, 8453, 7980 and 7633 collaborative authors, respectively.

In the next tier, Rajshahi University of Engineering and Technology (RUET) exhibited 6646 authors; Chittagong University of Engineering and Technology (CUET) 6271 authors; International Islamic University Chittagong (IIUC) 6020 authors; Jagannath University (JnU), 6002 authors; and Independent University Bangladesh (IUB), 5751 authors.

Down the tier, Noakhali Science and Technology University (NSTU) represented 5743 authors, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) 5734 authors, and Ahsanullah University of Science and Technology (AUST) 5430 authors.

Further down the tier, Sher-e-Bangla Agricultural University (SAU) enlisted 4833 authors, and East-West University (EWU) 4754 authors. Hajee Mohammad Danesh Science and Technology University (HSTU) followed closely with 4603 collaborative authors, Patuakhali Science and Technology University (PSTU) with 4463 authors, and Dhaka University of Engineering and Technology (DUET) with 4019 authors.

The United International University (UIU) ranked at the bottom of the list with 3789 collaborative authors, Southeast University (SEU) followed with 3693 authors, the University of Asia Pacific (UAP) with 3658 authors, the Islamic University, Bangladesh (IU) with 3638 authors, Stamford University Bangladesh (SU) with 2557 authors, and the University of Science and Technology Chittagong (USTC) with 1930 authors.

Trends and Patterns:

The following patterns and trends were identified by analyzing the data on universities and collaborative authors:

1. **University Participation:**
   The University of Dhaka (DU) distinguished itself with the highest number of collaborative authors, highlighting its prominent role in academic collaboration. BRAC University

(BRACU) and the University of Rajshahi (RU) closely trailed behind, demonstrating their substantial involvement.

2. **Medical and Agricultural Universities:**
   Bangabandhu Sheikh Mujib Medical University (BSMMU) and Bangladesh Agricultural University (BAU) were notable institutions that firmly focused on collaboration.

3. **Medium-Sized Universities:**
   Falling in the mid-range, universities such as Jahangirnagar University (JU), Shahjalal University of Science and Technology (SUST), and Khulna University (KU) enrolled a moderate number of collaborative authors.

4. **Emerging Players:**
   Daffodil International University (DIU), International Islamic University Chittagong (IIUC), and United International University (UIU) exhibited themselves as emerging players in the academic collaboration landscape, as evidenced by the significant number of collaborative authors associated with these universities.

5. **Specialized Agricultural Universities:**
   Bangladesh Agricultural University (BAU), Sher-e-Bangla Agricultural University (SAU), and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) were the specialized agricultural universities that actively participated in collaborative research endeavors.

6. **Geographical Distribution:**
   The geographical distribution of collaborative authorship indicated a widespread involvement of authors in collaboration throughout the nation.

7. **Variability in Sizes:**
   A significant variation was observed in the universities' collaborative authors, indicating diversity in research outputs, collaboration networks, and academic focus.

8. **Collaborative Landscape in Private Universities in Bangladesh:**

   Private universities exhibited a substantial number of collaborative authors, indicating the prominence of collaborative authorship in this area. For instance, BRAC University led the enlistment of collaborative authors with an impressive count of 25,019. Following this trend, North South University, Daffodil International University, American International University-Bangladesh, and International Islamic University Chittagong enrolled a substantial number of authors, indicating a dynamic culture of collaboration within private academic institutions in the country.

9. **Collaboration Levels Among Universities:**

   Higher levels of collaboration in some universities indicated the diversity in the extent of collaboration. For example, Sher-e-Bangla Agricultural University, East West University, Hajee Mohammad Danesh Science and Technology University, and Patuakhali Science and Technology University exhibited a comparatively higher number of shared authorships, indicating an elevated level of collaboration than others.

10. **University Authorship Dynamics:**

    The popularity of research collaboration was evidenced in universities compared to individual efforts in research outputs. For instance, the University of Dhaka, Bangladesh University of Engineering and Technology, University of Rajshahi, BRAC University, University of Chittagong, North South University, Jahangirnagar University, and Shahjalal University of Science and Technology led the enrollment of collaborative authorship, highlighting the emphasis on collaboration within academia.

11. **The Prominence of Collaboration in Engineering and Technological Universities:**

    Engineering and Technological universities such as Bangladesh University of Engineering and Technology, Khulna University of Engineering and Technology, Rajshahi University of Engineering and Technology, Chittagong University of Engineering and Technology, Noakhali Science and Technology University, and Ahsanullah University of Science and

Technology demonstrated the dominance of collaborative authorships, indicating the importance of collaboration in shaping the research landscape of these domains.

In conclusion, the patterns and trends highlighted the dominance, diversity, and distribution of collaborative authorships, indicating a robust drive toward research collaboration.

5.4 Comparative analysis of authors

The data on total documents were analyzed through the "Biblioshiny" tool. The total number of authors and the number of single authors were retrieved through the analysis; later, Collaborative authors were calculated from the deviation between collaborative and single authors. Finally, a comparative analysis was conducted among the author categories, and the results were distributed according to discipline and university.

5.4.1: Comparative analysis of authors in disciplines

Table 5.4.1 represented the research outputs produced by 33 sample universities in Bangladesh from 2012-2021. Each row linked to a specific discipline, and each column represented author categories, together with the corresponding number of authors in each discipline. Some exciting patterns and trends emerged in the data, which offered a comparative analysis of author categories.

Table 5.4.1: Comparative analysis of authors in disciplines

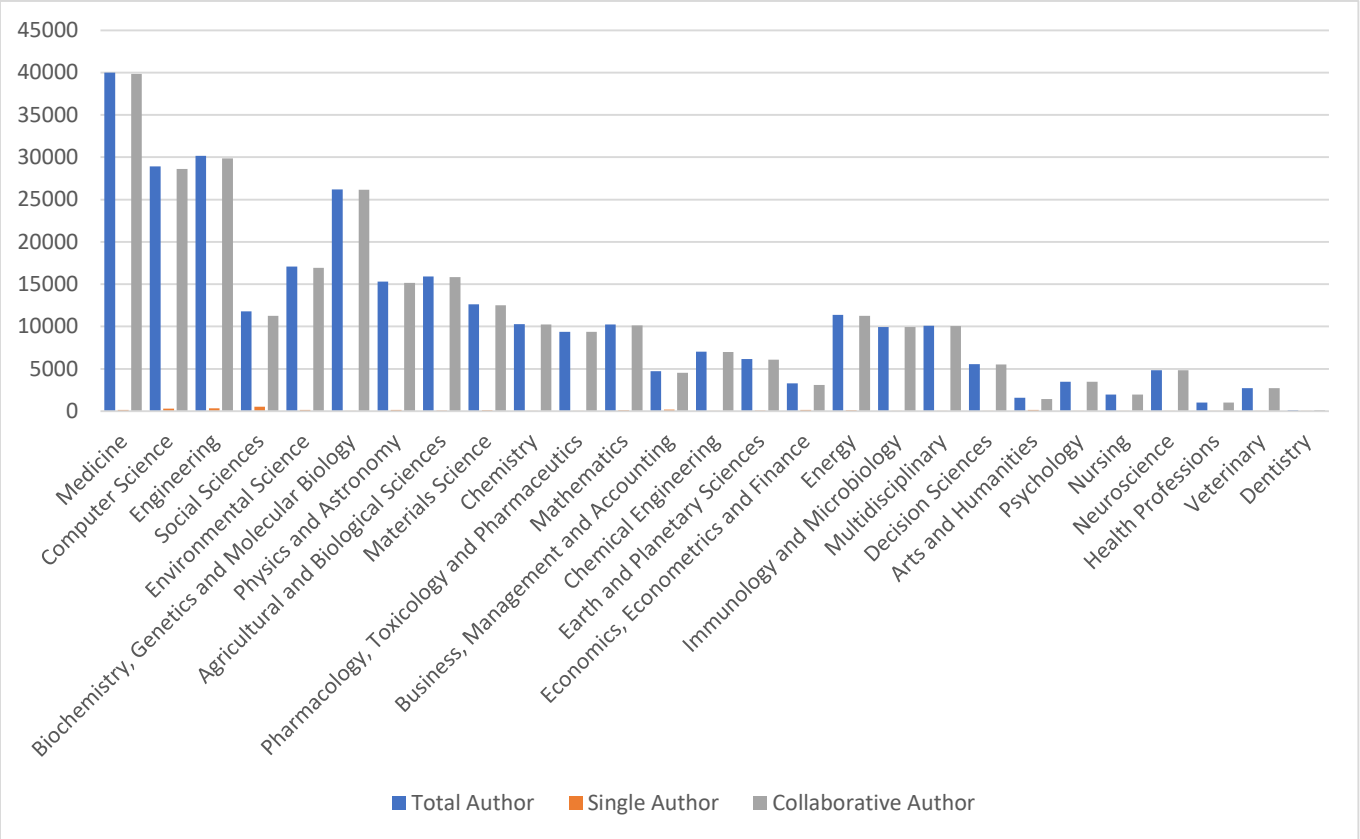
Disciplines	**Total Author**	**Single Author**	**Collaborative Author**
Medicine	39982	136	39846
Computer Science	28909	300	28609
Engineering	30182	327	29855
Social Sciences	11784	510	11274
Environmental Science	17091	154	16937
Biochemistry, Genetics and Molecular Biology	26211	51	26160
Physics and Astronomy	15302	131	15171
Agricultural and Biological Sciences	15904	74	15830
Materials Science	12614	112	12502
Chemistry	10279	31	10248
Pharmacology, Toxicology and Pharmaceutics	9382	22	9360
Mathematics	10225	96	10129
Business, Management and Accounting	4706	186	4520
Chemical Engineering	7035	32	7003
Earth and Planetary Sciences	6154	81	6073
Economics, Econometrics and Finance	3277	160	3117
Energy	11378	119	11259
Immunology and Microbiology	9942	16	9926
Multidisciplinary	10088	16	10072
Decision Sciences	5567	53	5514

Table 5.4.1 Continued

Disciplines	Total Author	Single Author	Collaborative Author
Arts and Humanities	1603	157	1446
Psychology	3495	30	3465
Nursing	1967	12	1955
Neuroscience	4842	7	4835
Health Professions	1027	5	1022
Veterinary	2733	3	2730
Dentistry	122	2	120

Figure 5.4.1.1 visually represented Table 5.4.1. It denoted the different author categories in the disciplines on the X-axis, namely Total Author, Single Author, and Collaborative Author. The Y-axis indicated the number of authors falling under each category. This Figure offered valuable insights into the extent and pattern of collaboration in authorship.

Figure 5.4.1.1: Comparative analysis of author based on disciplines



The data provided an overview of scholarly contributions across various academic disciplines, examining the total number of authors, as well as the distribution of single authorship and collaborative authorship.

In Medicine, a substantial volume of scholarly work was evident, with 39,982 authors. The vast majority (39,846) were collaborative, while only a tiny fraction (136) were single authors, indicating a strong emphasis on collaborative research in Medicine.

Computer Science also exhibited a significant level of productivity, with 28,909 authors. Here, collaborative authorship (28,609) accounted for most contributions, with 300 single authors.

Engineering followed a similar pattern with 30,182 authors, of which 29,855 were collaborative and 327 were by single authors. This observation suggested that collaboration became a common approach in Engineering research.

Social Sciences showed a moderate level of contributions, with 11,784 authors. The majority of authors (11,274) were collaborative, while 510 were single.

The total number of authors in Environmental Science was 17,091, with collaborative authors (16,937) and single authors (154). This finding highlighted a robust collaborative culture within this discipline.

Biochemistry, Genetics, and Molecular Biology demonstrated a significant number of authors (26,211), primarily collaborative (26,160), and single author 51. Physics and Astronomy showed a similar trend, with 15,302 authors, of which 15,171 were collaborative and 131 were single authors.

Agricultural and Biological Sciences enlisted 15,904 authors, with 15,830 collaborative and 74 single authors. Materials Science enrolled 12,614 authors, with 12,502 collaborative and 112 single.

Chemistry exhibited 10,279 authors, with a dissimilar distribution between collaborative (10,248) and single authorship (31). Pharmacology, Toxicology, and Pharmaceutics displayed 9,382 authors, with 22 single and 9,360 collaborative authors.

Mathematics showed a total of 10,225 authors, with collaborative contributors (10,129) prevailing over single authors (96). Business, Management, and Accounting exhibited 4,706 authors, of which 4,520 were collaborative and 186 were single.

Chemical Engineering showed 7,035 authors, of which the majority (7,003) were collaborative and 32 single. Earth and Planetary Sciences displayed 6,154 authors, of which 6,073 were collaborative and 81 single authors.

Economics, Econometrics, and Finance exhibited 3,277 authors, of which 3,117 were collaborative and 160 single. The energy exhibited 11,378 authors, of which 11,259 were collaborative and 119 were single.

Immunology and Microbiology showcased 9,942 authors, of which 9,926 were collaborative and 16 single. Multidisciplinary research demonstrated 10,088 authors, including 10,072 collaborative and only 16 single authorships.

Decision Sciences showed a total of 5,567 authors, of which collaborative contributors (5,514) and single authorship (53). Arts and Humanities enlisted 1,603 authors, including 1,446 collaborative and 157 single authorships.

Psychology exhibited 3,495 authors, of which 3,465 were collaborative and 30 single. Nursing showcased 1,967 authors, of which 1,955 were collaborative and 12 single.

Neuroscience displayed 4,842 total works, of which collaborative authors (4,835) and 7 single authors. Health Professions exhibited 1,027 authors, of which 1,022 were collaborative and 5 single.

Veterinary research enrolled 2,733 authors, of which 2,730 were collaborative and only 3 single authors. Finally, Dentistry displayed 122 authors, of which 120 were collaborative and 2 single authors.

Patterns and Trends:

The data allowed the recognition of patterns and trends in the research aspect across diverse academic domains. Several significant observations and valuable perspectives were extracted from this analysis.

1. **Total Authors vs. Single Authors vs. Collaborative Authors:**

   The field of scholarly authorship experienced a significant transformation, particularly within the domain of academic research. There was a clear shift towards collaborative authorship, exceeding the single-authored works in all disciplines. The finding proved that scholarly pursuits in the academic domain emphasized collective efforts rather than individual contributions. Consequently, collaborative and interdisciplinary research emerged to integrate diverse expertise, and the authorship concept was changed to accept shared knowledge and joint exploration.

2. **Most Collaborative Fields:**

   Social Sciences, Engineering, Computer Science, and Medicine exhibited a substantial extent of collaboration. This observation indicated the importance of shared endeavors, diverse perspectives, and interdisciplinary methodologies within these academic areas.

3. **Fields with More Single Authors:**

   Some disciplines significantly contributed to single authorship compared to others. For example, Dentistry, Health Professions, Veterinary Science, Neuroscience, Arts and Humanities, Economics, Econometrics, and Finance enrolled a substantial number of single authors, indicating a choice for personalized and dedicated scholarly approaches, distinctive research methodologies, professional practices, and knowledge frameworks. The following data revealed single authorship of exemplary disciplines and their proportions:

   - **Social Sciences**: 510 single authors out of 11,784 (4.3%).
   - **Arts and Humanities**: 157 single authors out of 1,603 (9.8%).
   - **Economics, Econometrics, and Finance**: 160 single authors out of 3,277 (4.9%).

4. **Percentage of collaborative authors:**

The percentages of collaborative authors varied in disciplines. However, all disciplines exhibited significantly higher percentages of collaborative authors; for instance, Medicine enrolled 99.7% (39846 collaborative authors out of 39982); Pharmacology, Toxicology, and Pharmaceutics 99.8% (9360 collaborative authors out of 9382); Biochemistry, Genetics, and Molecular Biology 99.8% (26,160 were collaborative authors Out of 26211); Neuroscience 99.9% (4,835 collaborative authors out of 4,842), Social Sciences 95.7% (11,274 collaborative authors out of 11,784), Mathematics 99.1% (10,129 collaborative authors out of 10,225), Economics, Econometrics, and Finance 95.1% (3,117 collaborative authors out of 3,277), Arts and Humanities 90.2% (1,446 collaborative authors out of 1,603) Business, Management, and Accounting 96.1% (4,520 collaborative authors out of 4,706).

5. **Exceptionally Low Single Authorship**

Some disciplines enlisted exceptionally poor participation of single authors, highlighting extreme efforts toward collaboration. For example, in Dentistry and Veterinary Science, the percentages of collaborative authors were 98.4% (120 collaborative authors out of 122) and 99.9% (2,730 collaborative authors out of 2,733).

6. **Correlation between author counts and collaboration:**

Disciplines exhibited an interesting relationship between author counts and collaboration. Some fields displayed high author counts and high collaboration. For example:

- **Medicine**: 39,982 authors, 99.7% collaborative.
- **Computer Science**: 28,909 authors, 99% collaborative.
- **Engineering**: 30,182 authors, 98.9% collaborative.
- **Environmental Science**: 17,091 authors, 99.1% collaborative.
- **Biochemistry, Genetics, and Molecular Biology**: 26,211 authors, 99.8% collaborative.

On the other hand, some fields displayed Moderate author counts but high collaboration. For example:

- **Physics and Astronomy**: 15,302 authors, 99.1% collaborative.
- **Agricultural and Biological Sciences**: 15,904 authors, 99.5% collaborative.

- **Materials Science**: 12,614 authors, 99.1% collaborative.
- **Chemistry**: 10,279 authors, 99.7% collaborative.
- **Lower Author Counts but High Collaboration**:
- **Chemical Engineering**: 7,035 authors, 99.5% collaborative.
- **Earth and Planetary Sciences**: 6,154 authors, 98.7% collaborative.
- **Immunology and Microbiology**: 9,942 authors, 99.8% collaborative.
- **Multidisciplinary Research**: 10,088 authors, 99.8% collaborative.

Summary of Key Findings

1. **Collaborative Dominance**: All disciplines evidently exhibited dominance in collaboration.
2. **STEM Collaboration**: Science, Technology, Engineering, And Mathematics (STEM) fields exhibited a high level of collaboration compared to others.
3. **Social Sciences and Humanities**: Social Sciences and Humanities exhibited variant collaboration levels with a slightly higher proportion of single-authored works compared to Science, Technology, Engineering, And Mathematics (STEM) fields.
4. **Niche Fields:** Immunology, Veterinary, and Dentistry exhibited extremely high collaboration rates.

5.4.2: Comparative analysis of authors in universities

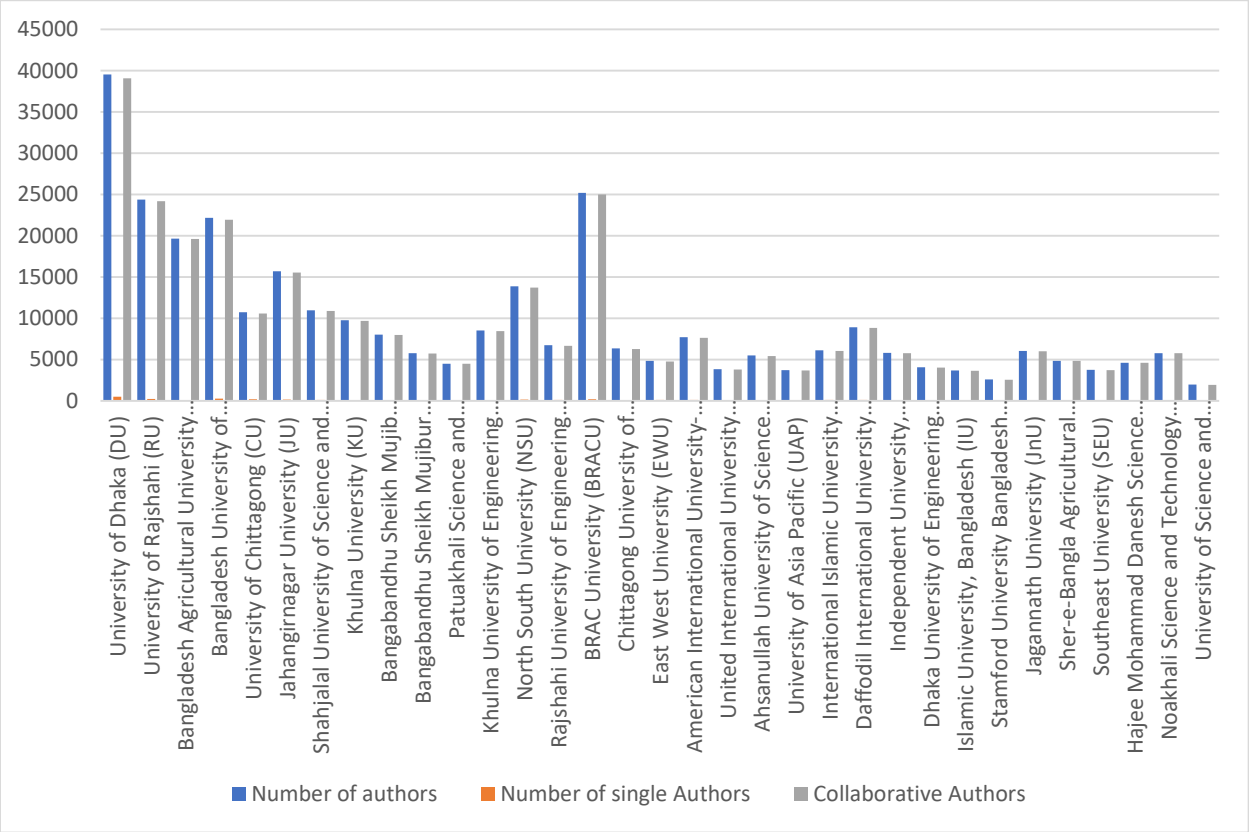
Table 5.4.2 represented the research outputs produced by 33 sample universities in Bangladesh from 2012-2021. Each row linked to a specific university, and each column signified author categories, together with the corresponding authorship categories in each university.

Table 5.4.2: Comparative analysis of authors in universities

Universities	Number of authors	Number of single Authors	Collaborative Authors
University of Dhaka (DU)	39557	492	39065
University of Rajshahi (RU)	24386	208	24178
Bangladesh Agricultural University (BAU)	19667	39	19628
Bangladesh University of Engineering and Technology (BUET)	22184	263	21921
University of Chittagong (CU)	10727	166	10561
Jahangirnagar University (JU)	15686	148	15538
Shahjalal University of Science and Technology (SUST)	10975	106	10869
Khulna University (KU)	9775	79	9696
Bangabandhu Sheikh Mujib Medical University (BSMMU)	8005	25	7980
Bangabandhu Sheikh Mujibur Rahman Agricultural University	5752	18	5734
Patuakhali Science and Technology University (PSTU)	4476	13	4463
Khulna University of Engineering and Technology (KUET)	8514	61	8453
North South University (NSU)	13871	151	13720
Rajshahi University of Engineering and Technology (RUET)	6733	87	6646
BRAC University (BRACU)	25197	178	25019
Chittagong University of Engineering and Technology (CUET)	6346	75	6271
East West University (EWU)	4839	85	4754
American International University-Bangladesh (AIUB)	7718	85	7633
United International University (UIU)	3827	39	3789
Ahsanullah University of Science and Technology (AUST)	5500	70	5430
University of Asia Pacific (UAP)	3697	39	3658
International Islamic University Chittagong (IIUC)	6104	84	6020
Daffodil International University (DIU)	8915	88	8827
Independent University, Bangladesh (IUB)	5786	35	5751
Dhaka University of Engineering and Technology (DUET)	4056	37	4019
Islamic University, Bangladesh (IU)	3657	19	3638
Stamford University Bangladesh (SU)	2588	31	2557
Jagannath University (JnU)	6040	38	6002
Sher-e-Bangla Agricultural University (SAU)	4844	11	4833
Southeast University (SEU)	3736	43	3693
Hajee Mohammad Danesh Science and Technology University (HSTU)	4615	12	4603
Noakhali Science and Technology University (NSTU)	5753	10	5743
University of Science and Technology Chittagong (USTC)	1944	14	1930

Figure 5.4.2.1 visually represented Table 5.4.2. It denoted the different author categories in universities on the X-axis. The Y-axis indicated the number of authors falling under each category.

Figure 5.4.2.1: Comparative analysis of author in universities



Universities in Bangladesh exhibited notable trends in research outputs and authorship patterns in their publication data.

In the top tier, the University of Dhaka (DU) enrolled the highest number of authors, recording 39557, of which 39,065 were collaborative and 492 single. BRAC University (BRACU) enrolled 25,197 authors in total, of which 25,019 were collaborative and 178 single. The University of Rajshahi (RU) enrolled 24386 authors in total, of which 24178 were collaborative and 208 single. Bangladesh University of Engineering and Technology (BUET) enrolled 22,184 authors, of which 21,921 were collaborative and 263 single. Bangladesh Agricultural University (BAU) enrolled 19,667 authors in total, of which 19,628 were collaborative and 39 single.

Down the list, Jahangirnagar University (JU) enrolled 15,686 authors, of which 15,538 were collaborative and 148 single. North South University (NSU) enrolled 13,871 authors, of which

13,720 were collaborative and 151 single. Shahjalal University of Science and Technology (SUST enrolled 10,975 authors, of which 10,869 were collaborative and 106 single. The University of Chittagong (CU) enrolled 10,727 authors in total, of which 10,561 were collaborative and 166 single.

Down the tier, Khulna University (KU) enrolled 9775 authors, of which 9,696 were collaborative and 79 single. Bangabandhu Sheikh Mujib Medical University (BSMMU) enrolled 8,005 authors in total, of which 7,980 were collaborative and 25 single. Khulna University of Engineering and Technology (KUET) signed up 8,514 authors, of which 8,453 were collaborative and 61 single. American International University-Bangladesh (AIUB) enlisted 7,718 authors in total, of which 7,633 were collaborative and 85 single. Daffodil International University (DIU) enrolled 8,915 authors in total, of which 8,827 were collaborative and 88 single.

Further down the tier, Chittagong University of Engineering and Technology (CUET) enrolled 6,346 authors, of which 6,271 were collaborative and 75 single. Rajshahi University of Engineering and Technology (RUET) signed up 6,733 authors, of which 6,646 were collaborative and 87 single. International Islamic University Chittagong (IIUC) enlisted 6,104 authors, of which 6,020 were collaborative and 84 single. Jagannath University (JnU) registered 6,040 authors, including 38 single and 6,002 collaborative authors, suggesting a strong inclination towards group research.

In the next tier, Independent University, Bangladesh (IUB) enrolled 5,786 authors, of which 5,751 were collaborative and 35 single. Noakhali Science and Technology University (NSTU) enlisted 5,753 authors, of which 5,743 were collaborative and 10 single. Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) enrolled 5,752 authors in total, of which 5,734 were collaborative and 18 single. Ahsanullah University of Science and Technology (AUST) signed up 5,500 authors in total, of which 5,430 were collaborative and 70 single.

Down the tier, Patuakhali Science and Technology University (PSTU) registered 4,476 authors in total, of which 4,463 were collaborative and 13 single. East West University (EWU) enrolled 4,839 authors in total, of which 4,754 were collaborative and 85 single. United International University (UIU) enlisted 3,827 authors in total, of which 3,789 were collaborative and 39 single. University of Asia Pacific (UAP) enrolled 3,697 authors, of which 3,658 were collaborative and 39 single.

Down the list, Dhaka University of Engineering and Technology (DUET) enrolled 4,056 authors in total, of which 4,019 were collaborative and 37 single. Hajee Mohammad Danesh Science and Technology University (HSTU) registered 4,615 authors in total, of which 4,603 were collaborative and 12 single. Sher-e-Bangla Agricultural University (SAU) recorded 4,844 authors, including 11 single and 4,833 collaborative authors, highlighting a focus on collaborative research. Islamic University, Bangladesh (IU) reported 3,657 authors, including 19 single and 3,638 collaborative authors, demonstrating a preference for collaborative efforts. Southeast University (SEU) enrolled 3,736 authors, including 43 single and 3,693 collaborative authors, indicating a preference for collaborative projects.

At the bottom of the list, Stamford University Bangladesh (SU) recorded 2,588 authors, including 31 single and 2,557 collaborative authors, highlighting a focus on group research. University of Science and Technology Chittagong (USTC) enrolled 1,944 authors in total, of which 1,930 were collaborative and 14 single.

Patterns and Trends:

Universities exhibited several patterns and trends as follows:

1. **Total Authors:**

   The University of Dhaka (DU) led the authorship landscape with an impressive author count of 39557. BRAC University (BRACU) and the University of Rajshahi (RU) closly followed with a remarkable number of authors. In contrast, the University of Science and Technology Chittagong (USTC) enlisted the lowest number of authors, indicating a divergence in the participation of scholarly endeavors in universities.

2. **Single Authors:**

   The University of Dhaka (DU) dominated enrolling single authors with 492 author counts, indicating the identical nature of scholarly activities. BRAC University (BRACU) and the University of Rajshahi (RU) signed up a significant number of single authors within their academic domains.

3. **Collaborative Authors:**

   The authorship patterns indicated that most of the authors joined in collaborative endeavors. Like the leadership in producing total authors and single authors, the University of Dhaka (DU) led the collaborative authors' enrolment, closely followed by the BRAC University (BRACU) and the University of Rajshahi (RU). Similar to enlisting total authors, the University of Science and Technology Chittagong (USTC) enrolled the lowest number of authors in collaborative endeavors.

4. **The ratio of Single to Collaborative Authors:**

   The dominance of modality of research conduction, i.e., individual or collective, can be identified through the ratio of single authors and collaborative authors in each institution or discipline. The University of Dhaka (DU) exhibited a significantly minimal ratio, highlighting the prevailance toward collaboration.

5. **Comparison of Specialized Universities:**

   Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), Rajshahi University of Engineering and Technology (RUET), and Chittagong University of Engineering and Technology (CUET) signed up a substantial number of authors, indicating their dedication to advancing the field of engineering and technology.

6. **Smaller Universities:**

   Although Patuakhali Science and Technology University (PSTU) and United International University (UIU) exhibited comparatively fewer authors, they significantly impacted the research domain.

7. **Variation in Single Authorship:**

   Universities exhibited diversity in Single authorship patterns, indicating differences in research strategies and culture in their domains. A threadbare analysis may provide valuable insights into the patterns and trends.

8. **Variation in Collaborative Authorship:**

   Universities unveiled disparity in collaborative authorship patterns, indicating diversity in the impact and importance of collaboration within these institutions. This observation highlighted their distinct strategies and preferences to extend research domains.

In conclusion, the patterns and trends highlighted the dominance of collaborative research in universities, indicating growing shared activities in scholarly domains that promoted teamwork and collaborative knowledge production. However, an in-depth analysis of additional qualitative data and perspective on each university's research areas, funding, and international collaborations may reveal more comprehensive insights into these trends and patterns.

5.5 Local Co-Authorship %

The data on total documents were analyzed through the "Biblioshiny" tool. International co-authorships % were retrieved through the analysis. Later, the number of International collaborative authors was calculated using the following equation:

International collaboration (author) =Collaborative author % International co-authorship (%).

After retrieving the number of International collaborative authors, Local collaborative authors were calculated using the following equation:

Local collaboration (author)=Collaborative Author-International collaboration (Author).

Finally, the results were divided according to discipline and university.

5.5.1: Local co-authorship percentage in disciplines

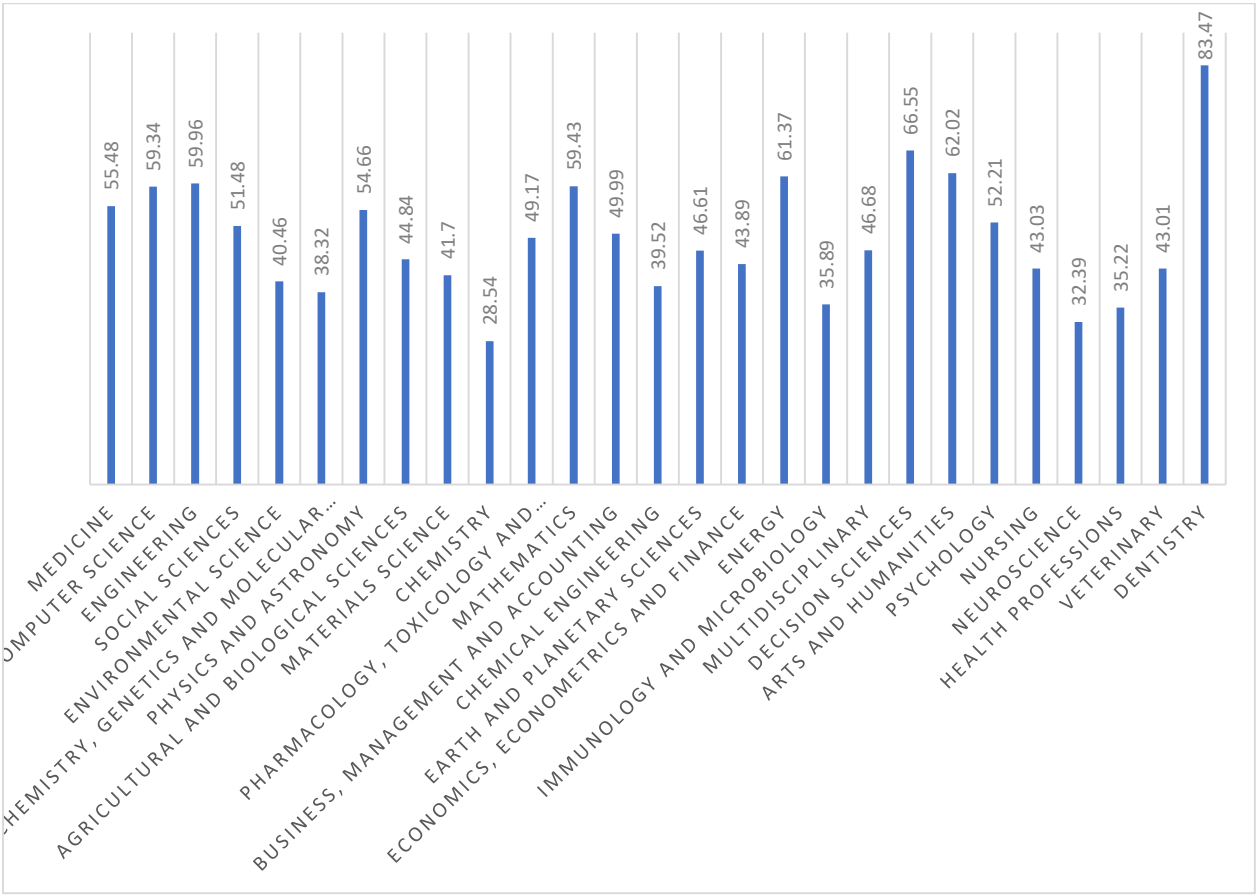
Table 5.5.1 was extracted from Appendix 10. It represented different disciplines on the left, while the local co-authorship percentage in each discipline from 2012 to 2021 on the right. These data denoted the proportion of local collaborative authors across various disciplines. A higher numerical value generally signified a greater emphasis on local collaboration in research within a particular discipline. In contrast, a lower value indicated a weaker focus on research in local partnerships.

Table 5.5.1: Local co-authorship percentage in disciplines

Disciplines	Local Co-authorship Percentage
Medicine	55.48
Computer Science	59.34
Engineering	59.96
Social Sciences	51.48
Environmental Science	40.46
Biochemistry, Genetics and Molecular Biology	38.32
Physics and Astronomy	54.66
Agricultural and Biological Sciences	44.84
Materials Science	41.70
Chemistry	28.54
Pharmacology, Toxicology and Pharmaceutics	49.17
Mathematics	59.43
Business, Management and Accounting	49.99
Chemical Engineering	39.52
Earth and Planetary Sciences	46.61
Economics, Econometrics and Finance	43.89
Energy	61.37
Immunology and Microbiology	35.89
Multidisciplinary	46.68
Decision Sciences	66.55
Arts and Humanities	62.02
Psychology	52.21
Nursing	43.03
Neuroscience	32.39
Health Professions	35.22
Veterinary	43.01
Dentistry	83.47

Figure 5.5.1.1 visually represented Table 5.5.1. It highlighted different disciplines on the X-axis. The Y-axis indicated the Local co-authorship percentage of disciplines. This figure offered valuable insights into the extent and pattern of local co-authorship.

Figure 5.5.1.1: Local co-authorship percentage in disciplines



Disciplines displayed variable extents of local co-authorship, highlighting the nature and scope of their respective research domains.

Computer Science and Engineering exhibited higher local co-authorship percentages of 59.34% and 59.96%, respectively, followed by Medicine at 55.48%. Social Sciences, Environmental Science, Biochemistry, Genetics, and Molecular Biology represented 51.48%, 40.46%, and 38.32% of local co-authorship percentages in their domains.

Down the list, Physics and Astronomy, Chemistry, Agricultural and Biological Sciences, and Materials Science displayed varied local co-authorship percentages at 54.66%, 28.54%, 44.84%, and 41.70%, respectively. Similarly, Business, Management, and Accounting, Decision Sciences,

and Arts and Humanities exhibited diverse local co-authorship percentages at 49.99%, 66.55%, and 62.02%, respectively.

In contrast, the Nursing and Veterinary fields presented similar co-authorship percentages of 43.03% and 43.01%, respectively. On the other hand, dentistry distinguished itself with an exceptionally high local co-authorship rate of 83.47%.

These varying percentages across disciplines highlighted the importance of context and the nature of research activities in shaping local co-authorship dynamics.

Patterns and trends:

1. **High Co-authorship Rates**: The academic research landscape demonstrated a predominant pattern of extensive local co-authorship rates in different fields, indicating a positive regional culture of collaboration. Dentistry served as a prime example, with a local co-authorship rate of 83.47%, while the Decision Sciences, Arts and Humanities, and Energy sectors also revealed convincing rates above 60%. These statistics highlighted the collective commitment to knowledge generation within local domains.

2. **Moderate Co-authorship Rates**: The co-authorship rates in technology and applied science disciplines, including Decision Sciences, Arts and Humanities, Energy, Engineering, Mathematics, and Computer Science, were typically moderate, usually around 60%. These fields increased regional interdisciplinary collaboration, bringing together expertise and viewpoints from diverse sub-domains of disciplines and fostering a dynamic research environment.

3. **Mixed Co-authorship Rates**: In disciplines such as Medicine, Physics and Astronomy, Psychology, Social Sciences, Business, Management and Accounting, Pharmacology, Toxicology and Pharmaceutics, a balanced combination of local and international co-authorship percentages was observed, resulting in approximately 50%. This balance

highlighted a similar approach to generating knowledge, demonstrating the importance of local and international cooperative efforts within these fields.

4. **Lower Co-Authorship Rates**: Biochemistry, Genetics and Molecular Biology, Immunology and Microbiology, Health Professions, Neuroscience, and Chemistry all exhibited a notable trend of reduced local collaboration, suggesting a strong inclination towards international collaboration. The distinctive research methodologies and investigative frameworks utilized in these fields actively encouraged global exploration, potentially impacting the dissemination of knowledge and fostering interdisciplinary collaboration worldwide.

5. **Varied Local Co-authorship Rates in Biological and Environmental Sciences**: The local co-authorship rates within Biological and Environmental Sciences varied considerably. Agricultural and Biological Sciences (44.84%) and Environmental Science (40.46%) were prime examples of the insignificant balance between local and international collaborative research. This complex interaction of research practices within these domains enhanced understanding of collaborative dynamics.

6. **Economics, Econometrics, and Finance (43.89%)**: Economics, Econometrics, and Finance (43.89%) exhibited a moderate local co-authorship rate, reflecting a biased research landscape where global scholars collaborate to explore complex economic phenomena.

7. **Below Average Co-authorship Rates**: Local co-authorship rates in disciplines like Chemical Engineering, Health Professions, Immunology, and Microbiology were below average. This outcome indicated a preference for international collaborations within these fields. Investigating the existing academic culture and collaborative practices in these disciplines can provide a deeper understanding of collaborative research environments.

5.5.2: Local Co-authorship Percentage in Universities

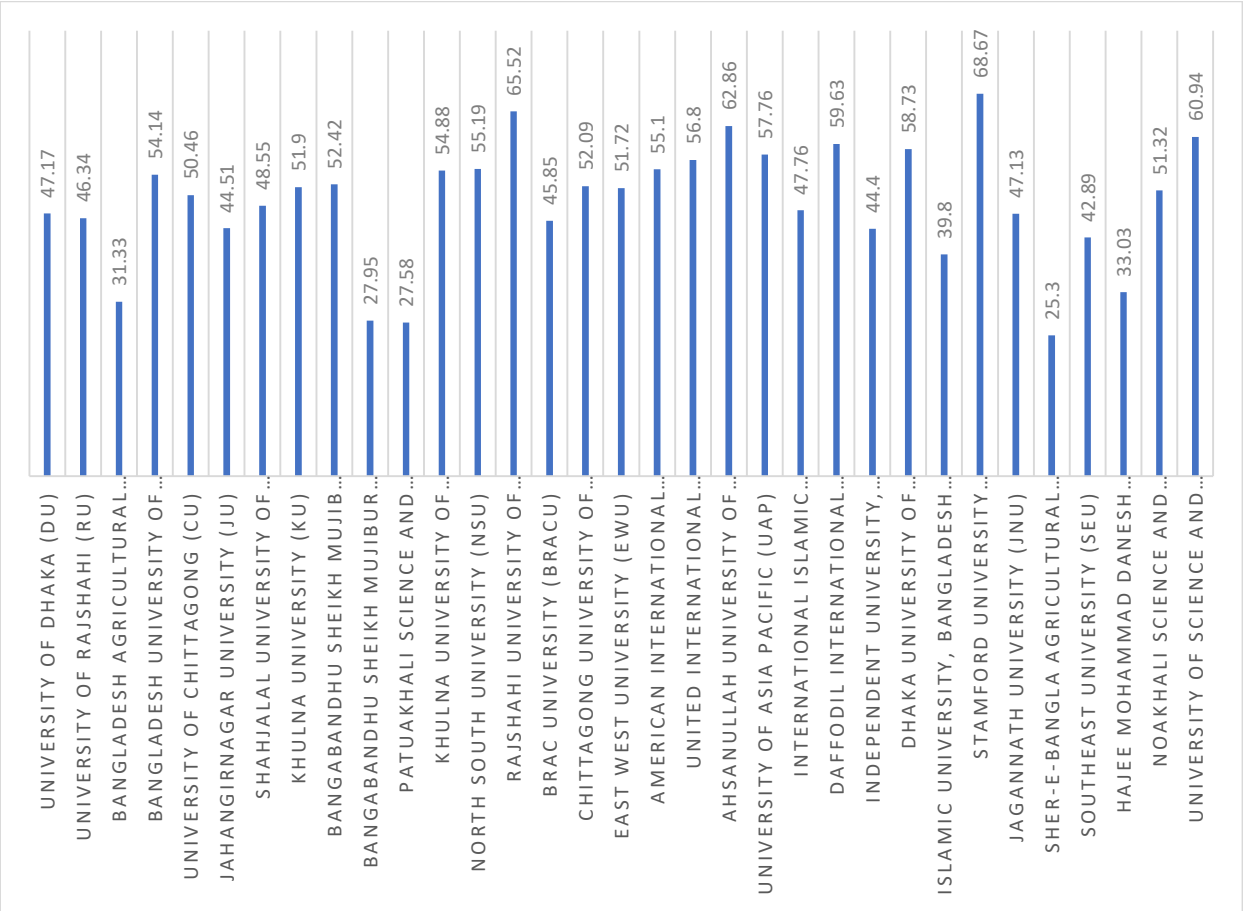
Table 5.5.2 was extracted from Appendix 10. It showcased various universities on the left, while the local co-authorship percentage in each university from 2012 to 2021 on the right. These data served as a representation of local collaborative authors across various universities.

Table 5.5.2: Local Co-authorship Percentage in Universities

Universities	**Local Co-authorship Percentage**
University of Dhaka (DU)	47.17
University of Rajshahi (RU)	46.34
Bangladesh Agricultural University (BAU)	31.33
Bangladesh University of Engineering and Technology (BUET)	54.14
University of Chittagong (CU)	50.46
Jahangirnagar University (JU)	44.51
Shahjalal University of Science and Technology (SUST)	48.55
Khulna University (KU)	51.90
Bangabandhu Sheikh Mujib Medical University (BSMMU)	52.42
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	27.95
Patuakhali Science and Technology University (PSTU)	27.58
Khulna University of Engineering and Technology (KUET)	54.88
North South University (NSU)	55.19
Rajshahi University of Engineering and Technology (RUET)	65.52
BRAC University (BRACU)	45.85
Chittagong University of Engineering and Technology (CUET)	52.09
East West University (EWU)	51.72
American International University-Bangladesh (AIUB)	55.10
United International University (UIU)	56.80
Ahsanullah University of Science and Technology (AUST)	62.86
University of Asia Pacific (UAP)	57.76
International Islamic University Chittagong (IIUC)	47.76
Daffodil International University (DIU)	59.63
Independent University, Bangladesh (IUB)	44.40
Dhaka University of Engineering and Technology (DUET)	58.73
Islamic University, Bangladesh (IU)	39.80
Stamford University Bangladesh (SU)	68.67
Jagannath University (JnU)	47.13
Sher-e-Bangla Agricultural University (SAU)	25.30
Southeast University (SEU)	42.89
Hajee Mohammad Danesh Science and Technology University (HSTU)	33.03
Noakhali Science and Technology University (NSTU)	51.32
University of Science and Technology Chittagong (USTC)	60.94

Figure 5.5.2.1 visually represented Table 5.5.2. It displayed the universities on the X-axis. The Y-axis indicated the local co-authorship percentage in universities. This figure offered valuable insights into the extent and pattern of regional collaboration in authorship.

Figure 5.5.2.1: Local co-authorship percentage in universities



The data below illustrated the local co-authorship percentages of various universities in Bangladesh, shedding light on the extent to which researchers collaborate with their local counterparts.

Stamford University Bangladesh (SU) exhibited the highest local co-authorship percentage at 68.67%, followed by Rajshahi University of Engineering and Technology (RUET) at 65.52% and Ahsanullah University of Science and Technology (AUST) at 62.86%.

Down the list, the University of Science and Technology Chittagong (USTC), Daffodil International University (DIU), Dhaka University of Engineering and Technology (DUET), and University of Asia Pacific (UAP) displayed a local co-authorship percentage of 60.94%, 59.63%, 58.73%, and 57.76%, respectively.

Further down the list, United International University (UIU), North South University (NSU), American International University-Bangladesh (AIUB), Khulna University of Engineering and Technology (KUET), and Bangladesh University of Engineering and Technology (BUET) exhibited local co-authorship percentages of 56.80%, 55.19%, 55.10%, 54.88%, and 54.14%, individually.

As we move towards the middle range, Bangabandhu Sheikh Mujib Medical University (BSMMU), Chittagong University of Engineering and Technology (CUET), Khulna University (KU), East West University (EWU), Noakhali Science and Technology University (NSTU), and University of Chittagong (CU) represented local co-authorship percentages of 52.42%, 52.09%, 51.90%, 51.72%, 51.32%, and 50.46%, respectively.

Down the tier, Shahjalal University of Science and Technology (SUST), International Islamic University Chittagong (IIUC), University of Dhaka (DU), and Jagannath University (JnU) displayed local co-authorship percentages of 48.55%, 47.76%, 47.17%, and 47.13%, respectively.

Further down the tier, universities with relatively lower local co-authorship percentages included the University of Rajshahi (RU), BRAC University (BRACU), Jahangirnagar University (JU), Independent University, Bangladesh (IUB), Southeast University (SEU), and Islamic University, Bangladesh (IU) at 46.34%, 45.85%, 44.51%, 44.40%, 42.89%, and 39.80%, respectively.

At the bottom of the list, Hajee Mohammad Danesh Science and Technology University (HSTU), Bangladesh Agricultural University (BAU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Patuakhali Science and Technology University (PSTU), and Sher-e-Bangla Agricultural University (SAU) exhibited below average local co-authorship percentages at 33.03%, 31.33%, 27.95%, 27.58%, and 25.30%, correspondingly.

In conclusion, the data indicated that higher local co-authorship percentages revealed vital intra-institutional collaboration. Conversely, lower percentages indicated preferences for international collaboration.

Patterns and Trends:

The local co-authorship rates of given universities demonstrated the following patterns and trends:

1. **Wide Range of Local Co-authorship Rates:** A diverse landscape regarding local co-authorship rates was visible in universities, indicating different collaborative practices, distinct research cultures, and varying levels of collaboration. This finding highlighted the complex nature of scholarly partnerships in academia, the internalization of each university's research approach, and the vigorous interaction between researchers and their institutional environments.
2. **Variation in Co-authorship Rates:** Universities revealed a significant dissimilarity in the local co-authorship rates. For example, Sher-e-Bangla Agricultural University (SAU) exhibited the lowest 25.30% regional co-authorship percentage, whereas Stamford University Bangladesh (SU) demonstrated an impressive 68.67%. This observation indicated discrete methods for encouraging homegrown collaborative activities and promoting a research-friendly atmosphere in universities.
3. **Engineering and Technology Universities:** Engineering and Technology universities such as Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), and Rajshahi University of Engineering and Technology (RUET) exhibited local co-authorship percentages of 54.14%, 54.88%, and 65.52%, respectively. This observation highlighted a positive culture of regional research activities within this specialized domain.
4. **Medical and Agricultural Universities:** Medical and Agricultural Universities such as Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh Agricultural University (BAU), and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) exhibited mid-range to lower local co-authorship percentages of 52.42%, 31.33%,

and 27.95%, respectively. This observation indicated the variations of regional research collaboration within these institutions.

5. **Private Universities:** North South University (NSU), BRAC University (BRACU), Daffodil International University (DIU), and Ahsanullah University of Science and Technology (AUST) significantly contributed to local collaborative research efforts, indicating a vigorous concern for collaborative research within the private university sector, where internal partnership became essential for confronting complex challenges and advancing knowledge domains, in line with existing scholastic patterns.
6. **Public Universities:** Public universities promoted a convincing impression that established scholarly teamwork among faculty and researchers. For instance, Rajshahi University (RU) and Jahangirnagar University (JU) exhibited over 40% local co-authorship percentages, indicating dedication to regional collaborative research within these institutions.
7. **High Local Co-authorship Rate Outliers:** High local co-authorship percentages underlined the extreme role of collaborative research efforts in the local domains. For example, Stamford University Bangladesh (SU) exhibited a local co-authorship rate of 68.67%, indicating a robust scholarly collaboration policy that included institutional strategies, research policies, and cultural factors that promoted regional collaborative involvement.
8. **Low Local Co-authorship Rate Outliers:** Sher-e-Bangla Agricultural University (SAU) and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) were the outliers that exhibited lower local co-authorship percentages, indicating a potential growth of international research collaboration. This observation highlighted identical institutional initiatives to promote research partnership culture globally.

The patterns and trends in local co-authorship percentages revealed a diverse landscape of local partnerships in universities. These dissimilarities indicated distinctions in scholastic concentration, public-private relationships, international and local collaboration topography, and the unique research values within each institution.

5.6 International Co-authorship (%)

The data on total documents were analyzed through the "Biblioshiny" tool. International co-authorships % were retrieved through the analysis. Later, the number of International collaborative authors was calculated using the following equation:

International collaboration (author) =Collaborative author % International co-authorship (%).

Finally, the results were divided according to discipline and university.

5.6.1: International co-authorship percentage in disciplines

Table 5.6.1 was extracted from Appendix 11. It represented different disciplines on the left, while the International co-authorship percentage in each discipline from 2012 to 2021 on the right. These data served as an illustration of contributors to International co-authorship percentages across various disciplines. A higher numerical value generally signified a greater emphasis on International collaborative research within a particular discipline. In contrast, a lower value indicated a weaker focus on International collaborative research.

Table 5.6.1: International co-authorship percentage in disciplines

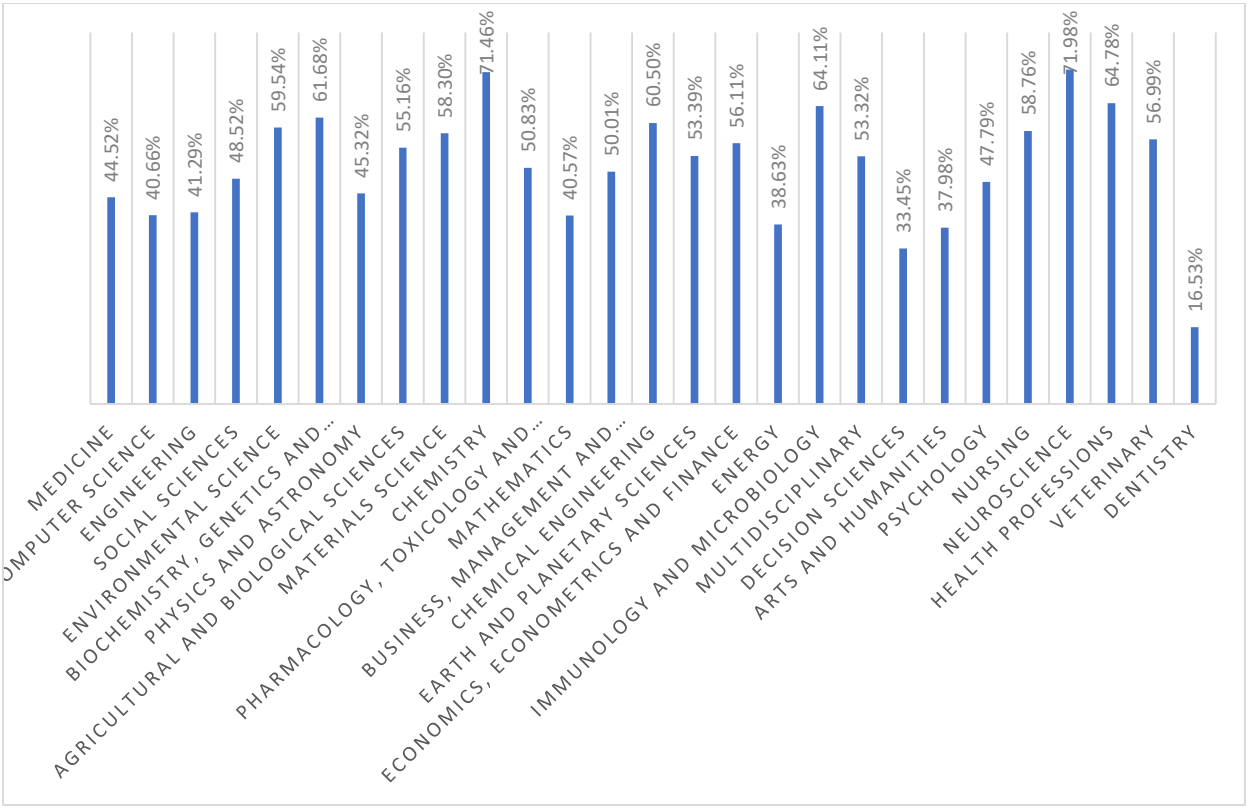
Disciplines	**International Co-authorship Percentage**
Medicine	44.52%
Computer Science	40.66%
Engineering	41.29%
Social Sciences	48.52%
Environmental Science	59.54%
Biochemistry, Genetics and Molecular Biology	61.68%
Physics and Astronomy	45.32%
Agricultural and Biological Sciences	55.16%
Materials Science	58.30%
Chemistry	71.46%
Pharmacology, Toxicology and Pharmaceutics	50.83%
Mathematics	40.57%
Business, Management and Accounting	50.01%
Chemical Engineering	60.50%
Earth and Planetary Sciences	53.39%

Table 5.6.1 Continued

Disciplines	International Co-authorship Percentage
Economics, Econometrics and Finance	56.11%
Energy	38.63%
Immunology and Microbiology	64.11%
Multidisciplinary	53.32%
Decision Sciences	33.45%
Arts and Humanities	37.98%
Psychology	47.79%
Nursing	58.76%
Neuroscience	71.98%
Health Professions	64.78%
Veterinary	56.99%
Dentistry	16.53%

Figure 5.6.1.1 visually represented Table 5.6.1. It demonstrated the different disciplines on the X-axis. The Y-axis indicated the international co-authorship percentage of disciplines. This figure offered valuable insights into the extent and pattern of global collaboration in authorship.

Figure 5.6.1.1: International co-authorship percentage in disciplines



Significant differences were observed in international co-authorship percentages within various academic disciplines. Among the disciplines, Neuroscience and Chemistry exhibited the highest percentages at 71.98% and 71.46%, respectively, whereas Health Professions, Immunology and Microbiology, along with Biochemistry, Genetics, and Molecular Biology, displayed 64.78%, 64.11%, and 61.68%, individually. Down the list, Chemical Engineering, Environmental Science, Nursing, and Materials Science were exposed to 60.50%, 59.54%, 58.76%, and 58.30% international co-authorship percentages, respectively. In contrast, Veterinary Science, Economics, Econometrics and Finance, and Agricultural and Biological Sciences exhibited 56.99%, 56.11%, and 55.16%, individually.

Further down the list, Earth and Planetary Sciences, Multidisciplinary, Pharmacology, Toxicology and Pharmaceutics, and Business, Management, and Accounting displayed international co-authorship percentages at 53.39%, 53.32%, 50.83% and 50.01%, respectively, whereas Social Sciences, Psychology, Physics and Astronomy, and Medicine showed 48.52%, 47.79%, 45.32% and 44.52%, separately. In the next tier, Engineering, Computer Science, Mathematics, Energy, and Arts and Humanities exhibited 41.29%, 40.66%, 40.57%, 38.63%, and 37.98% international co-authorship rates. At the bottom, Decision Sciences and Dentistry displayed the lowest percentages of international co-authorship rates at 33.45% and 16.53%, respectively.

The differences in international co-authorship percentages underscored diverse levels of collaborative partnerships in each discipline and provided insights into the collaboration tendencies and nature of the research environment.

Patterns and Trends:

1. **High Co-authorship Rates:** The percentages of international co-authorship in the disciplines of Chemistry, Neuroscience, Health Professions, Immunology and Microbiology, Biochemistry, Genetics and Molecular Biology, and Chemical Engineering were remarkably high, reaching 71.98%, 71.46%, 64.78%, 64.11%, 61.68%, and 60.50%, respectively. These figures emphasized the strong inclination towards collaborative efforts that exceed national boundaries within these scientific fields. The increased global co-authorship rates underscored

the interconnected and global nature of contemporary research in Chemistry and the life sciences. Moreover, this extensive collaboration signified the internationalization of scientific knowledge and an enhanced recognition among researchers in these disciplines gained from cross-cultural and interdisciplinary exchanges. However, this pattern raised questions about the impact of globalization on scientific collaboration, the factors that facilitated international partnerships, and the collaborations that contributed to the collective advancement of knowledge in these domains.

2. **Medium Co-authorship Rates:** The field of Environmental Science exhibited an exemplary international co-authorship rate of 59.54%, showing an integration of global and domestic collaborative efforts. Similarly, disciplines like Nursing displayed an international co-authorship percentage of 58.76%, Materials Science at 58.30%, Veterinary at 56.99%, Economics, Econometrics and Finance at 56.11%, Agricultural and Biological Sciences at 55.16%, Earth and Planetary Sciences at 53.39%, Multidisciplinary at 53.32%, Pharmacology, Toxicology and Pharmaceutics at 50.83%, and Business, Management and Accounting at 50.01%. This midpoint signified an equilibrium between global and local collaborative endeavors within these fields, underscoring the complicated nature of contemporary research ecosystems.

3. **Low International Co-authorship Rates:** International co-authorship rates in scholarly domains reflected the level of collaboration among researchers. For instance, Dentistry exhibited a significantly low global co-authorship rate, measured at 16.53%, indicating a clear trend of limited international collaboration. The implications of such low co-authorship rates in Dentistry suggested potential isolation from the global research community, underscoring the necessity for increased efforts to promote international partnerships and knowledge exchange in this specialized domain.

4. **Varied International Co-authorship Rates in Core Sciences:** Core science disciplines such as Physics and Astronomy and Mathematics exhibited international co-authorship percentages

of 45.32% and 40.57%, respectively, indicating lower global co-authorship rates compared to other science disciplines like Chemistry and Biology. This observation denoted divergence in the collaborative authorship dynamics in scientific research.

5. **Interdisciplinary Trends:** International collaboration encouraged innovation and expanded knowledge boundaries. Consequently, Multidisciplinary and Earth and Planetary Sciences demonstrated 53.32% and 53.39% international co-authorship percentages, respectively, underscoring the importance of cross-disciplinary relationships, the distinctive interdisciplinary culture, and the necessity of shared expertise to deal with complex challenges within these scientific fields.

6. **Business and Social Sciences:** Business, Management and Accounting, and Social Sciences exhibited 50.01% and 48.52% international co-authorship percentages, indicating friendly relationships among scholars and researchers to enhance globally shared commitment and interconnectedness within these disciplines.

In conclusion, the data suggested that scientific disciplines, including Chemistry, Neuroscience, and Environmental Science, demonstrated a greater inclination toward international collaboration. On the other hand, Dentistry and Decision Sciences exhibited lower collaboration rates. Additionally, a wide range of global co-authorship rates were observed across various fields, highlighting the diverse nature of international collaboration in academic research.

5.6.2: International co-authorship percentage in universities

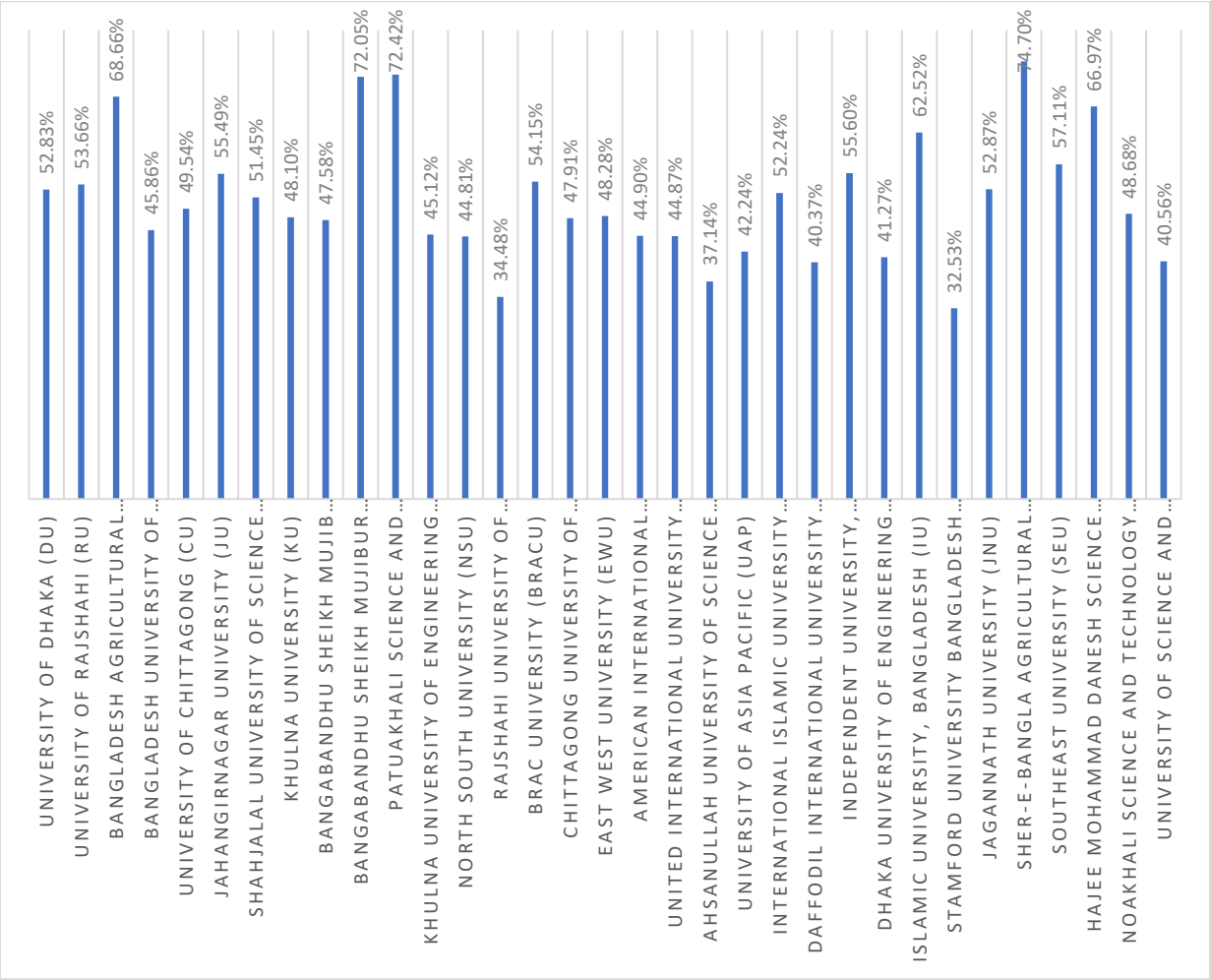
Table 5.6.2 was extracted from Appendix 11. It showcased different universities on the left, while the International co-authorship percentage in each university from 2012 to 2021 on the right. These figures served as a representation of participating International collaborative authors across various universities.

Table 5.6.2: International co-authorship percentage in universities

Universities	**International Co-authorship Percentage**
University of Dhaka (DU)	52.83%
University of Rajshahi (RU)	53.66%
Bangladesh Agricultural University (BAU)	68.66%
Bangladesh University of Engineering and Technology (BUET)	45.86%
University of Chittagong (CU)	49.54%
Jahangirnagar University (JU)	55.49%
Shahjalal University of Science and Technology (SUST)	51.45%
Khulna University (KU)	48.10%
Bangabandhu Sheikh Mujib Medical University (BSMMU)	47.58%
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	72.05%
Patuakhali Science and Technology University (PSTU)	72.42%
Khulna University of Engineering and Technology (KUET)	45.12%
North South University (NSU)	44.81%
Rajshahi University of Engineering and Technology (RUET)	34.48%
BRAC University (BRACU)	54.15%
Chittagong University of Engineering and Technology (CUET)	47.91%
East West University (EWU)	48.28%
American International University-Bangladesh (AIUB)	44.90%
United International University (UIU)	44.87%
Ahsanullah University of Science and Technology (AUST)	37.14%
University of Asia Pacific (UAP)	42.24%
International Islamic University Chittagong (IIUC)	52.24%
Daffodil International University (DIU)	40.37%
Independent University, Bangladesh (IUB)	55.60%
Dhaka University of Engineering and Technology (DUET)	41.27%
Islamic University, Bangladesh (IU)	62.52%
Stamford University Bangladesh (SU)	32.53%
Jagannath University (JnU)	52.87%
Sher-e-Bangla Agricultural University (SAU)	74.70%
Southeast University (SEU)	57.11%
Hajee Mohammad Danesh Science and Technology University (HSTU)	66.97%
Noakhali Science and Technology University (NSTU)	48.68%
University of Science and Technology Chittagong (USTC)	40.56%

Figure 5.6.2.1 visually represented Table 5.6.2. It exhibited the different universities on the X-axis. The Y-axis indicated the number of authors falling under each university. This figure offered valuable insights into the extent and pattern of collaboration in International authorship.

Figure 5.6.2.1: International co-authorship percentage in universities



International co-authorship percentages among various universities exposed substantial discrepancies in research collaboration worldwide. Among the universities, Sher-e-Bangla Agricultural University (SAU), Patuakhali Science and Technology University (PSTU), and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) exhibited the highest percentages of international co-authorship at 74.70%, 72.42%, and 72.05%, respectively.

On the other hand, Bangladesh Agricultural University (BAU), Hajee Mohammad Danesh Science and Technology University (HSTU), and Islamic University, Bangladesh (IU) displayed 68.66%, 66.97%, and 62.52% international research partnerships, respectively.

Down the list, Southeast University (SEU), Independent University, Bangladesh (IUB), Jahangirnagar University (JU), and BRAC University (BRACU) exhibited international co-authorship percentages at 57.11%, 55.60%, 55.49%, and 54.15%, respectively.

In contrast, the University of Rajshahi (RU), Jagannath University (JnU), the University of Dhaka (DU), International Islamic University Chittagong (IIUC), and Shahjalal University of Science and Technology (SUST) represented 53.66%, 52.87%, 52.83%, 52.24%, and 51.45% international co-authorship percentages, respectively.

Further down the list, the University of Chittagong (CU), Noakhali Science and Technology University (NSTU), East West University (EWU), Khulna University (KU), and Chittagong University of Engineering and Technology (CUET) displayed international co-authorship rates of 49.54%, 48.68%, 48.28%, 48.10%, and 47.91%, respectively.

Conversely, Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), and American International University-Bangladesh (AIUB) displayed international co-authorship rates of 47.58%, 45.86%, 45.12%, and 44.90%, respectively.

In the next tier, United International University (UIU), North South University (NSU), University of Asia Pacific (UAP), Dhaka University of Engineering and Technology (DUET), University of Science and Technology Chittagong (USTC), and Daffodil International University (DIU) exhibited 44.87%, 44.81%, 42.24%, 41.27%, 40.56% and 40.37% international co-authorship rates, respectively.

At the bottom, Ahsanullah University of Science and Technology (AUST), Rajshahi University of Engineering and Technology (RUET), and Stamford University Bangladesh (SU) displayed lower international co-authorship rates of 37.14%, 34.48%, and 32.53%, respectively.

These variances in global research collaboration across universities in Bangladesh highlighted the diversity of international research partnerships and the inherent nature of the research environment.

Patterns and trends:

1. **Highest International Co-authorship Rates:**

   The collaborative environment within academic institutions played a crucial role in promoting research excellence and the dissemination of knowledge. Among the universities, Sher-e-Bangla Agricultural University (SAU), Patuakhali Science and Technology University (PSTU), and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) emerged as leaders, with impressive international co-authorship rates of 74.70%, 72.42%, and 72.05%, respectively. These statistics highlighted a strong global collaborative culture in these institutions.

   Bangladesh Agricultural University (BAU), Hajee Mohammad Danesh Science and Technology University (HSTU), and Islamic University, Bangladesh (IU) also demonstrated significant international co-authorship rates of 68.66%, 66.97%, and 62.52%, highlighting the widespread spirit of global collaboration in the academic landscape of agricultural research in Bangladesh.

2. **Moderate International Co-authorship Rates:**

   Southeast University (SEU), Independent University, Bangladesh (IUB), and Jahangirnagar University (JU) exhibited 55% to 57% international co-authorship rates, representing almost equal global and domestic participation in research.

   BRAC University (BRACU), University of Rajshahi (RU), Jagannath University (JnU), University of Dhaka (DU), International Islamic University Chittagong (IIUC), and Shahjalal University of Science and Technology (SUST) also displayed international co-authorship rates between 51.45% and 54.15%, highlighting balanced engagement in research. These findings

emphasized the dominance of a collaborative culture that promoted domestic and international joint research initiatives and fostered collaboration among researchers at home and abroad.

3. **Lower International Co-authorship Rates:**

The globalization of collaborative research efforts and scholarly engagement within a specific educational landscape can be identified by assessing international co-authorship rates. Stamford University Bangladesh (SU) distinguished itself by displaying a lower international co-authorship rate compared to other selected institutions, with a rate of 32.53%.

American International University-Bangladesh (AIUB), United International University (UIU), North South University (NSU), University of Asia Pacific (UAP), Dhaka University of Engineering and Technology (DUET), University of Science and Technology Chittagong (USTC), Daffodil International University (DIU), Ahsanullah University of Science and Technology (AUST), and Rajshahi University of Engineering and Technology (RUET) also exhibited lower international co-authorship percentages below 45%. This observation highlighted distinct globalization cultures and knowledge-sharing practices within the academic community at these institutions.

4. **Clusters:**

Distinct patterns of co-authorship percentages were observed in the international collaborative landscape within academic institutions. Consequently, two clusters were developed. Sher-e-Bangla Agricultural University (SAU), Patuakhali Science and Technology University (PSTU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Bangladesh Agricultural University (BAU), Hajee Mohammad Danesh Science and Technology University (HSTU), Islamic University, Bangladesh (IU), Southeast University (SEU), Independent University, Bangladesh (IUB), Jahangirnagar University (JU), BRAC University (BRACU), University of Rajshahi (RU), Jagannath University (JnU), University of Dhaka (DU), and International Islamic University Chittagong (IIUC) were enlisted in the first cluster with co-authorship rates ranging from 50% to 75%. University of Chittagong (CU), Noakhali Science and Technology University (NSTU), East West University (EWU), Khulna University (KU), Chittagong University of Engineering and Technology (CUET),

Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh University of Engineering and Technology (BUET), Khulna University of Engineering and Technology (KUET), American International University-Bangladesh (AIUB), United International University (UIU), North South University (NSU), University of Asia Pacific (UAP), Dhaka University of Engineering and Technology (DUET), University of Science and Technology Chittagong (USTC), Daffodil International University (DIU), Ahsanullah University of Science and Technology (AUST), Rajshahi University of Engineering and Technology (RUET), and Stamford University Bangladesh (SU) were enrolled in the second cluster ranging from 32% to 50% co-authorship rates.

This observation highlighted the presence of internal groups within these institutions that promoted international collaboration, shared research interests, interdisciplinary expeditions, or strategic partnerships.

5. **Diversity:**

Universities exhibited diversity in co-authorship percentages. For instance, Sher-e-Bangla Agricultural University (SAU), Patuakhali Science and Technology University (PSTU), and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) presented high percentages of international collaboration at 74.70%, 72.42%, and 72.05%, respectively.

On the other hand, Ahsanullah University of Science and Technology (AUST), Rajshahi University of Engineering and Technology (RUET), and Stamford University Bangladesh (SU) demonstrated the lowest percentages of international collaboration at 37.14%, 34.48%, and 32.53%, respectively.

6. **Potential Influencing Factors:**

The patterns and trends exhibited potential influencing factors. One of the factors was the nature of the universities with different characteristics, focused on various disciplines like agriculture, science, and engineering. Sher-e-Bangla Agricultural University (SAU) and Bangladesh Agricultural University (BAU) were examples that exhibited higher co-authorship percentages due to the universal nature of agricultural research.

Geographical settings and local landscapes also affected international co-authorship proportions since institutions in major cities had more opportunities for collaboration worldwide.

7. **Influence of University Size:**

The patterns and trends indicated the correlation between university size and co-authorship percentages in international collaboration. Universities with larger communities exhibited proportionally higher collaboration rates because of their extensive community size, abundant resources, and strong networks.

5.7 Local Vs. International Co-authorship %

The data on total documents were analyzed through the "Biblioshiny" tool. International co-authorships % were retrieved through the analysis. Later, the number of International collaborative authors was calculated using the following equation:

International collaboration (author) =Collaborative author % International co-authorship (%).

After retrieving the number of International collaborative authors, Local collaborative authors were calculated using the following equation:

Local collaboration (author)=Collaborative Author-International collaboration (Author).

Finally, a comparative analysis was conducted between the collaboration categories, and the results were divided according to discipline and university.

5.7.1: Local Vs. International Co-authorship % in disciplines

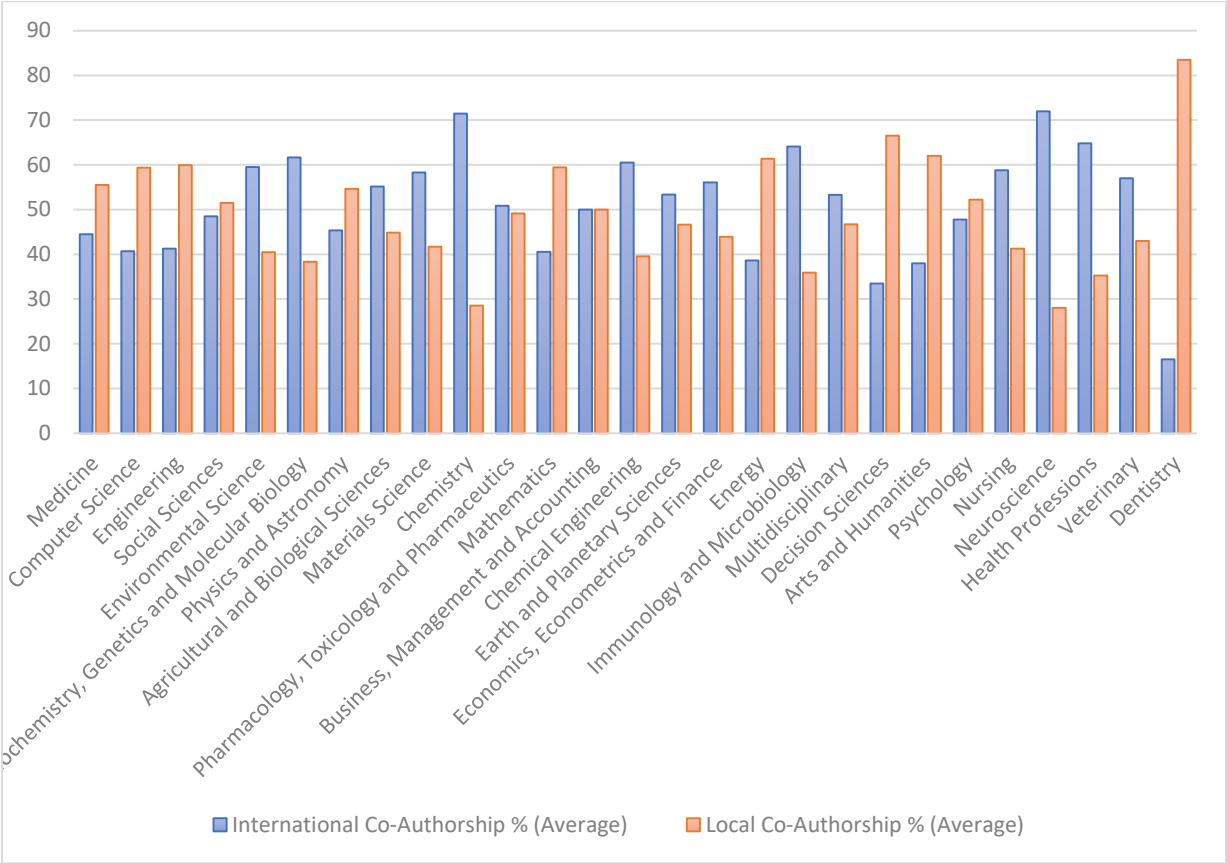
Table 5.7.1 highlighted the overview of the Local vs. international Co-authorship ratio in the research outputs of 33 universities in Bangladesh from 2012 to 2021. Each row in the table corresponded to a specific discipline, and each column represented the local and international Co-authorship percentages in various disciplines. The data revealed interesting patterns and trends, offering valuable insights into the research landscape of these institutions.

Table 5.7.1: Local Vs. International Co-authorship % in disciplines

Discipline	International Co-Authorship % (Average)	Local Co-Authorship % (Average)
Medicine	44.52	55.48
Computer Science	40.66	59.34
Engineering	41.29	59.96
Social Sciences	48.52	51.48
Environmental Science	59.54	40.46
Biochemistry, Genetics and Molecular Biology	61.68	38.32
Physics and Astronomy	45.32	54.66
Agricultural and Biological Sciences	55.16	44.84
Materials Science	58.30	41.70
Chemistry	71.46	28.54
Pharmacology, Toxicology and Pharmaceutics	50.83	49.17
Mathematics	40.57	59.43
Business, Management and Accounting	50.01	49.99
Chemical Engineering	60.50	39.52
Earth and Planetary Sciences	53.39	46.61
Economics, Econometrics and Finance	56.11	43.89
Energy	38.63	61.37
Immunology and Microbiology	64.11	35.89
Multidisciplinary	53.32	46.68
Decision Sciences	33.45	66.55
Arts and Humanities	37.98	62.02
Psychology	47.79	52.21
Nursing	58.76	41.24
Neuroscience	71.98	28.02
Health Professions	64.78	35.22
Veterinary	56.99	43.01
Dentistry	16.53	83.47

Figure 5.7.1.1 visually represented Table 5.7.1. It displayed the disciplines on the X-axis. The Y-axis indicates the local and international co-authorship percentage in disciplines. This figure offered valuable insights into the extent and pattern of collaboration in the authorship landscape.

Figure 5.7.1.1: Local Vs. International Co-authorship % in disciplines



The dynamics of research collaboration in different disciplines vary on the percentages of international and local co-authorship. However, several trends were observed for global and local partnerships in the academic disciplines.

Medicine exhibited international and local co-authorship rates at 44.52% and 55.48%, respectively. On the other hand, Computer Science demonstrated a lower international co-authorship rate of 40.66% and a higher local rate of 59.34%.

Engineering exhibited a similar pattern, with 41.29% international and 59.96% local co-authorship percentages, while the Social Sciences displayed nearly balanced dissemination between international and local co-authorship at 48.52% and 51.48%, respectively.

Environmental Science distinguished itself for its international collaboration at 59.54% and 40.46% local co-authorship percentages, whereas Biochemistry, Genetics, and Molecular Biology also preferred international co-authorship, with 61.68%, compared to 38.32% local.

Physics and Astronomy maintained a moderate balance, with 45.32% international and 54.66% local co-authorship, indicating a combination of global and local research collaborations.

Physics and Astronomy exhibited 45.32% international and 54.66% local co-authorship percentages; on the other hand, Agricultural and Biological Sciences displayed international co-authorship at 55.16%, with local co-authorship at 44.84%.

Materials Science displayed an international co-authorship rate of 58.30% and a local rate of 41.70%. Conversely, Chemistry demonstrated an international co-authorship rate of 71.46% and a local rate of 28.54%.

Pharmacology, Toxicology, and Pharmaceutics showed a near-equal distribution, with 50.83% international and 49.17% local co-authorship percentages, whereas Mathematics displayed a preference for local collaboration, with 40.57% international and 59.43% local co-authorship.

Business, Management, and Accounting maintained almost equal distribution of international (50.01%) and local (49.99%) co-authorship, suggesting a balanced approach to research collaboration.

Chemical Engineering presented a higher international co-authorship rate of 60.50% and a lower local rate of 39.52%, whereas Earth and Planetary Sciences exhibited 53.39% international and 46.61% local co-authorship percentages.

Economics, Econometrics, and Finance exhibited 56.11% international and 43.89% local co-authorship; on the other hand, Energy showed international co-authorship rates at 38.63% and a higher local rate of 61.37%.

Immunology and Microbiology displayed a high international co-authorship rate of 64.11% and a lower local rate of 35.89%, whereas Multidisciplinary disciplines exhibited 53.32% international and 46.68% local co-authorship percentages.

Decision Sciences preferred local collaboration, with only 33.45% international and 66.55% local co-authorship, indicating a stronger focus on local research efforts. Arts and Humanities, on the

other hand, inclined towards local co-authorship, with just 37.98% international and 62.02% local co-authorship, suggesting a stronger focus on local research networks.

Psychology showed a nearly balanced approach, with 47.79% international and 52.21% local co-authorship; conversely, Nursing presented an international co-authorship rate of 58.76% and local co-authorship rate of 43.03%, reflecting a global focus in this field.

Neuroscience exhibited one of the highest international co-authorship rates at 71.98% and a local co-authorship rate of 32.39%, underscoring strong global research collaborations; on the contrary, Health Professions followed with 64.78% international and 35.22% local co-authorship percentages.

Veterinary research indicated a higher international co-authorship rate at 56.99% and local co-authorship at 43.01%, whereas Dentistry demonstrated 16.53% international and 83.47% local co-authorship percentages, signifying an extensive emphasis on local research networks.

In summary, these disparities highlighted the various approaches to research collaboration within educational disciplines.

Patterns and Trends:

The comparative study of international and local co-authorship in disciplines disclosed the following patterns and trends:

1. **Discipline-specific Collaboration Preferences:**

   Chemistry, Pharmacology, Toxicology and Pharmaceutics, and Biochemistry, Genetics, and Molecular Biology exhibited high international co-authorship percentages, indicating a robust preference for global collaboration. On the other hand, Dentistry distinguished itself by its poor global co-authorship percentage, highlighting an inclination for local collaboration.

2. **Interdisciplinary Collaboration:**

   Multidisciplinary, Environmental Science, Earth, and Planetary Sciences displayed more or less equal dissemination of co-authorship percentages between international and local co-authorships.

Researchers in these disciplines demonstrated interdisciplinary research, combining their expertise and insights from local and international backgrounds.

3. **Globalization of Research in Health-related Fields:**

   Disciplines such as Medicine, Nursing, Health Professions, and Immunology and Microbiology exhibited a substantial international collaboration percentage, underlining an inclination toward globalization in research to share knowledge and expertise in health-related disciplines.

4. **Localized Focus in Energy and Decision Sciences:**

   Energy and Decision Sciences revealed a poor ratio of international co-authorship, signifying domestic insights into research and policymaking within these disciplines.

5. **Variability in Social Sciences and Economics:**

   Disciplines such as Social Sciences and Economics, Econometrics, and Finance exposed international and local co-authorship disparities. This observation emphasized a particular approach to preferring partnership categories within these disciplines.

6. **Strong Global Collaboration in Neuroscience:**

   A multifaceted and interdisciplinary nature of the research environment was revealed in Neuroscience by its significant international co-authorship percentage. This observation emphasized the globalization of research activities in this area.

7. **Regional Variations in Computer Science and Engineering:**

   Computer Science and Engineering exposed diversity in local co-authorship percentages. This disparity occurred due to research impacts, relationships with local industries, or collaboration activities in this domain.

8. **Arts and Humanities with a Local Emphasis:**

   Arts and Humanities exhibited a preference for regional or local collaboration, evidenced by its substantial local co-authorship percentages. This observation highlighted the domestic approach to research activities rather than globalization.

9. **Materials Science and Agricultural and Biological Sciences:**

   Materials Science and Agricultural and Biological Sciences exhibited almost equal distribution of co-authorship percentages. This finding highlighted an unbiased approach to selecting collaborative partnerships in this discipline.

10. **Globalization of Chemistry Research:**

    Chemistry exhibited a substantial percentage of international co-authorship, highlighting the preference for global partnerships. This observation indicated the existence of a unique research environment in this discipline.

In summary, the analysis extracted the aspects that impacted the collaboration categories, the nature of research, interdisciplinary behaviors, regional interests, and globalization.

5.7.2: Local Vs. International Co-authorship % in universities

Table 5.7.2 highlighted the overview of the Local vs. international Co-authorship ratio in the research outputs of 33 universities in Bangladesh from 2012 to 2021. Each row in the table corresponded to specific universities, and each column represented the local and international Co-Authorship percentages in various universities. The data revealed interesting patterns and trends, offering valuable insights into the research landscape of these institutions.

Table 5.7.2: Local Vs. International Co-authorship % in universities

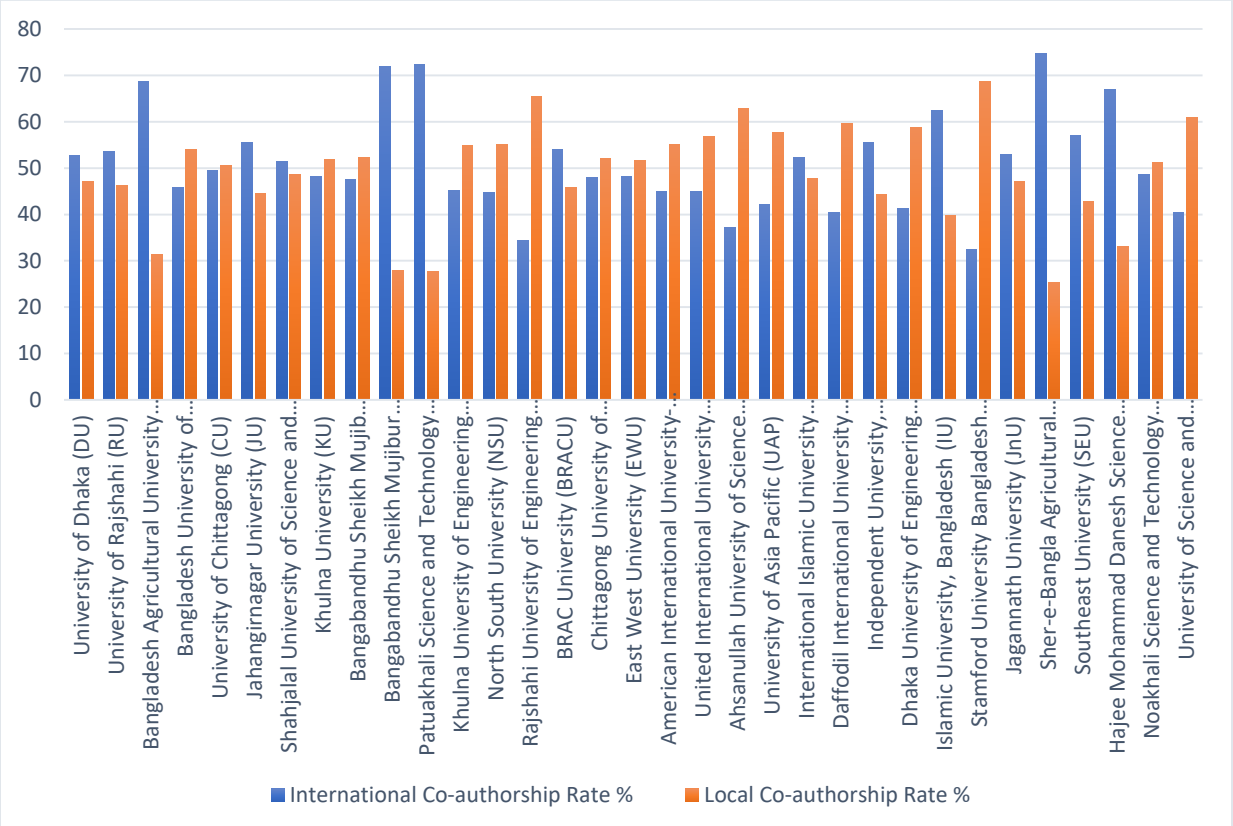
Universities	**International Co-authorship Rate %**	**Local Co-authorship Rate %**
University of Dhaka (DU)	52.83	47.17
University of Rajshahi (RU)	53.66	46.34
Bangladesh Agricultural University (BAU)	68.66	31.33
Bangladesh University of Engineering and Technology (BUET)	45.86	54.14
University of Chittagong (CU)	49.54	50.46
Jahangirnagar University (JU)	55.49	44.51
Shahjalal University of Science and Technology (SUST)	51.45	48.55
Khulna University (KU)	48.10	51.90
Bangabandhu Sheikh Mujib Medical University (BSMMU)	47.58	52.42
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	72.05	27.95
Patuakhali Science and Technology University (PSTU)	72.42	27.58
Khulna University of Engineering and Technology (KUET)	45.12	54.88
North South University (NSU)	44.81	55.19
Rajshahi University of Engineering and Technology (RUET)	34.48	65.52
BRAC University (BRACU)	54.15	45.85
Chittagong University of Engineering and Technology (CUET)	47.91	52.09
East West University (EWU)	48.28	51.72
American International University-Bangladesh (AIUB)	44.90	55.10
United International University (UIU)	44.87	56.80
Ahsanullah University of Science and Technology (AUST)	37.14	62.86
University of Asia Pacific (UAP)	42.24	57.76
International Islamic University Chittagong (IIUC)	52.24	47.76
Daffodil International University (DIU)	40.37	59.63

Table 5.7.2 Continued

Universities	International Co-authorship Rate %	Local Co-authorship Rate %
Independent University, Bangladesh (IUB)	55.60	44.40
Dhaka University of Engineering and Technology (DUET)	41.27	58.73
Islamic University, Bangladesh (IU)	62.52	39.80
Stamford University Bangladesh (SU)	32.53	68.67
Jagannath University (JnU)	52.87	47.13
Sher-e-Bangla Agricultural University (SAU)	74.70	25.30
Southeast University (SEU)	57.11	42.89
Hajee Mohammad Danesh Science and Technology University (HSTU)	66.97	33.03
Noakhali Science and Technology University (NSTU)	48.68	51.32
University of Science and Technology Chittagong (USTC)	40.56	60.94

Figure 5.7.2.1 visually represented Table 5.7.2. It displayed the universities on the X-axis. The Y-axis indicated the local and international co-authorship percentage in universities. This figure offered valuable insights into the extent and pattern of collaboration in the authorship landscape.

Table 5.7.2.1: Local Vs. International Co-authorship % in universities



Bangladeshi universities exhibited diverse international and local co-authorship rates in the country's research landscape, indicating valuable insights into approaches to research collaboration.

The University of Dhaka (DU) and the University of Rajshahi (RU) exhibited 52.83% and 53.66% international co-authorship rates and 47.17% and 46.34% local co-authorship rates, respectively.

Down the list, Bangladesh Agricultural University (BAU), Bangladesh University of Engineering and Technology (BUET), and University of Chittagong (CU) demonstrated 68.66%, 45.86%, and 49.54% international co-authorship rates and 31.33%, 54.14%, and 50.46% local co-authorship rates, individually.

Further down the list, Jahangirnagar University (JU), Shahjalal University of Science and Technology (SUST), and Khulna University (KU) displayed 55.49%, 51.45%, and 48.10% international co-authorship rates and 44.51%, 48.55%, and 51.90% local co-authorship rates, separately.

In the next tier, Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), and Patuakhali Science and Technology University (PSTU) exhibited 47.58%, 72.05%, and 72.42% international co-authorship percentages and 52.42%, 27.95%, and 27.58% local co-authorship percentages, respectively.

Down the tier, Khulna University of Engineering and Technology (KUET), North South University (NSU), and Rajshahi University of Engineering and Technology (RUET) exhibited 45.12%, 44.81%, and 34.48% international co-authorship rates and 54.88%, 55.19%, and 65.52% local co-authorship percentages, respectively.

Further down the tier, BRAC University (BRACU), Chittagong University of Engineering and Technology (CUET), and East-West University (EWU) displayed 54.15%, 45.85%, and 47.91% international co-authorship percentages and 45.85%, 52.09%, and 51.72% local co-authorship percentages, individually.

Down the list, American International University-Bangladesh (AIUB), United International University (UIU), and Ahsanullah University of Science and Technology (AUST) exhibited 44.90%, 44.87%, and 37.14% international co-authorship percentages and 55.10%, 56.80%, and 62.86% local co-authorship percentages, respectively.

Further down the list, the University of Asia Pacific (UAP), International Islamic University Chittagong (IIUC), and Daffodil International University (DIU) demonstrated international co-authorship rates of 42.24%, 52.24%, and 59.63%, respectively, and local co-authorship percentages of 57.76%, 47.76%, and 40.37%, individually.

Down the tier, Independent University, Bangladesh (IUB), Dhaka University of Engineering and Technology (DUET), and Islamic University, Bangladesh (IU) displayed international co-authorship rates of 55.60%, 41.27%, and 62.52%, respectively, and local co-authorship percentages of 44.40%, 58.73%, and 39.80%, individually.

Down the tier, Stamford University Bangladesh (SU), Jagannath University (JnU), and Sher-e-Bangla Agricultural University (SAU) exhibited international co-authorship rates of 32.53%, 52.87%, and 74.70%, separately, and local co-authorship percentages of 68.67%, 47.13%, and 25.30%, respectively.

At the bottom of the list, Southeast University (SEU), Hajee Mohammad Danesh Science and Technology University (HSTU), Noakhali Science and Technology University (NSTU), and University of Science and Technology Chittagong (USTC) displayed international co-authorship rates of 57.11%, 66.97%, 48.68%, and 40.56%, individually, and local co-authorship percentages of 42.89%, 33.03%, 51.32%, and 60.94%, respectively.

Varying research strategies and collaboration approaches were observed in academia due to diverse rates of international and local co-authorship percentages, significantly shaping these institutions' academic output and impact.

Patterns and Trends:

The following patterns and trends were observed in the given data regarding universities' international and local co-authorship ratios:

1. **Overall Distribution:** A significant divergence was observed in the international co-authorship rates of the universities, varying from 32.53% to 74.70%. Differences were also visible in the local co-authorship percentages, ranging from 25.30% to 68.67%.
2. **Balanced Collaboration:** The University of Dhaka (DU), University of Rajshahi (RU), and Bangladesh University of Engineering and Technology (BUET) exhibited a comparatively similar distribution of international and local co-authorship rates, around 50%.
3. **Predominantly International Collaboration:** Sher-e-Bangla Agricultural University (SAU), Patuakhali Science and Technology University (PSTU), and Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) displayed 74.70%, 72.42%, and 72.05% international co-authorship percentages, respectively, indicating strong commitment to fostering international collaboration in the agricultural research domain.
4. **Predominantly Local Collaboration:** With a strong focus on local collaboration, Stamford University Bangladesh (SU) maintained a relatively low international co-authorship rate of 32.53%.
5. **Engineering and Technology Universities:** Khulna University of Engineering and Technology (KUET) and Bangladesh University of Engineering and Technology (BUET) displayed higher levels of local co-authorship, signifying an increased emphasis on collaboration in engineering and technology within the country.
6. **Medical and Agricultural Universities:** Bangladesh Agricultural University (BAU) and Bangabandhu Sheikh Mujib Medical University (BSMMU) demonstrated significantly high levels of local co-authorship, indicating close connections to the local context.
7. **Diversity in Collaboration Approaches:** Collaboration approaches varied among universities. North South University (NSU) exhibited a slightly higher rate of local co-authorship, whereas International Islamic University Chittagong (IIUC) demonstrated a marginally higher rate of international co-authorship. This result highlights the diversity in approaches to collaboration.

8. **Potential Areas for Improvement:** Universities dealing with significant disparities in co-authorship rates can adopt measures to enhance collaboration within the lower percentage category. This proactive approach will facilitate the advancement of a balanced and diversified research network.

The above observations comprehensively outlined the collaborative patterns identified in universities. Further analysis of the utilization of domain-specific knowledge can reveal more reflective insights into the underlying reasons for these patterns and focus on the potential implications they hold for the research strategies of these universities.

5.8 Co-Authors per Document

The data on total documents were analyzed through the "Biblioshiny" tool. The statistics on co-authors per document were retrieved through the analysis, and results were divided according to discipline and university.

5.8.1: Co-Authors per Document in Disciplines

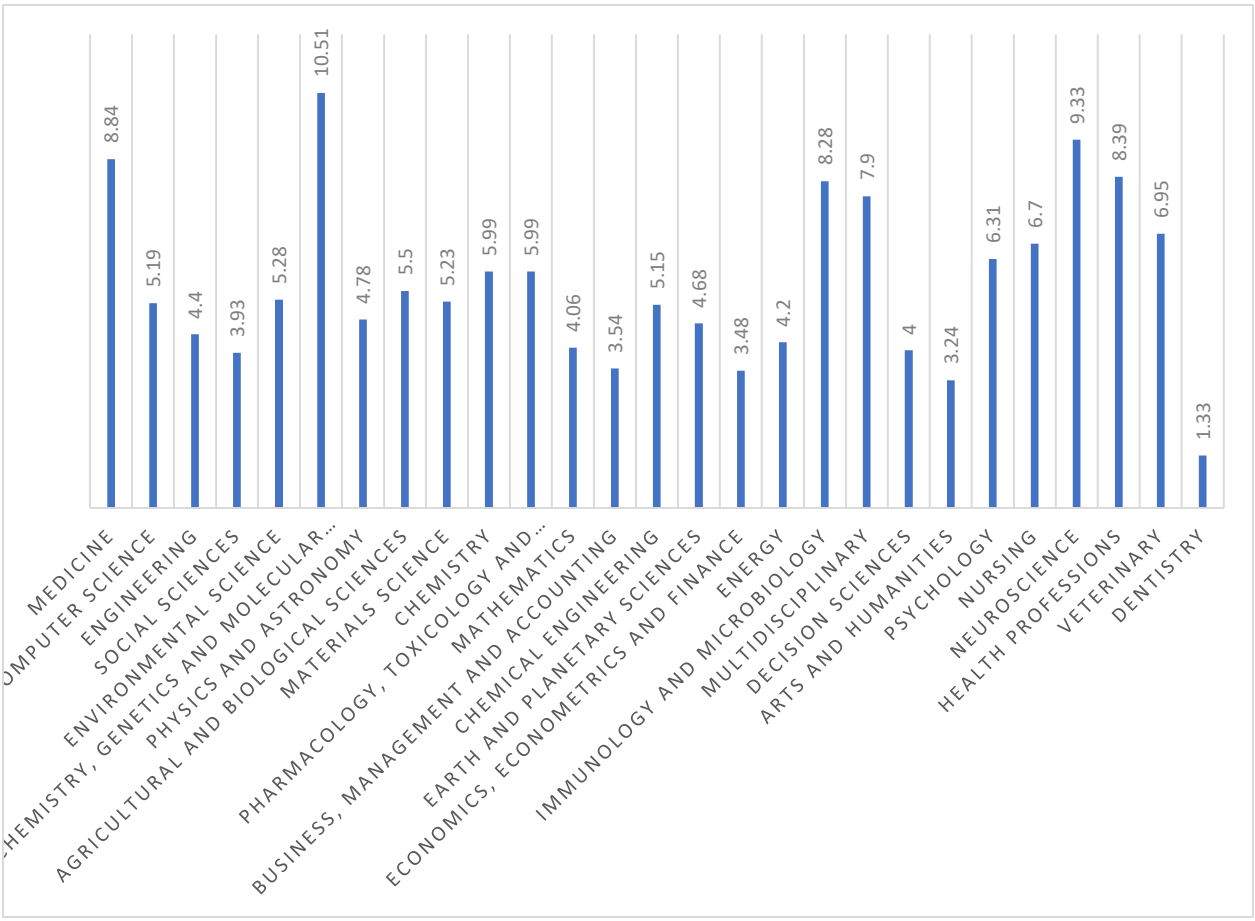
Table 5.8.1 was extracted from Appendix 12. It showcased different disciplines on the left, while Co-Authors per Document in each discipline from 2012 to 2021 on the right. A higher numerical value generally denoted an extended number of co-authors per document in a particular discipline, whereas a lower value specified a reduced number of co-authors per document in each discipline.

Table 5.8.1: Co-Authors per Document in Disciplines

Disciplines	**Co-authors per Document**
Medicine	8.84
Computer Science	5.19
Engineering	4.40
Social Sciences	3.93
Environmental Science	5.28
Biochemistry, Genetics and Molecular Biology	10.51
Physics and Astronomy	4.78
Agricultural and Biological Sciences	5.50
Materials Science	5.23
Chemistry	5.99
Pharmacology, Toxicology and Pharmaceutics	5.99
Mathematics	4.06
Business, Management and Accounting	3.54
Chemical Engineering	5.15
Earth and Planetary Sciences	4.68
Economics, Econometrics and Finance	3.48
Energy	4.20
Immunology and Microbiology	8.28
Multidisciplinary	7.90
Decision Sciences	4.00
Arts and Humanities	3.24
Psychology	6.31
Nursing	6.70
Neuroscience	9.33
Health Professions	8.39
Veterinary	6.95
Dentistry	1.33

Figure 5.8.1.1 visually represented Table 5.8.1. It exhibited the disciplines on the X-axis. The Y-axis indicated the co-authors per document in disciplines. This chart suggested valuable insights into the extent and pattern of co-authorship in documents.

Figure 5.8.1.1: Co-Authors per Document in disciplines



The average number of co-authors per document in different disciplines specified the extent of collaboration in academic research.

Disciplines in health domains such as Biochemistry, Genetics, and Molecular Biology, Neuroscience, Medicine, Health Professions, and Immunology and Microbiology exhibited the highest average number of co-authors per document at 10.51, 9.33, 8.84, 8.39, and 8.28, respectively.

Down the list, Multidisciplinary, Veterinary, and Nursing displayed an average number of co-authors per document at 7.90, 6.95, and 6.70, respectively.

Further down the list, Psychology, Pharmacology, Toxicology, and Pharmaceutics, Chemistry, and Agricultural and Biological Sciences exhibited 6.31, 6.00, 5.99, and 5.50 co-authors per document, respectively, whereas Environmental Science, Materials Science, Computer Science, and Chemical Engineering demonstrated 5.28, 5.23, 5.19, and 5.15 average co-authors per document.

Down the tier, Physics and Astronomy, Earth and Planetary Sciences, Engineering, Energy, and Mathematics exhibited 4.78, 4.68, 4.40, 4.20, and 4.06 co-authors per document, respectively.

In the next tier, Decision Sciences, Social Sciences, Business, Management and Accounting, Economics, Econometrics and Finance, and Arts and Humanities exhibited a lower average number of co-authors per document at 4.00, 3.93, 3.54, 3.48, and 3.24, respectively.

At the bottom, Dentistry demonstrated the lowest average number of co-authors per document at 1.33.

The above data provide patterns and trends in the extent of collaboration among disciplines and insights into the distinct nature of research in each field.

Patterns and Trends:

The data indicated the following patterns and trends extracted from the average count of co-authors per document in diverse academic disciplines:

1. **High Co-authorship Disciplines:** Biochemistry, Genetics, and Molecular Biology, Neuroscience, and Medicine exhibited the highest average count of co-authors per document at 10.51, 9.33, and 8.84, respectively, indicating the inherent collaborative nature of health-related research, encouraging the shared scholarly talent of various contributors.

2. **Moderate Co-authorship Disciplines:** Immunology and Microbiology, Health Professions, and Multidisciplinary disciplines displayed a moderate average count of co-authors per

document at 8.28, 8.39, and 7.90, respectively, signifying a comparatively moderate level of collaboration and the interdisciplinary nature of research in these domains.

3. **Moderate to Low Co-authorship Disciplines:** A moderate to low number of co-authors was visible in Veterinary, Nursing, Psychology, Pharmacology, Toxicology, and Pharmaceutics, Chemistry, Agricultural and Biological Sciences, Environmental Science, Materials Science, Computer Science, Chemical Engineering, Physics and Astronomy, Earth and Planetary Sciences, Engineering, Energy, and Mathematics at 6.95, 6.70, 6.31, 6.00, 5.99, 5.50, 5.28, 5.23, 5.19, 5.15, 4.78, 4.68, 4.40, 4.20, and 4.06, respectively. Although moderate to low, some disciplines within this category underscored progressive collaboration intensities.

4. **Low Co-authorship Disciplines:** Decision Sciences, Social Sciences, Business, Management and Accounting, Economics, Econometrics and Finance, and Arts and Humanities exhibited low co-authorship percentages at 4.00, 3.93, 3.54, 3.48, and 3.24, respectively, indicating fewer co-authors were engaged in these disciplines due to their more distinctive or narrowly focused nature of research.

5. **Outlier:** Dentistry exhibited itself as the outlier with the lowest average count of co-authors per document at 1.33, indicating a noteworthy inclination toward singular or small-group research and signifying the unique nature of collaboration within this discipline.

6. **Interdisciplinary Nature:** The multidisciplinary discipline exhibited a higher average number of co-authors per document, indicating that the nature of interdisciplinary research seemed collaborative and benefited from the shared knowledge of researchers from different fields.

The above patterns and trends highlighted the nature of research in various disciplines. Collaboration in these disciplines was influenced by intricacies in subjects, varied research methodologies, and specific applications.

5.8.2: Co-Authors per Document in Universities

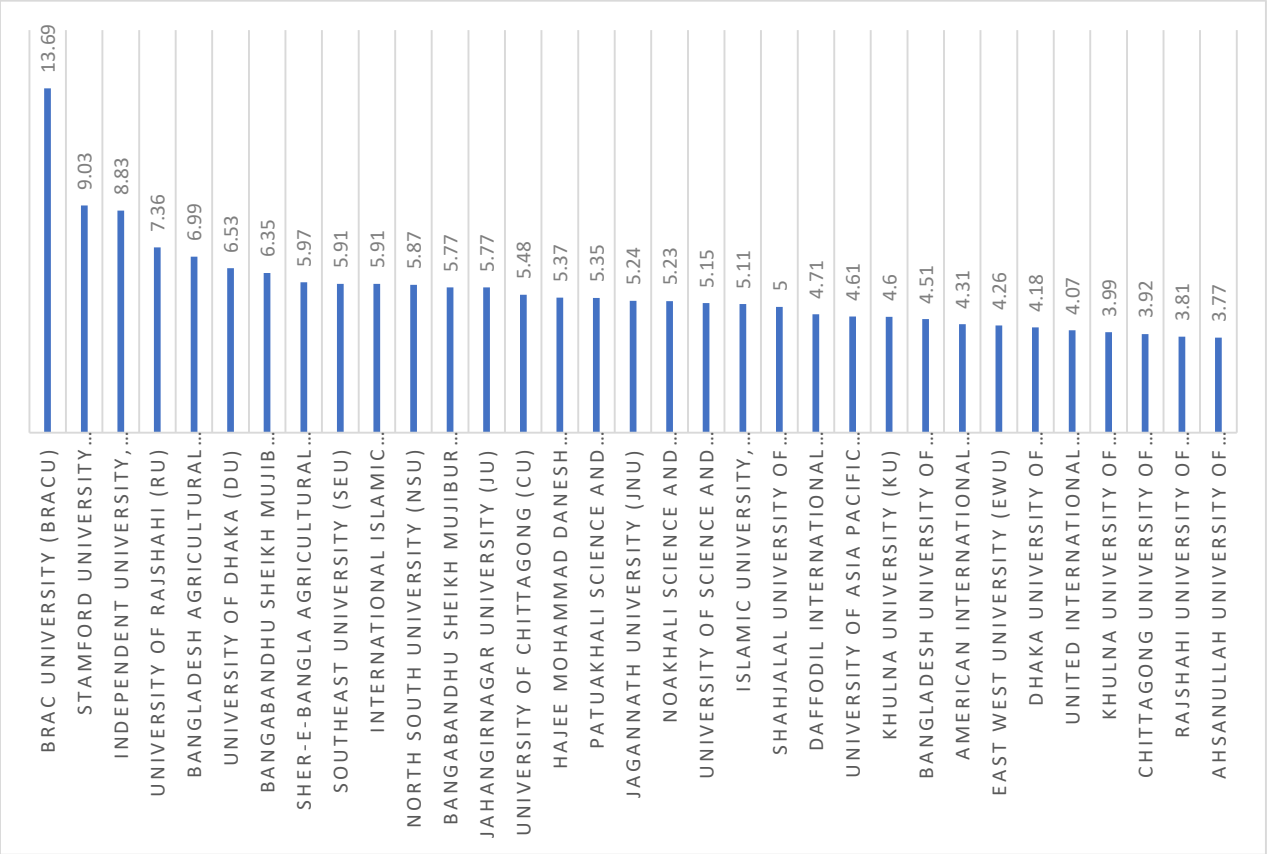
Table 5.8.2 was extracted from Appendix 12. It presented different universities on the left, while the co-authors per document for each university from 2012 to 2021 on the right.

Table 5.8.2: Co-Authors per Document in Universities

Universities	**Co-authors per Document**
BRAC University (BRACU)	13.69
Stamford University Bangladesh (SU)	9.03
Independent University, Bangladesh (IUB)	8.83
University of Rajshahi (RU)	7.36
Bangladesh Agricultural University (BAU)	6.99
University of Dhaka (DU)	6.53
Bangabandhu Sheikh Mujib Medical University (BSMMU)	6.35
Sher-e-Bangla Agricultural University (SAU)	5.97
Southeast University (SEU)	5.91
International Islamic University Chittagong (IIUC)	5.91
North South University (NSU)	5.87
Bangabandhu Sheikh Mujibur Rahman Agricultural	5.77
Jahangirnagar University (JU)	5.77
University of Chittagong (CU)	5.48
Hajee Mohammad Danesh Science and Technology	5.37
Patuakhali Science and Technology University (PSTU)	5.35
Jagannath University (JnU)	5.24
Noakhali Science and Technology University (NSTU)	5.23
University of Science and Technology Chittagong (USTC)	5.15
Islamic University, Bangladesh (IU)	5.11
Shahjalal University of Science and Technology (SUST)	5.00
Daffodil International University (DIU)	4.71
University of Asia Pacific (UAP)	4.61
Khulna University (KU)	4.60
Bangladesh University of Engineering and Technology	4.51
American International University-Bangladesh (AIUB)	4.31
East West University (EWU)	4.26
Dhaka University of Engineering and Technology (DUET)	4.18
United International University (UIU)	4.07
Khulna University of Engineering and Technology (KUET)	3.99
Chittagong University of Engineering and Technology	3.92
Rajshahi University of Engineering and Technology	3.81
Ahsanullah University of Science and Technology (AUST)	3.77

Figure 5.8.2.1 visually represented Table 5.8.2. It displayed the universities on the X-axis. The Y-axis indicates the co-authors per document in universities. This figure presented valuable insights into the extent and pattern of co-authors in research outputs.

Figure 5.8.2.1: Co-Authors per Document in Disciplines



The universities exhibited diversity in co-authors per document. BRAC University (BRACU), Stamford University Bangladesh (SU), Independent University, Bangladesh (IUB), and University of Rajshahi (RU) exhibited the highest co-authors per document ratios at 13.68667, 9.026538, 8.833704, and 7.362593, respectively.

Down the list, Bangladesh Agricultural University (BAU), University of Dhaka (DU), Bangabandhu Sheikh Mujib Medical University (BSMMU), Sher-e-Bangla Agricultural University (SAU), Southeast University (SEU) and International Islamic University Chittagong

(IIUC) displayed moderate number co-authors per document at 6.991481, 6.525556, 6.345185, 5.968148, 5.908148 and 5.905185, individually.

Further down the list, North South University (NSU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Jahangirnagar University (JU), University of Chittagong (CU), Hajee Mohammad Danesh Science and Technology University (HSTU) and Patuakhali Science and Technology University (PSTU) exposed 5.865556, 5.7732, 5.768519, 5.477778, 5.365185 and 5.34963 average co-authors per document, separately.

In the next tier, Jagannath University (JnU), Noakhali Science and Technology University (NSTU), University of Science and Technology Chittagong (USTC), Islamic University, Bangladesh (IU) and Shahjalal University of Science and Technology (SUST) disclosed average co-authors per document at 5.235556, 5.231481, 5.152222, 5.107308 and 5.001111, respectively.

Down the tier, Daffodil International University (DIU), University of Asia Pacific (UAP), Khulna University (KU), Bangladesh University of Engineering and Technology (BUET), American International University-Bangladesh (AIUB), East West University (EWU), Dhaka University of Engineering and Technology (DUET) and United International University (UIU) exhibited comparatively lower average co-authors per document at 4.712222, 4.61037, 4.598889, 4.513889, 4.31, 4.258148, 4.177407 and 4.070385, individually.

At the bottom, Khulna University of Engineering and Technology (KUET), Chittagong University of Engineering and Technology (CUET), Rajshahi University of Engineering and Technology (RUET), and Ahsanullah University of Science and Technology (AUST) displayed the lowest average co-authors per document at 3.993704, 3.918889, 3.8088 and 3.767778, respectively.

In conclusion, the study on the statistics regarding co-authors per document in universities exposed various patterns of research collaboration and provided insights on partnerships and dynamics of the nature of research endeavors.

Patterns and Trends:

Following patterns and trends were observed in the data on universities and their co-authors per document:

1. **High Co-authorship Rates:**

   BRAC University (BRACU), Stamford University Bangladesh (SU), Independent University, Bangladesh (IUB), and University of Rajshahi (RU) exhibited the highest number of co-authors per document ranging from 13.69 to 7.36, indicating an exemplary range of participation in collective pursuits and dedication to collaborative research.

2. **Moderate Co-authorship Rates:**

   In contrast, a more moderate and noteworthy degree of collaboration was visible at the Bangladesh Agricultural University (BAU), University of Dhaka (DU), Bangabandhu Sheikh Mujib Medical University (BSMMU), Sher-e-Bangla Agricultural University (SAU), Southeast University (SEU), International Islamic University Chittagong (IIUC), North South University (NSU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Jahangirnagar University (JU), University of Chittagong (CU), Hajee Mohammad Danesh Science and Technology University (HSTU), Patuakhali Science and Technology University (PSTU), Jagannath University (JnU), Noakhali Science and Technology University (NSTU), University of Science and Technology Chittagong (USTC), Islamic University, Bangladesh (IU) and Shahjalal University of Science and Technology (SUST) ranging from 6.99 to 5.00, signifying the existence of substantial collaborative endeavors within these institutes.

3. **Lower Co-authorship Rates:**

   Daffodil International University (DIU), University of Asia Pacific (UAP), Khulna University (KU), Bangladesh University of Engineering and Technology (BUET), American International University-Bangladesh (AIUB), East West University (EWU), Dhaka University of Engineering and Technology (DUET), United International University (UIU), Khulna University of Engineering and Technology (KUET), Chittagong University of Engineering and Technology (CUET), Rajshahi University of Engineering and Technology (RUET) and

Ahsanullah University of Science and Technology (AUST) revealed comparatively lower rates of co-authorship per document, indicating a preference for singular research or in-house partnerships.

4. **Variability in Co-authorship Rates:**

   Universities exhibited a significant variation in co-authorship rates, ranging from 13.69 to 3.77. This observation highlighted the existence of diverse approaches to collaboration or the absence of uniformity in categorizing and conducting collaborative research.

5. **Similarity in Co-authorship Rates:**

   A resemblance was visible in the co-authorship rates of Bangladesh Agricultural University (BAU), Bangabandhu Sheikh Mujib Medical University (BSMMU), and Shahjalal University of Science and Technology (SUST) indicating the existence of similar shared strategies to promote a research culture that encourages collaboration.

6. **Potential Collaboration Hubs:**

   BRAC University (BRACU), Stamford University Bangladesh (SU), Independent University, Bangladesh (IUB), and University of Rajshahi (RU) turned into potential collaboration hubs for their remarkable co-authorship rates. This finding highlighted the culture and environment these universities promoted for advancing collaborative endeavors, which made them iconic for research partnerships.

7. **Diversity in Research Practices:**

   The variation in co-authorship rates among universities in Bangladesh highlighted the substantial diversity in research practices. Universities did not put equal importance to promote a collaborative environment that improved productivity and reduced the complexity of academia.

A comprehensive understanding of research collaboration could not be achieved only from co-authorship rates. Several factors shaped these trends, such as the types of research, academic

specializations, and institutional size. More inclusive analysis and contextual details were required to understand the research atmosphere in these universities.

Chapter 6

Limitations, Barriers, Recommendations, Future Research Direction

6.1 Limitations

Limitations of the study

The study's main limitation is managing access to the research tool "Scopus Database" since it is not free and very few universities were subscribed to access it. Other limitations were common in research, such as time frame, large area, selecting an arithmetic technique to analyze data, etc. The unavailability of research outputs online was another limitation since some of them were not accessible from the country.

The researcher's inexperience in conducting a bibliometric study became a limitation to doing such research. The researcher conquered the hurdles by applying learning through doing that slowed down the speed of the study.

Limitations of the Scientometric Analysis

The scientometric analysis primarily focuses on quantitative measures, such as publication counts, citations, and co-authorship networks. However, this analysis provides valuable insights but may not fully capture the quality, impact, or interdisciplinary nature of research collaborations. Consequently, the study may present an incomplete reflection of the current state of collaboration in Bangladesh. However, the following limitations have been observed:

a. **Data Availability and Quality**

   The accuracy of scientometric analysis can be compromised by the limited or incomplete data available on research outputs, particularly in developing countries like Bangladesh. Biased

results and incomplete representations of research collaboration may occur due to poor databases and missing information.

b. **Language Barriers**

In Bangladesh, lots of publications are published in other languages than English. This language barrier causes a significant challenge, possibly excluding a considerable amount of research from scientometric analyses, thereby affecting the accuracy of collaboration assessments.

c. **Interdisciplinary Research**

The interdisciplinary nature of modern research is not always fully captured by predefined subject categories in scientometric analyses. Subsequently, collaborations in various disciplines may be misjudged or ignored in traditional scientometric analyses.

d. **Authorship Practices**

Different authorship practices, including complementary authors or ignoring eligible contributors, may affect the accuracy of collaboration metrics. As a result, credit may not go to actual researchers or important contributors.

e. **National vs. International Collaborations**

Scientometric analysis often fails to identify the distinction between national and international collaborations. A threadbare analysis of the research domain requires considering international collaboration as well as local and national collaborations.

f. **Contextual Factors**

Socioeconomic or political factors have an impact on collaborative research in a country. Scientometric analysis usually ignores these factors. Inclusive context analysis is crucial to understanding collaboration patterns comprehensively.

g. **Dynamic Nature of Collaboration**

Collaboration patterns are dynamic in nature and usually change in a short duration. A sample at a specific time may not precisely present the long-term trends or the changes in collaboration patterns. A longitudinal study can give more comprehensive results, even though they are not so sustainable.

h. **Qualitative Aspects**

Scientometric analysis usually emphasizes quantitative data. Qualitative aspects like communication skills, collaboration impact on results, and the effectiveness of multidisciplinary approaches may be ignored.

i. **Institutional vs. Individual Collaborations**

The scientometric analysis focuses on institutional collaborations and often overlooks collaboration in persons. Analysis of both aspects is crucial in order to measure the total collaboration.

j. Policy and Funding Impact

The impact of public policies and funding is typically overlooked in scientometric analyses. The inclusion of these factors in the analysis will affect collaboration patterns, resulting in more extensive outcomes.

To overcome these limitations, the study incorporated scientometric analysis in a wide range of analytical tools concerning quantitative methods and understanding the specific research context. Moreover, the accuracy and reliability of scientometric analysis were ensured by collecting real-time information from the Scopus database.

6.2 Barriers to Research Collaboration

Successful academic activities heavily depend on effective research and collaboration can boost the production of research outputs. However, collaboration often affected by barriers ranging from geographical differences to communication success. The following discussion covers these obstacles to collaborative endeavors:

1. Communication Barriers:

Different locations of the collaborators, diverse time zones, languages, and cultural divergence create difficulties in successful communication. Moreover, differences in communication protocol occurring from diverse intellectual backgrounds and expected results may cause barriers to collaborative projects. Employing specific strategies in communication methods may solve the complications (Cummings & Kiesler, 2007).

2. Different Research Objectives:

Research collaboration encompasses researchers with varied concerns, purposes, and approaches. Managing this diversity in an interrelated context is challenging, as any inconsistency may affect collaborative outcomes ((Eisenhardt,1989; Sonnenwald, 2007; Denis & Lomas, 2003)

3. Resource Allocation and Competition:

Research collaboration involves resource sharing such as funding, equipment, personnel, etc. However, there is competition for resource collection among researchers because of the limited supplies, resulting in debates and inequality in resource access (Kling et al., 2000).

4. Intellectual Property Concerns

In collaborative efforts, researchers may not disclose their original findings or discoveries due to improper explanations of intellectual property rights. A well-defined guidelines covering copyrights and usage can build trust among partners and ensure unbiased credit and incentives (Evans, N. & Miklosik, A., 2023).

5. Limited Funding

Funding is essential for collaborative endeavors. Researchers often suffer from limited financing that may shrink the research area's extent and degrade the outcome's quality. Governments and institutions should allocate adequate financial support for the uninterrupted completion of collaborative research (Kling et al., 2000; Heffner, 1981).

6. Infrastructure and Resources:

Advanced research infrastructure and facilities can support the progress of technology-driven study. The impact of insufficient advanced resources and facilities on collaborative endeavors indicates the need to develop successful collaboration arrangements (Evans, N. & Miklosik, A., 2023) .

7. Bureaucratic Barriers

Bureaucratic processes and procedures may hamper the progress of collaborative efforts. Researchers often face challenges conducting paperwork regarding approval and funding. A one-stop service may beat the challenges and speed up the process (Evans, N. & Miklosik, A., 2023)

8. Lack of Interdisciplinary Collaboration

Institutional isolation and disciplinary research practice fail to incorporate the diverse aspects. Interdisciplinary collaboration is necessary to include various aspects and break down barriers among disciplines to promote more extensive outcomes (Börner et al., 2010).

9. Limited Research Culture

The culture of giving preference to teaching rather than research demotivates researchers to join research programs. Collaborative efforts require a cultural shift in the academic arena so that researchers can get enough time to join research projects (Cummings & Kiesler, 2007).

10. Inadequate Training and Skills Development

Inadequate training is a barrier to collaborative research. In that case, researchers fail to acquire the necessary skills and competencies, affecting outcomes. This effect emphasizes the necessity to enhance researchers' capabilities through training (Bozeman & Dietz, 2001).

In summary, an explicit strategic and operational plan involving the academic community, government bodies, and researchers is required to overcome these hurdles.

6.3 Recommendations for Research Collaboration

Considering the vast research domain, the collaborative research project can be a vision in Bangladesh. Some suggestions have been placed to promote successful collaboration:

1. **Identifying Potential Patterns**

   A thorough analysis is required to identify and reshape the patterns in the research domain and tailor them to the collaborative research landscape. Researchers may find these patterns when they join conferences, workshops, and collaborative networking events and utilize online platforms.

2. **Investing in Long-Term Partnerships:**

   A successful collaboration culture requires building long-term relationships among researchers, institutions, and other stakeholders. Collaborative research should focus on long-standing results rather than short-term outputs. Consequently, funding agencies, institutions, and governments should promote multi-year projects and involve individuals in durable relationships.

3. **Understanding Local Context**

   Researchers should be aware of local communities' socio-cultural and economic complexities while conducting local collaborative research. Local collaborators can provide valuable insights and help avoiding culturally sensitive contexts.

4. **Building Relationships**

   Building strong relationships in collaborative research is essential. Continuous and meaningful virtual and face-to-face communication enables researchers to build strong relationships. Physical presence in an academic community can accurately represent the collaborative research landscape and ensure personal bonds.

5. **Seeking Funding Opportunities**

Collaborative research usually requires enough funds, especially for large-scale research. Consequently, exploring funds from both home and abroad is essential. For local grants, collaborative endeavors should include local collaborators.

6. **Addressing Ethical Considerations**

Following the ethical guidelines and practices in the local and international community is crucial. Research design and methodology need to be aligned with the community's existing morals, standards, and customs.

7. **Exploiting Technology**

Communication technology can play a vital role in collaborative research. Video conferencing, project management platforms, and shared repositories contribute to coordinating with partners and sharing documents and thoughts.

8. **Engaging with the Community**

Engaging the local community is essential to encompass diversity. Research becomes more effective and visible if it includes participation from local leaders and stakeholders that correlates with the requirements and interests of the larger population.

9. **Language Considerations**

Though English is the medium of instruction in higher education and research, learning the local language enables researchers to improve communication. In the same language, learning dialects may render similar results. However, understanding the local language or dialect promotes better and easier interaction and communication.

10. Publishing Collaborative Research

Researchers should publish their findings in international and local journals to increase the achievement of collaborative efforts. This distribution strategy boosts prominence and reception within the international and local academic communities.

11. **Stay Informed about Regulations:**

Researchers must be aware of regulations regarding research and collaboration. Regulations may be changed according to the needs of the community, encompassing communication protocols, intellectual rights, duration, extension, funding, audit, and so on.

12. Cultivating Interdisciplinary Collaboration:

Interdisciplinary research is more valuable and complex because of its enormous scope and divergence. A suitable environment and distinct place can enhance cross-disciplinary interactions through which researchers can meet together, exchange ideas, get training for skills, and build the framework of projects.

13. Promoting Inclusivity and Diversity:

Research collaboration is enriched by adopting various intellectual viewpoints, socio-economic backgrounds, and diverse methodologies. To promote diversity, institutions can support underrepresented or new researchers in publishing their collaborative research papers through mentorship programs.

14. Establishing Clear Communication Protocols:

Collaborative research heavily depends on successful communication among researchers, institutions, and other stakeholders. A well-defined communication protocol provides a framework that accurately defines expectations, accountabilities, and indications. Regular meetings, workshops, and participation in the social network platform enable the researchers to be aware of updates and be involved in research activities.

6.4 Future Research Directions of Scientometric Analysis on Research Collaboration in Bangladesh

1. **Mapping Cross-Disciplinary Collaboration**

   A thorough analysis of the research culture and practice in different disciplines may facilitate the assessment of collaboration in Bangladesh. A complete perception of the evolution of the country's collaboration landscape can be achieved by identifying possible interdisciplinary areas.

2. **Chronological Analysis**

   A specific longitudinal data analysis is required to analyze collaboration trends comprehensively. It involves assessing turning points, observing changes in collaboration patterns, and calculating the impact of changes in policies or external factors on collaborative research.

3. **International Collaboration Networks**

   Identifying the involvement of Bangladeshi researchers in international research collaboration requires a thorough analysis. It will also include the identification of countries and institutions concerned as well as factors affecting collaborative efforts.

4. **Institutional Analysis**

   An analysis of the research culture and practices at each institution or university is necessary to identify the complex nature of collaboration. The institution's role and a SWOT analysis in collaboration efforts make it easier to define critical factors responsible for efficient partnerships.

5. **Impact Assessment**

   As collaboration affects the productivity of research outputs, citation metrics, and knowledge development, it is essential to assess the impact of collaboration. Ways and means to enhance

collaboration and the importance and value of research outputs should be considered in this assessment.

6. **Identifying Barriers to Collaboration**

   The Bangladeshi researchers face organizational obstacles, financial constraints, cultural differences, and communication barriers while creating a collaborative effort. Policymakers need to be proactive in identifying and dealing with these challenges.

7. **Open Science and Data Sharing**

   Open science practices and data sharing in collaborative research in Bangladesh require extensive analysis. Their impact on collaboration, clarity, and research reproduction capability is noteworthy.

8. **Policy Implications**

   Creating a cooperative environment at the national level is necessary to improve research collaboration. Policy inventions should emphasize providing funds and resources to research institutions, encouraging a collaborative culture and knowledge sharing, and applying mechanisms to monitor and evaluate collaborative research projects efficiently.

9. **Social Network Analysis**

   Social network analysis techniques enable analyzing and mapping collaboration networks among researchers, institutes, and countries. This technique creates an image of collaborative relationships and assists in detecting focal points within the network.

10. **Technological Innovation and Collaboration**

    Identifying the contribution of emerging technologies to the research collaboration is essential. An extensive analysis may reveal the implication of technologies in shaping multidisciplinary research.

Researchers in Bangladesh are required to integrate qualitative and quantitative methods in scientometric analysis to understand collaboration comprehensively. This technique permits distinguishing divergent patterns of collaborative landscape. However, researchers must be aware

of the latest developments in scientometrics analysis, research policy, and technology trends to ensure the importance and influence of their outcomes.

Conclusion

The research showed the prevalence of research collaboration across many domains in Bangladesh, with articles published domestically and internationally, where Bangladeshi authors participated as co-authors. Despite this, very few researchers have examined the notion of authorship collaboration in Bangladesh. The absence of such studies highlights the need for reflective research in this area. This study aimed to address this gap, although more such studies are required to understand the collaboration scenario completely.

This scientometric analysis was conducted to provide valuable insight into the interaction between academic institutions and their research outputs. The analysis offered a comprehensive overview of the dynamics of research collaboration, showing the strengths and difficulties in academia by exploring journal articles, authorship patterns, and citation data.

Moreover, this study offers insights into the benefits of interdisciplinary collaboration, sharing knowledge, and combining expertise, leading to a significant increase in co-authored publications.

Furthermore, the authorship and citation data analysis shows differences in research output between institutions and disciplines, indicating the need for a more balanced collaboration among researchers in disciplines and regions. Thus, policymakers, funding agencies, and academic institutions must address this issue to build a more diverse and balanced research landscape.

In addition, an analysis of authors and citation data highlights the impact of collaboration research as well as their visibility and influence. However, the interconnected nature of research entities and significant collaborative authorship within the country emphasize the distribution of knowledge dissemination and increased participation in the international research domain. The impact of research outputs in Bangladesh in the global research domain could be enhanced by strengthening these connections and promoting international collaboration.

Finally, this scientometic analysis provides an extensive overview of the collaborative research efforts in Bangladesh, showing its successes and identifying areas for improvement.

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Appendices

Appendix 1. Total Documents in disciplines and universities

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	1274	1154	1140	932	741	719	706	696	562	546	533	409	343	341	306	283	251	243	212	188	152	87	68	48	44	29	11
University of Rajshahi (RU)	496	644	829	296	402	476	661	538	531	344	163	301	124	212	192	117	291	104	170	93	39	39	38	20	13	27	1
Bangladesh Agricultural University (BAU)	269	68	168	131	516	470	28	1487	28	78	73	12	17	94	96	33	71	226	105	5	2	4	21	19	6	303	1
Bangladesh University of Engineering and Technology (BUET)	256	2277	3142	382	522	159	1498	118	1037	294	23	525	136	324	290	29	503	18	71	190	56	8	6	13	25	1	0
University of Chittagong (CU)	9	480	455	277	349	275	295	26	2	229	149	121	113	85	114	111	146	64	76	36	54	24	13	6	18	14	0
Jahangirnagar University (JU)	496	562	459	252	380	285	505	255	277	342	224	167	64	112	185	61	102	127	81	94	36	43	25	53	19	14	1
Shahjalal University of Science and Technology (SUST)	180	305	355	200	332	197	220	343	223	280	38	85	69	195	121	80	118	58	97	48	41	6	13	9	3	6	0
Khulna University (KU)	287	422	476	150	331	192	209	335	167	103	151	113	70	96	81	61	88	33	67	57	13	10	15	8	5	17	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1182	13	14	20	20	115	8	19	4	8	60	1	1	5	0	2		63	44	0	2	40	20	29	5	3	11
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	84	20	53	65	175	205	12	482	17	45	21	9	6	24	36	13	27	87	60	4	2	0	5	7	0	48	0

University of Asia Pacific	Ahsanullah University of Science and Technology	United International University (UIU)	American International University-Bangladesh (AIUB)	East West University (EWU)	Chittagong University of Engineering and Technology (CUET)	BRAC University (BRACU)	Rajshahi University of Engineering and Technology	North South University (NSU)	Khulna University of Engineering and Technology (KUET)	Patuakhali Science and Technology University (PSTU)	University name and abbr.
135	39	80	76	120	62	539	46	362	157	100	Medicine
267	474	411	868	356	717	688	661	912	1288	93	Computer Science
266	521	281	777	271	772	489	999	617	1283	108	Engineering
50	62	88	75	120	69	345	59	278	100	72	Social Sciences
60	74	29	56	51	126	95	120	166	151	184	Environmental Science
35	11	36	9	46	25	97	34	155	36	87	Biochemistry, Genetics and Molecular
87	206	77	229	101	412	156	562	188	441	46	Physics and Astronomy
15	13	16	15	31	23	51	46	104	22	280	Agricultural and Biological Sciences
59	149	27	93	46	176	345	345	79	275	39	Materials Science
19	36	6	14	18	61	19	303	43	62	32	Chemistry
86	0	2	2	71	8	63	3	113	10	39	Pharmacology, Toxicology and
45	149	74	348	101	143	149	132	225	235	15	Mathematics
26	50	81	51	83	21	75	21	212	55	11	Business, Management and
19	48	6	38	17	76	26	94	33	99	12	Chemical Engineering
11	10	8	7	16	64	40	40	47	60	61	Earth and Planetary Sciences
8	10	45	23	67	7	67	4	104	6	14	Economics, Econometrics and
70	144	113	332	80	243	141	298	157	303	31	Energy
11	3	9	2	16	65	40		52	5	48	Immunology and Microbiology
17	11	10	18	18	12	76	22	58	33	40	Multidisciplinary
28	86	48	94	56	43	116	43	150	122	22	Decision Sciences
8	6	23	9	20	8	48	1	37	8	2	Arts and Humanities
6	3	8	1	15	1	31	0	24	1	8	Psychology
5	1		1	2	1	58	1	32	2	8	Nursing
8	1	11	5	7	2	32	4	24	7	7	Neuroscience
4	2	6	0	2	1	13	1	6	8	1	Health Professions
3	0	1	3	0	0	2	1	7	0	36	Veterinary
0	0	0	0	0	0	1	0	0	0	0	Dentistry

Appendix 1 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
International Islamic University Chittagong (IIUC)	103	449	424	95	45	79	205	67	151	35	80	71	45	23	5	50	180	22	19	37	31	1	9	3	4	5	0
Daffodil International University	254	953	784	124	72	73	294	33	145	37	90	226	135	57	22	42	132	4	18	256	24	13	4	11	6	1	0
Independent University, Bangladesh (IUB)	185	294	271	79	72	29	98	27	31	24	4	68	22	17	18	12	100	21	15	28	9	8	11	5	2	1	0
Dhaka University of Engineering and Technology (DUET)	80	411	281	88	29	36	77	16	27	6	2	74	81	6	8	45	113	9	10	48	23	77	1	11	6	1	0
Islamic University, Bangladesh (IU)	119	87		29	89	113	46	86	58	63	55	42	20	52	10	15	18	40	27	13	5	4	10	7	3	2	0
Stamford University Bangladesh (SU)	83	38	50	17	33	27	22	41	12	12	62	6	14	8	9	6	13	13	12	4	4	1	5		1	1	0
Jagannath University (JnU)	108	142	210	79	120	108	153	141	111	123	74	40	34	64	53	39	75	41	19	24	14	19	8	9	3	2	0
Sher-e-Bangla Agricultural University (SAU)	65	18	71	38	184	237	4	483	10	32	29		10	23	14	18	11	45	19	2	2	0	2	2	2	26	0
Southeast University (SEU)	99	117	87	63	29	111	35	20	24	22	135	47	47	14	3	18	16	12	6	11	12	8	7	43	1	4	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	53	116	142	41	88	87	2	271	35	46	14	47	37	40	18	22	46	33	11	31	4	1	1	0	3	29	0

Appendix 1 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Noakhali Science and Technology University (NSTU)	192	114	104	58	140	128	54	169	59	53	102	32	24	31	47	25	23	33	53	18	3	0	14	10	4	18	0
University of Science and Technology Chittagong (USTC)	52	94	77	12	8	40	29	21	8	19	34	31	4	12	2	1	28	6	6	8	1	0	3	0	1	3	0

Appendix 2. Single-Authored Documents in Disciplines and Universities

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	28	43	32	258	25	8	27	6	8	10	8	38	64	13	19	67	6	1	3	9	66	7	2	0	2	0	0
University of Rajshahi (RU)	17	11	19	72	15	9	20	24	16	4	5	13	20	1	10	20	9	0	2	1	11	3	0	1	1	0	0
Bangladesh Agricultural University (BAU)	0	0	3	7	10	2	0	12	0	1	0	0	1	0	2	1	3	0	0	0	0	1	0	0	0	2	0
Bangladesh University of Engineering and Technology (BUET)	8	61	105	5	10	2	36	2	26	3	0	21	6	14	10	1	25	0	0	8	5	0	0	0	1	0	0
University of Chittagong (CU)	1	13	32	91	26	25	18	3	0	4	22	1	10	0	6	13	7	0	2	1	16	6	1	0	0	0	0
Jahangirnagar University (JU)	10	6	4	67	16	3	20	7	3	5	2	3	18	0	3	14	2	4	1	2	14	1	1	1	0	0	0
Shahjalal University of Science and Technology (SUST)	13	11	8	22	12	3	15	9	1	0	3	5	2	1	5	7	5	2	0	4	8	1	2	0	0	0	0
Khulna University (KU)	9	5	8	16	11	1	3	8	0	0	0	2	8	1	2	9	2	2	0	0	7	2	0	0	0	0	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	34	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2	0	0	1
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	0	0	2	3	7	2	0	7	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Patuakhali Science and Technology University (PSTU)	4	1	0	3	1	3	0	2	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Khulna University of Engineering and Technology (KUET)	1	13	25	2	6	1	18	0	8	0	0	6	2	7	0	0	2	0	1	0	0	0	0	1	0	0	0

Appendix 2 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
North South University (NSU)	4	31	13	50	20	5	4	4	1	1	1	6	22	1	5	17	10	0	0	4	19	1	1	0	0	0	0
Rajshahi University of Engineering and Technology (RUET)	0	21	27	2	3	2	8	3	8	2	0	7	0	1	2	1	8	0	1	2	0	0	0	1	0	0	0
BRAC University (BRACU)	6	23	18	66	2	0	5	1	66	0	0	5	13	0	2	11	4	0	0	5	16	6	1	0	0	0	0
Chittagong University of Engineering and Technology (CUET)	4	27	21	4	3	1	10	0	6	1	0	1	3	2	5	0	8	5	0	3	0	0	0	0	0	0	0
East West University (EWU)	4	20	18	32	3	0	10	0	4	0	0	10	9	2	4	6	3	0	0	0	12	3	0	0	0	0	0
American International University-Bangladesh (AIUB)	1	23	22	2	3	1	5	1	0	2	0	9	5	4	0	4	12	0	0	3	1	0	0	0	0	0	0
United International University (UIU)	1	7	5	10	2	0	1	1	0	0	0	0	13	0	0	4	6	0	0	2	1	2	0	0	0	0	0
Ahsanullah University of Science and Technology (AUST)	4	26	32	5	6	1	8	0	3	0	0	3	4	2	1	0	8	0	0	6	2	0	0	0	0	0	0
University of Asia Pacific (UAP)	2	9	10	11	2	0	1	1	2	0	0	0	5	0	2	2	1	0	1	1	2	0	1	0	0	0	0
International Islamic University Chittagong (IIUC)	2	25	19	16	1	0	5	0	2	0	0	5	9	2	0	11	9	0	2	1	9	0	0	0	0	0	0
Daffodil International University (DIU)	7	17	14	17	10	1	1	4	2	1	0	2	12	3	1	4	2	0	0	3	4	0	1	0	2	0	0
Independent University, Bangladesh (IUB)	7	8	7	28	1	2	0	0	1	0	0	1	2	1	0	2	4	1	0	0	3	0	0	0	0	0	0

Appendix 2 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Dhaka University of Engineering and Technology (DUET)	1	7	5	10	2	0	1	1	0	0	0	0	13	0	0	4	6	0	0	2	1	1	0	0	0	0	0
Islamic University, Bangladesh (IU)	8	0		6	4	0	0	2	1	0	0	2	1	0	2	1	0	0	1	0	2	0	0	0	1	0	0
Stamford University Bangladesh (SU)	3	1	3	5	1	3	1	1	0	0	1	0	6	0	0	3	1	1	1	1	1	0	1		0	0	0
Jagannath University (JnU)	3	1	3	9	1	2	4	0	4	1	3	0	4	0	3	4	3	0	0	0	5	2	0	0	0	0	0
Sher-e-Bangla Agricultural University (SAU)	0	0	1	3	2	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Southeast University (SEU)	3	7	9	16	1	0	2	0	0	0	1	0	0	0	1	3	2	0	0	1	7	0	0	0	0	0	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	1	2	1	1	1	0	0	0	0	0	0	0	3	0	0	1	0	0	0	2	0	0	0	0	0	0	0
Noakhali Science and Technology University (NSTU)	1	0	0	3	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	2	0	0	0	0	0	0
University of Science and Technology Chittagong (USTC)	5	5	3	0	0	0	0	0	0	0	0	2	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0

Appendix 3. Collaborative Authored Documents

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	1246	1111	1108	674	716	711	679	690	554	536	525	371	279	328	287	216	245	242	209	179	86	80	66	48	42	29	11
University of Rajshahi (RU)	479	633	810	224	387	467	641	514	515	340	158	288	104	211	182	97	282	104	168	92	28	36	38	19	12	27	1
Bangladesh Agricultural University (BAU)	269	68	165	124	506	468	28	1475	28	77	73	12	16	94	94	32	68	226	105	5	2	3	21	19	6	301	1
Bangladesh University of Engineering and Technology (BUET)	248	2216	3037	377	512	157	1462	116	1011	291	23	504	130	310	280	28	478	18	71	182	51	8	6	13	24	1	0
University of Chittagong (CU)	8	467	423	186	323	250	277	23	2	225	127	120	103	85	108	98	139	64	74	35	38	18	12	6	18	14	0
Jahangirnagar University (JU)	486	556	455	185	364	282	485	248	274	337	222	164	46	112	182	47	100	123	80	92	22	42	24	52	19	14	1
Shahjalal University of Science and Technology (SUST)	167	294	347	178	320	194	205	334	222	280	35	80	67	194	116	73	113	56	97	44	33	5	11	9	3	6	0
Khulna University (KU)	278	417	468	134	320	191	206	327	167	103	151	111	62	95	79	52	86	31	67	57	6	8	15	8	5	17	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	1148	13	14	20	20	112	8	19	4	8	60	1	1	5	0	2	0	63	44	0	2	36	19	27	5	3	10
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	84	20	51	62	168	203	12	475	17	45	21	9	6	24	36	12	27	87	60	4	2	0	5	7	0	47	0

Appendix 3 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Patuakhali Science and Technology University (PSTU)	96	92	108	69	183	84	46	278	39	32	39	15	9	12	61	14	31	47	40	22	2	8	8	7	1	36	0
Khulna University of Engineering and Technology (KUET)	156	1275	1258	98	145	35	423	22	267	62	10	229	53	97	53	6	301	5	32	122	8	1	2	6	8	0	0
North South University (NSU)	358	881	604	228	146	150	184	100	78	42	112	219	190	32	42	87	147	52	58	146	18	23	31	24	6	7	0
Rajshahi University of Engineering and Technology (RUET)	46	640	972	57	117	32	554	43	337	301	3	125	21	93	38	3	290	0	21	41	1	0	1	3	1	1	0
BRAC University (BRACU)	533	665	471	279	93	97	151	50	279	19	63	144	62	26	38	56	137	40	76	111	32	25	57	32	13	2	1
Chittagong University of Engineering and Technology (CUET)	58	690	751	65	123	24	402	23	170	60	8	142	18	74	59	7	235	60	12	40	8	1	1	2	1	0	0
East West University (EWU)	116	336	253	88	48	46	91	31	42	18	71	91	74	15	12	61	77	16	18	56	8	12	2	7	2	0	0
American International University-Bangladesh (AIUB)	75	845	755	73	53	8	224	14	93	12	2	339	46	34	7	19	320	2	18	91	8	1	1	5	0	3	0
United International University (UIU)	79	404	276	78	27	36	76	15	27	6	2	74	68	6	8	41	107	9	10	46	22	6	0	11	6	1	0
Ahsanullah University of Science and Technology (AUST)	35	448	489	57	68	10	198	13	146	36	0	146	46	46	9	10	136	3	11	80	4	3	1	1	2	0	0
University of Asia Pacific (UAP)	133	258	256	39	58	35	86	14	57	19	86	45	21	19	9	6	69	11	16	27	6	6	4	8	4	3	0
International Islamic University Chittagong (IIUC)	101	424	405	79	44	79	200	67	149	35	80	66	36	21	5	39	171	22	17	36	22	1	9	3	4	5	0

Appendix 3 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Daffodil International University (DIU)	247	936	770	107	62	72	293	29	143	36	90	224	123	54	21	38	130	4	18	253	20	13	3	10	4	1	0
Independent University, Bangladesh (IUB)	178	286	264	51	71	27	98	27	30	24	4	67	20	16	18	10	96	20	15	28	6	8	11	5	2	1	0
Dhaka University of Engineering and Technology (DUET)	79	404	276	78	27	36	76	15	27	6	2	74	68	6	8	41	107	9	10	46	22	76	1	11	6	1	0
Islamic University, Bangladesh (IU)	111	87	0	23	85	113	46	84	57	63	55	40	19	52	8	14	18	40	26	13	3	4	10	7	2	2	0
Stamford University Bangladesh (SU)	80	37	47	12	32	24	21	40	12	12	61	6	8	8	9	3	12	12	11	3	3	1	4	0	1	1	0
Jagannath University (JnU)	105	141	207	70	119	106	149	141	107	122	71	40	30	64	50	35	72	41	19	24	9	17	8	9	3	2	0
Sher-e-Bangla Agricultural University (SAU)	65	18	70	35	182	236	4	481	10	32	29	0	10	23	14	18	10	45	19	2	1	0	2	2	1	26	0
Southeast University (SEU)	96	110	78	47	28	111	33	20	24	22	134	47	47	14	2	15	14	12	6	10	5	8	7	43	1	4	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	52	114	141	40	87	87	2	271	35	46	14	47	34	40	18	21	46	33	11	29	4	1	1	0	3	29	0
Noakhali Science and Technology University (NSTU)	191	114	104	55	139	128	54	168	59	53	102	32	24	31	46	25	23	33	52	18	1	0	14	10	4	18	0
University of Science and Technology Chittagong (USTC)	47	89	74	12	8	40	29	21	8	19	34	29	3	12	2	0	27	6	6	8	1	0	3	0	1	3	0

Appendix 4. Number of articles from various disciplines

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and	Physics and Astronomy	Agricultural and Biological	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	104	332	596	569	611	619	507	623	474	491	468	252	216	304	253	171	143	206	193	82	85	73	61	42	26	25	10
University of Rajshahi (RU)	3	1	3	1	3	4	4	4	3	3	1	1	7	1	1	6	7	9	1	2	3	3	3	1	1	2	1
Bangladesh Agricultural University (BAU)	222	53	100	109	429	401	19	1304	20	65	61	8	11	54	79	27	59	195	95	4	2	4	18	17	5	283	1
Bangladesh University of Engineering and Technology (BUET)	118	480	426	178	365	127	740	85	720	257	21	245	80	257	64	12	152	15	69	59	15	6	6	12	20	1	0
University of Chittagong (CU)	5	12	20	16	28	22	18	19	2	21	11	55	67	70	94	73	61	56	72	9	30	22	10	4	16	13	0
Jahangirnagar University (JU)	36	14	17	13	29	23	41	22	25	31	19	79	45	10	15	41	39	95	70	44	23	30	24	39	16	12	1
Shahjalal University of Science and Technology (SUST)	121	88	188	151	301	167	150	313	191	268	30	55	49	182	112	69	65	48	90	10	23	5	10	7	2	6	0
Khulna University (KU)	206	101	217	130	272	167	115	314	123	91	137	66	47	69	70	48	43	25	64	10	13	10	13	5	4	17	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	997	4	5	12	19	95	6	19	4	8	52	1	1	2	0	2		53	42	0	2	19	17	21	4	3	9
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	74	13	22	44	131	173	10	399	12	39	16	8	4	22	32	12	23	71	56	3	1	0	5	7	0	42	0
Patuakhali Science and Technology University (PSTU)	71	21	55	54	167	74	33	253	33	30	33	6	11	9	57	14	8	38	38	6	2	8	7	6	1	32	0
Khulna University of Engineering and Technology (KUET)	42	157	308	36	109	32	131	20	170	51	7	36	27	56	54	5	31	4	33	8	1	1	2	3	7	0	0
North South University (NSU)	218	171	157	160	112	135	68	89	47	34	102	78	173	20	27	75	45	44	54	37	20	22	26	23	4	7	0
Rajshahi University of Engineering and Technology (RUET)	21	104	400	28	73	32	272	36	234	31	3	49	15	59	35	3	82		21	11	1		1	4	1	1	0
BRAC University (BRACU)	357	89	81	193	58	67	47	40	193	15	32	27	51	11	26	47	17	32	69	16	26	24	55	13	8	2	1

Appendix 4 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and	Physics and Astronomy	Agricultural and Biological	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Chittagong University of Engineering and Technology (CUET)	18	137	246	40	99	22	183	19	125	57	8	45	12	59	51	6	59	51	11	10	4	1	1	2	1	0	0
East West University (EWU)	75	93	99	73	32	40	51	19	32	15	56	59	51	15	12	41	27	13	16	7	16	10	2	5	1	0	0
American International University-Bangladesh (AIUB)	16	142	181	24	26	7	75	12	55	13	2	97	29	28	5	18	42	1	17	14	2	1	1	5		3	0	0
United International University (UIU)	24	72	61	59	22	34	18	15	11	6	2	30	77	3	3	41	21	9	9	8	9	8		8	5	1	0	0
Ahsanullah University of Science and Technology (AUST)	4	84	192	29	47	5	72	10	110	26	0	110	33	38	4	5	38	3	10	10	5	3	1	2	2	0	0	0
University of Asia Pacific (UAP)	84	48	83	27	44	31	31	11	33	16	85	12	17	16	7	6	17	8	8	4	4	3	4	6	2	2	0	0
International Islamic University Chittagong (IIUC)	63	62	84	56	26	69	70	55	78	29	65	18	34	5	3	44	16	17	18	2	26	1	8	2	4	5	0	0
Daffodil International University (DIU)	73	157	234	82	57	59	155	26	113	32	78	54	122	44	20	36	25	3	13	15	17	13	2	8	4	1	0	0
Independent University, Bangladesh (IUB)	101	36	47	29	50	15	32	22	16	20	2	12	15	16	13	9	17	15	12	7	4	7	9	4	2	1	0	0
Dhaka University of Engineering and Technology (DUET)	24	72	61	59	22	34	18	15	11	6	2	30	77	3	3	41	21	9	9	8	9	18	1	8	5	1	0	0
Islamic University, Bangladesh (IU)	96	51		22	70	99	39	74	51	60	44	33	13	42	7	8	8	36	24	6	3	3	10	4		3	2	0
Stamford University Bangladesh (SU)	68	9	23	10	26	24	9	38	9	9	57	1	10	6	7	4	3	3	10	2	4	1	3		1	1	0	0
Jagannath University (JnU)	77	49	10	62	95	80	10	12	97	10	56	30	25	56	44	31	42	34	19	9	10	19	6	6	2	2	0	0
Sher-e-Bangla Agricultural University (SAU)	55	10	12	35	116	155	4	344	8	22	22	0	5	15	10	13	9	38	19	1	2	0	1	2	2	25	0	0
Southeast University (SEU)	51	27	36	50	12	45	9	18	12	8	54	32	32	7	1	15	4	6	3	1	11	8	7	13	1	4	0	0

Appendix 4 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and	Physics and Astronomy	Agricultural and Biological	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Hajee Mohammad Danesh Science and Technology University (HSTU)	39	48	73	30	77	77	2	247	24	44	11	32	29	32	15	16	28	30	11	18	3	1	1	0	3	28	0
Noakhali Science and Technology University (NSTU)	149	49	55	51	123	104	36	157	47	49	81	20	21	23	37	21	14	24	50	4	2	0	10	7	4	14	0
University of Science and Technology Chittagong (USTC)	34	17	12	3	3	36	2	19	6	17	29	9	2	9	1	1	3	6	5	8	1	0	3	0	1	3	0

Appendix 5. Annual Growth Rate of Documents.

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	11.17	20.01	14.99	15.6	24.14	10.96	14.89	7.09	13.48	13.73	-3.07	7.42	22.23	18.87	25.25	24.86	28.31	16.65	61.8	43.62	4.35	47.16	8.84	31.8	8.01	29.68	22.28
University of Rajshahi (RU)	24.82	26.2	25.61	13.84	19.28	12.59	23.07	4.48	26.22	17.21	10.36	16.94	17.29	31.49	6.6	13.99	47.48	21.1	22.58	34.07	0	30.53	6.42	19.58	16.65	8.01	0
Bangladesh Agricultural University (BAU)	18.67	44.22	30.96	26.84	19.31	15.82	30	14.30	13	18.9	25.99	25	0.00	23	13.57	31.8	41.68	12.98	12.98	18.92	0	200	22	19.58	100	10.33	0
Bangladesh University of Engineering and Technology (BUET)	26.28	0.69	-4.82	25.99	22.29	36.39	16.44	44.81	17.95	17.93	14.93	6.45	11.20	8.19	17.23	25.99	13.86	24.14	44.22	32.2	3.25	8.01	0	14.87	0	0	0
University of Chittagong (CU)	49.53	27.03	25.85	20.23	19.13	20.29	13.5	8.01	0	12.16	25.55	32.98	35.45	25.4	11.67	27.25	48.91	22.76	20.68	53.34	17.44	29.17	19.58	9.05	9.05	10.72	0
Jahangirnagar University (JU)	17.27	31.21	26.84	23.94	25.7	17.4	9.28	15.35	19.77	18.98	-1.43	15.7	40.25	20.1	21.26	22.76	32.2	21.37	36.08	48.91	14.93	39.08	25.99	26.84	11.17	5.2	0
Shahjalal University of Science and Technology (SUST)	45.09	33.64	17.49	22.31	19.1	25.4	10.3	26.77	9.16	8.01	14.72	21.45	25.09	10.99	12.56	16.65	45.37	25.99	45.37	36.61	3.25	0	8.01	0	18.92	41.42	0
Khulna University (KU)	22.94	24.44	17.53	38.7	28.17	14.93	30.53	19.58	33.35	43	7.63	43.62	11.17	42.35	40.98	31.8	35.11	25.99	34.95	55.25	0	41.42	10.41	0	18.92	10.72	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	3.89	0	29.17	10.72	0	11.32	0	-3.15	0	5.2	9.43	0	0	12.25	0	0	0	6.97	19.58		0	14.31	22.03	22.28	0	-7.41	-7.41

Appendix 5 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	40.98	41.42	43.52	20.44	45.92	33.26	25.74	31.55	23.59	29.15	16.95	5.96	6.99	21.9	32.5	12.98	40.85	34.6	42.5	0	0	0	0	0	0	30.66	0
Patuakhali Science and Technology University (PSTU)	23.11	44.81	32.98	44.26	47.23	40.98	22.42	30.34	3.71	30.53	42.62	16.65	81.71	31.95	17.44	115.44	19.68	30.53	26.84	41.42	0	0	25.99	0	0	30.53	0
Khulna University of Engineering and Technology (KUET)	51.08	20.44	16.55	24.62	18.32	16.65	29.39	5.84	25.99	29.86	25.1	32.69	34.59	35.11	29.86	12.98	19.77	18.92	28.64	65.4	-16.73	0	0	0	12.25	0	0
North South University (NSU)	40.62	26.22	22.62	31.59	38.9	34.07	44.52	22.47	43	35.11	23.64	49.78		32.98	22.89	34.07	40	43	44.81	53.75	4.2	55.18	38.95	33.35	0	31.61	0
Rajshahi University of Engineering and Technology (RUET)	29.68	34.18	22.43	37	32.4	40.29	35.81	7.25	38.01	19.77	0	43.31	16.65	44.22	13.99	0	37.22		44.26	60.35	0	0	0	0	0	0	0
BRAC University (BRACU)	36.49	29.9	28.48	16.97	34.07	37.44	48.91	16.65	16.97	29.68	29.15	40.25	24.14	16.99	16.65	18.9	28.42	43.52	23.03	129.74	14.93	16.95	22.03	58.49	5.2	0	0
Chittagong University of Engineering and Technology (CUET)	23.97	31.32	26.17	36.08	30.2	19.58	36.77	25.1	61.08	32.98	16.99	52.27	-5.52	24.14	39.5	9.05	31.3	40.25	10.41	52.29	8.01	0	0	0	0	0	0
East West University (EWU)	10.49	20.38	15.7	58.58	23.47	6.75	24.14	16.65	-1.7	0	-9.68	25.99	15.99	20.11	22.03	40.98	46.31	25.85	12.98	38.7	29.17	8.45	0	0	0	0	0

Appendix 5 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
East West University (EWU)	10.49	20.38	15.7	58.58	23.47	6.75	24.14	16.65	-1.7	0	-9.68	25.99	15.99	20.11	22.03	40.98	46.31	25.85	12.98	38.7	29.17	8.45	0	0	0	0	0
American International University-Bangladesh (AIUB)	53.42	19.71	20.04	22.76	24.14	14.72	31.8	0	15.99	22.28	0	39.5	-8.62	9.05	0	0	33.77	0	16.65	22.35	182.84	0	0	44.22		-15.91	0
United International University (UIU)	25.99	19.04	18.76	43.62	47.24	27.54	13.04	25.99	12.98	100	0	25.95	41.68	18.92	8.01	40.29	4.11	0	6.99	77.83	-12.27	41.42		8.01	-9.43	0	0
Ahsanullah University of Science and Technology (AUST)	51.57	28.04	27.16	58.38	15.3	12.98	27.96	10.72	35.11	19.58	0	35.11	35.11	34.07	6.99	25.99	29.15	12.25	43.1	57.57	-29.29	0	0	0	0	0	0
University of Asia Pacific (UAP)	7.02	25.99	20.55	15.53	51.12	29.15	20.85	16.65	10.36	27.54	-13.19	38.95	44.22	25.99	24.57	0	25.09	32.64	56.51	34.59	-11.49	31.95	24.57	30.77	200	0	0
International Islamic University Chittagong (IIUC)	19.58	14.67	11.45	10.36	40.29	35.6	46.31	46.46	42.35	37.8	21.45	46.31	33.35	-18.29	300	15.53	18.67	29.15	30.77	44.22	-7.41	0	8.01	18.92	0	0	0
Daffodil International University (DIU)	68.07	51.23	46.63	51.48	47.98	32.98	58.74	29.68	47.48	18.19	22.03	57.57	31.8	20.09	16.65	37.8	49.16	200	24.57	101.03	21.9	46.78	0	350	0	0	0
Independent University, Bangladesh (IUB)	40.58	22.03	15.67	23.12	18.67	25.85	26.36	22.03	32.98	16.65	0	34.07	21.9	5.96	24.14	12.98	29.15	22.28	25.99	34.07	16.99	0	0	-9.43	0	0	0
Dhaka University of Engineering and Technology (DUET)	25.99	19.04	18.76	43.62	47.24	27.54	13.04	25.99	12.98	100	0	25.95	41.68	18.92	8.01	40.29	4.11	0	6.99	77.83	-12.27	13.04	0	8.01	-9.43	0	0

Appendix 5 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Islamic University, Bangladesh (IU)	15.82	43.52	0	18.19	21.45	23.33	18.19	18.19	4.61	4.04	11.2	58.74	23.22	16.65	21.9	30.77	43.1	29.15	32.98	35.72	0	0	16.99	0	0	0	0
Stamford University Bangladesh (SU)	0	12.98	0	0	19.58	10.72	-4.41	10.72	8.01	8.01	-13.44	0	-17.97	12.98	-11.49	20.09	0	0	9.05	-20.63	18.92	0	-29.29		0	0	0
Jagannath University (JnU)	24.62	41.33	35.36	32.98	62.24	34.77	29.86	19.25	28.17	19.13	13.66	35.11	27.65	25.95	45.42	23.3	38.7	34.59	34.59	30.77	16.65	41.42	0	164.58	0	0	0
Sher-e-Bangla Agricultural University (SAU)	32.98	31.61	29.15	30.53	55.45	33.42	0	29.04	47.58	29.15	27.54	0	-12.64	27.65	6.99	18.92	3.79	36.08	16.65	0	0	0	0	0	0	45.79	0
Southeast University (SEU)	22.58	40.98	17.44	10.72	89.88	54.79	30.53	19.58	29.68	61.54	25.99	40.25	40.25	25.74	0	0	0	49.53	0	71	0	-15.91	-15.91	29.67	0	16.99	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	47.24	40.98	55.45	74.11	34.6	28.17	0	21.13	39.08	42.5	10.41	40.25	67.03	29.15	49.53	46.78	32.93	28.49	0	32.98	41.42	0	0	0	100	19.58	0
Noakhali Science and Technology University (NSTU)	48.68	61.37	44.78	88.82	44.81	31.8	37.87	35.11	31.18	21.45	21.57	34.95	21.67	8.01	47.16	61.54	31.61	68.18	14.13	35.1	41.42	0	81.71	71	41.42	16.65	0
University of Science and Technology Chittagong (USTC)	2.05	26.84	37	11.99	12.25	19.58	-2.9	3.25	12.98	19.58	11.51	29.15	200	25.85	0	0	25.99	0	18.92	66.67	0	0	0	0	0	0	0

Appendix 6. Average Citation per Document

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	35.68	9.75	14.5	9.912	25.62	18.99	13.52	13.16	19.31	22.8	13.02	9.704	15.56	17.95	18.85	8.94	18.03	15.86	22.08	14.68	6.211	12.49	14.5	18.85	12.84	12.9	3.455
University of Rajshahi (RU)	25.52	6.815	8.925	9.182	17.75	19.53	11.71	13.76	12.79	16.68	15.5	8.08	7.911	12.77	17.67	9.684	7.199	14.62	18.94	6.226	6.333	10.15	26.68	41.65	27	8.148	65
Bangladesh Agricultural University (BAU)	19.08	16.28	15	15.18	32.36	20.74	14.36	16.34	17	35.06	22.71	11	18.29	18.69	22.12	10.64	48.27	17.25	25.76	7.8	3	9.75	19.43	20.79	15	11.39	13
Bangladesh University of Engineering and Technology (BUET)	21.37	9.68	9.98	12.89	22.53	16.35	9.293	18.48	12.61	17.99	33.61	9.116	22.64	19.5	13.25	13.14	12.87	17.22	25.14	9.674	5.893	7.75	14.5	108.6	25.4	14	0
University of Chittagong (CU)	13.67	10.95	13.67	9.798	23.05	16.57	9.319	19.73	0.5	16.35	14.66	10.89	15.32	22.33	19.23	10.5	19.87	14.14	11.34	17.33	3.685	46.79	8.385	33.17	13.72	6.929	0
Jahangirnagar University (JU)	21.75	12.93	10.42	12.02	21.67	17.47	14.45	13.45	17.09	19.09	19.67	11.16	10.22	18.74	16.25	19.13	12.2	26.14	40.9	12.26	5.139	49.70	14.68	39.66	16.95	10.29	2
Shahjalal University of Science and Technology (SUST)	21.15	7.203	9.715	9.69	18.64	16.41	10.62	14.78	17.20	24.27	19.03	6.106	8.174	24.29	12.99	9.475	13.46	14.53	26.27	3.417	5.22	2	17	13.89	18	5.167	0
Khulna University (KU)	15.92	8.834	11.75	13.38	20.48	17.83	10.79	14.06	22.5	35.09	13.99	10.6	9.986	26.77	19.09	10.64	18.77	11.88	22.85	4.421	2	9.7	38.67	6.75	55.8	8.412	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	11.2	97.38	90.43	10.75	18.9	26.26	44.88	17.84	297.2	28	9.1	23	4	47.8	0	3		10.67	23.3	0	3	14.3	7.3	5.069	7.2	4.333	7.273

Appendix 6 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	28.05	17	9.585	27.71	25.73	24.21	28.83	19.36	21.71	35.51	27.19	3.444	5.167	33.58	19.06	21.77	23.89	24.09	47.25	35.5	3	0	47.6	24.71	0	12.69	0
Patuakhali Science and Technology University (PSTU)	20.19	5.806	12.44	15.64	34.9	16.13	10.74	19.74	21.72	38.38	33.15	4.933	10.36	9.667	15.07	8.5	10.29	20.02	20.4	69.32	5.5	12.88	22.12	23.14	2	7	0
Khulna University of Engineering and Technology (KUET)	20.08	8.141	8.365	7.95	15.26	18.56	6.658	9.636	13.42	14.92	59.8	8.34	18.02	14.14	10.43	11.67	7.69	112	18	4.975	3.5	2	20	11.86	21.25	0	0
North South University (NSU)	22.08	8.482	9.587	12.66	26.57	15.05	9.846	15.56	29.96	17.98	11.74	7.764	16.65	24.7	10.79	12.16	18.17	16.79	18.16	8.613	5.324	29.42	32.94	25.79	6	10.71	
Rajshahi University of Engineering and Technology (RUET)	15.46	7.219	13.26	14.19	19.74	20.09	14.65	16.72	17.43	7.69	7.667	10.35	25.52	17.32	15.62	12.5	14.29	0	7.773	4.186	1	0	25	4.75	149	1	0
BRAC University (BRACU)	64.28	6.642	7.544	9.238	21.55	23.67	8.994	12.51	9.238	22.53	26.11	6.953	12.44	13.54	14.45	11.43	6.993	16.98	26.18	2.845	9.354	14.29	11.66	28.88	7.154	12	4
Chittagong University of Engineering and Technology (CUET)	5.129	8.49	8.685	16.36	21.56	27.64	12.39	21.17	13.93	14.33	6.125	7.483	16.33	20.41	18.64	12.43	11.19	18.38	17.17	13.09	5.875	2	12	13.5	12	0	0
East West University (EWU)	10.07	8.003	9.247	5.767	21.78	16.93	10.45	5.645	14.8	22.5	11.37	9.337	8.831	8.471	6.438	18.66	19.05	10.69	9.222	4.857	3.3	11.4	29	15.29	3.5	0	0
American International University-Bangladesh (AIUB)	4.158	5.583	7.161	7.547	18.98	21.78	11.51	11.53	10.8	20.21	4.5	5.5	13.06	19.05	25.14	9.043	7.852	4	17.11	4.543	7.556	0	1	45.4		6	0

Appendix 6 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
United International University (UIU)	6.175	7.771	9.157	10.22	15.69	18.78	5.766	36.12	6.148	5.167	2.5	8.932	11.77	7.167	4.625	8.422	8.088	27.44	25.6	3.812	6.087	18.5	0	28.64	10	22	0
Ahsanullah University of Science and Technology (AUST)	4.205	9.468	14.94	9.919	48.58	33.18	11.34	20.85	14.76	22.31	0	14.76	26.02	29.12	3.7	18	17.34	36.67	18.45	6.419	0.8333	10.67	9	5	14.5	0	0
University of Asia Pacific (UAP)	11.64	9.139	11.36	8.68	23	18.03	8.782	17.67	16.73	24.47	9.395	12.58	33.35	23.42	4.727	11.75	13.66	25.18	22.24	6.357	5.875	10.5	9.4	20.88	8	7.333	0
International Islamic University Chittagong (IIUC)	11.88	6.967	7.719	6.653	15.56	17.06	11.03	11.48	13.9	29.03	19.79	10.89	11.09	10.48	35.4	9.02	6.006	17.59	13.58	4.973	4.645	17	13.67	16	6.25	6.4	0
Daffodil International University (DIU)	7.543	7.169	8.629	8.024	17.03	16.55	13.08	9.485	14.94	16.78	5.5	7.106	5.356	13.32	12.14	4	7.371	56.75	16.44	5.211	3.458	13.69	7.75	23.36	2.167	0	0
Independent University, Bangladesh (IUB)	61.97	5.935	16.44	13.96	54.96	28.83	13.05	16.85	23.9	111.5	65.75	6.529	37.41	157.4	22.22	13	11.57	11.81	28.6	9.571	6.333	27.25	29.36	19.6	9	5	0
Dhaka University of Engineering and Technology (DUET)	6.175	7.771	9.157	10.22	15.69	18.78	5.766	36.12	6.148	5.167	2.5	8.932	11.77	7.167	4.625	8.422	8.088	27.44	25.6	3.812	6.087	5.766	25	28.64	10	22	0
Islamic University, Bangladesh (IU)	15.45	12.21		17.66	27.63	16.73	23.13	17.88	28.02	29.9	18.58	9.476	11.5	25.33	8.9	13.53	30.67	15.43	9.37	11.08	3.2	56.75	4.8	25.86	7.333	14.5	0
Stamford University Bangladesh (SU)	24.17	6.026	10.9	5.941	20.45	29.22	10.32	8.268	15.33	15.33	16.06	4.5	9.714	49	17.11	8	5.846	5.846	14.58	1.25	11	19	13.8	0	478	2	0
Jagannath University (JnU)	13.22	6.887	11.57	11.57	19.3	17.03	12.82	7.957	19.74	23.08	15.27	12.1	9.824	19.38	16.26	5.974	16.83	10.8	21.42	6.125	6.143	10.89	15.12	19.11	4.667	8.5	0

Appendix 6 continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Sher-e-Bangla Agricultural University (SAU)	22.94	118.4	20.59	16.68	28.14	43.25	3	28.01	22.3	78.34	36.62	0	8.2	93.39	24.86	15.56	27.09	34.91	14	9.5	4.5	0	34.5	3.5	7	4.885	0
Southeast University (SEU)	12.04	17.84	14.39	8.127	30.17	24.27	3.486	14.05	13.96	39.14	20.45	11.3	11.3	28.5	1.667	11.28	6.875	25.83	22.67	3.364	4.833	8.375	10.43	38.58	5	11	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	15.26	8.638	10.65	10.9	15.82	13.63	6.5	10.67	8.971	15.74	43.29	11.49	14.46	11.2	18.39	14.82	13.17	18.85	12.64	11.13	11.5	0	1	0	17.33	8.103	0
Noakhali Science and Technology University (NSTU)	12.46	10.24	11.49	14.86	22.14	11.91	11.19	10.18	16.88	15.09	10.92	11.88	10.12	9.161	16.62	10.12	17.96	11	18.15	7.833	11.67	0	5.929	18	1.75	7.889	0
University of Science and Technology Chittagong (USTC)	14.04	10.69	9.688	13.08	12.88	11.1	8	10.95	19.88	17.58	6.794	7.774	4.75	21.33	9	0	9.75	7.5	21.33	12	3	0	3.667	0	12	15.33	0

Appendix 7. Total Author

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	7009	2203	2375	1710	2545	4087	1630	2218	1384	1785	1628	961	635	932	908	503	782	1524	1853	549	248	741	263	752	134	151	47
University of Rajshahi (RU)	3897	1174	1501	496	973	4969	1132	1380	1052	994	663	624	211	687	511	215	604	883	585	214	85	575	157	555	66	175	8
Bangladesh Agricultural University (BAU)	1235	1859	607	428	1738	3361	136	5211	123	366	312	64	62	381	488	115	253	918	705	27	6	15	92	86	33	1038	8
Bangladesh University of Engineering and Technology (BUET)	719	3457	4751	958	1438	496	2172	387	1770	707	102	954	323	777	722	116	1171	52	286	418	175	48	33	50	89	13	0
University of Chittagong (CU)	34	1026	880	669	1145	1110	579	110	9	691	546	498	427	346	328	235	407	341	392	248	122	292	53	68	76	95	0
Jahangirnagar University (JU)	2252	1157	1126	639	1056	1068	741	857	777	848	832	450	133	449	468	142	331	936	346	248	85	189	118	237	101	89	11
Shahjalal University of Science and Technology (SUST)	660	611	898	453	1416	717	523	1442	571	632	134	213	144	480	338	187	338	250	557	121	84	38	60	62	14	32	0
Khulna University (KU)	824	784	914	341	915	796	450	106	470	403	576	280	136	280	276	133	249	182	284	149	19	42	64	27	18	94	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	4876	65	62	114	140	847	32	113	26	71	283	4	7	19	0	12	0	452	333	0	12	155	117	150	49	23	43

Appendix 7 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	363	116	218	183	614	869	89	1395	124	239	122	28	23	136	149	48	143	393	206	15	11	0	25	47	0	196	0
Patuakhali Science and Technology University (PSTU)	348	200	257	231	508	371	97	789	98	133	170	52	31	56	196	52	111	191	221	68	8	29	55	30	7	167	0
Khulna University of Engineering and Technology (KUET)	401	1557	1764	287	411	127	775	56	651	197	54	475	136	293	160	33	596	36	125	284	23	4	16	16	37	0	0
North South University (NSU)	2847	1834	1345	572	516	752	483	475	256	197	534	625	350	142	173	203	437	787	354	418	65	103	166	148	35	54	0
Rajshahi University of Engineering and Technology (RUET)	180	932	1279	173	293	111	854	99	643	596	12	308	61	281	109	15	537		83	133	2		5	17	7	3	0
BRAC University (BRACU)	6848	1585	1241	1111	397	3016	433	273	1111	108	250	446	166	106	129	175	640	1625	2192	344	104	584	279	47	19	5
Chittagong University of Engineering and Technology (CUET)	179	1068	1264	195	314	81	762	86	437	189	27	388	59	224	148	31	540	149	42	108	27	5	6	11	6	0	0
East West University (EWU)	548	690	596	238	152	240	259	130	146	96	310	261	174	61	45	142	236	106	76	166	34	59	10	56	8	0	0
American International University-Bangladesh (AIUB)	302	1880	1629	221	188	33	569	59	285	57	11	895	112	114	29	46	867	13	50	276	28	8	4	23	0	19	0

Appendix 7 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
United International University (UIU)	266	899	699	203	96	114	242	52	106	27	4	218	144	26	24	82	274	29	33	146	49	18		48	21	7	0
Ahsanullah University of Science and Technology (AUST)	124	1039	1143	208	247	46	532	54	431	111	0	431	150	140	32	36	431	14	33	255	12	9	7	4	11	0	0
University of Asia Pacific (UAP)	414	522	574	134	149	149	238	64	177	75	300	149	88	57	35	18	178	63	81	80	20	16	23	54	23	16	0	0
International Islamic University Chittagong (IIUC)	426	839	823	246	201	385	401	319	323	161	362	217	106	92	41	104	460	138	97	129	65	11	60	27	33	38	0	0
Daffodil International University (DIU)	687	1662	1505	355	239	295	611	127	406	179	272	580	319	217	62	104	395	23	82	594	64	46	14	42	22	13	0	0
Independent University, Bangladesh (IUB)	1282	571	523	314	330	513	299	136	134	112	23	197	64	60	144	28	265	98	305	95	23	75	126	28	35	6	0	0
Dhaka University of Engineering and Technology	266	899	699	203	96	114	242	52	106	27	4	218	144	26	24	82	274	29	33	146	49	5	5	48	21	7	0	0
Islamic University, Bangladesh (IU)	400	283	0	91	293	458	168	287	182	249	235	116	49	180	46	36	86	193	131	32	12	23	31	45	18	13	0	0
Stamford University Bangladesh (SU)	295	146	148	42	101	1017	56	148	49	49	160	25	23	28	35	11	47	47	51	13	7	4	9	0	68	9	0	0
Jagannath University (JnU)	457	339	481	263	414	494	406	493	304	384	316	125	85	215	178	92	256	221	71	68	68	127	55	101	14	13	0	0
Sher-e-Bangla Agricultural University (SAU)	325	107	205	163	617	778	26	1280	64	188	185		36	119	70	58	57	250	85	10	8		33	15	18	147	0	0
Southeast University (SEU)	370	351	263	157	127	534	119	124	132	156	508	124	124	83	6	43	45	80	35	35	65	40	37	133	4	41	0	0

Appendix 7 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Hajee Mohammad Danesh Science and Technology University (HSTU)	274	321	453	138	396	410	17	881	127	222	108	124	98	181	92	62	188	165	95	79	12	6	8	0	13	145	0
Noakhali Science and Technology University (NSTU)	647	362	337	215	530	530	270	596	220	230	378	125	82	134	178	117	99	168	227	68	8	0	63	68	16	85	0
University of Science and Technology Chittagong (USTC)	238	222	197	38	42	221	87	117	24	117	166	106	9	84	13	1	81	46	39	31	3	0	21	0	10	31	0

Dhaka University Institutional Repository

Appendix 8. Single authors

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	26	32	19	141	20	8	13	6	8	10	8	18	47	3	16	44	6	1	3	8	45	7	2	0	1	0	0
University of Rajshahi (RU)	13	10	14	41	13	6	11	19	10	3	3	6	13	1	7	13	9	0	2	1	9	2	0	1	1	0	0
Bangladesh Agricultural University (BAU)	0	0	3	5	8	2	0	11	0	1	0	0	1	0	2	1	2	0	0	0	0	1	0	0	0	2	0
Bangladesh University of Engineering and Technology (BUET)	7	42	74	5	10	2	26	2	17	3	0	16	5	12	10	1	20	0	0	6	4	0	0	1	0	0	0
University of Chittagong (CU)	1	10	19	46	18	4	6	3	0	3	1	1	10	0	5	13	7	0	2	1	10	5	1	0	0	0	0
Jahangirnagar University (JU)	7	5	4	44	11	3	6	5	3	5	2	3	13	0	3	9	2	4	1	2	13	1	1	1	0	0	0
Shahjalal University of Science and Technology (SUST)	8	9	7	19	7	3	9	5	1	0	3	4	2	1	5	6	3	2	0	3	6	1	2	0	0	0	0
Khulna University (KU)	6	5	7	13	8	1	3	8	0	0	0	1	7	1	2	7	2	2	0	0	4	2	0	0	0	0	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	18	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	1
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	0	0	1	2	6	2	0	5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Patuakhali Science and Technology University (PSTU)	2	1	0	2	1	3	0	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Dhaka University Institutional Repository

Appendix 8 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Khulna University of Engineering and Technology (KUET)	1	9	15	2	5	1	9	0	4	0	0	4	1	1	5	0	2	0	1	0	0	0	0	1	0	0	0
North South University (NSU)	3	24	10	29	14	4	4	3	1	1	1	5	13	1	5	12	7	0	0	4	8	1	1	0	0	0	0
Rajshahi University of Engineering and Technology (RUET)	0	20	24	2	2	1	7	2	7	2	0	5	0	1	2	1	7	0	1	2	0		0	1	0	0	0
BRAC University (BRACU)	6	14	13	43	2	0	4	1	43	0	0	5	11	0	2	9	4	0	0	4	14	2	1	0	0	0	0
Chittagong University of Engineering and Technology (CUET)	2	13	16	4	3	1	8	0	6	1	0	1	2	2	4	0	6	4	0	2	0	0	0	0	0	0	0
East West University (EWU)	4	7	7	21	2	0	5	0	1	0	0	6	8	1	4	6	2	0	0	0	8	3	0	0	0	0	0
American International University-Bangladesh (AIUB)	1	22	20	2	3	1	4	1	0	1	0	7	5	1	0	4	9	0	0	3	1	0	0	0	0	0	0
United International University (UIU)	1	6	5	4	2	0	1	1	0	0	0	0	5	0	0	3	5	0	0	0	1	2	0	0	0	0	1
Ahsanullah University of Science and Technology (AUST)	4	12	15	5	6	1	4	0	3	0	0	3	2	2	1	0	6	0	0	4	2	0	0	0	0	0	0
University of Asia Pacific (UAP)	2	6	8	5	2	0	1	1	2	0	0	0	4	0	1	2	1	0	1	1	1	0	1	0	0	0	0
International Islamic University Chittagong (IIUC)	2	13	11	14	1	0	4	0	1	0	0	5	8	1	0	9	4	0	2	1	8	0	0	0	0	0	0

Dhaka University Institutional Repository

Appendix 8 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Daffodil International University (DIU)	3	16	12	12	6	1	1	4	2	1	0	2	10	3	1	3	2	0	0	3	3	0	1	1	1	0	0
Independent University, Bangladesh (IUB)	2	4	3	11	1	1	0	0	1	0	0	1	2	1	0	2	2	1	0	0	3	0	0	0	0	0	0
Dhaka University of Engineering and Technology (DUET)	1	6	5	4	2	0	1	1	0	0	0	0	5	0	0	3	5	0	0	2	1	1	0	0	0	0	0
Islamic University, Bangladesh (IU)	3	0		4	2	0	0	1	1	0	0	1	1	0	1	1	0	0	1	0	2	0	0	0	1	0	0
Stamford University Bangladesh (SU)	3	1	3	5	1	3	1	1	0	0	1	0	3	0	0	3	1	1	1	1	1	0	1		0	0	0
Jagannath University (JnU)	3	1	1	8	1	2	1	0	1	1	2	0	3	0	3	3	1	0	0	0	5	2	0	0	0	0	0
Sher-e-Bangla Agricultural University (SAU)	0	0	1	3	2	1	0	2	0	0	0		0	0	0	0	1	0	0	0	1		0	0	0	0	0
Southeast University (SEU)	3	6	9	10	1	0	2	0	0	0	1	0	0	0	1	2	2	0	0	1	5	0	0	0	0	0	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	1	2	1	1	1	0	0	0	0	0	0	0	3	0	0	1	0	0	0	2	0	0	0	0	0	0	0
Noakhali Science and Technology University (NSTU)	1	0	0	3	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	2	0	0	0	0	0	0
University of Science and Technology Chittagong (USTC)	2	4	3	0	0	0	0	0	0	0	0	2	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0

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Appendix 9. Collaborative authors

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	6983	2171	2356	1569	2525	4079	1617	2212	1376	1775	1620	943	588	929	892	459	776	1523	1850	541	203	734	261	752	133	151	47
University of Rajshahi (RU)	3884	1164	1487	455	960	4963	1121	1361	1042	991	660	618	198	686	504	202	595	883	583	213	76	573	157	554	65	175	8
Bangladesh Agricultural University (BAU)	1235	1859	604	423	1730	3359	136	5200	123	365	312	64	61	381	486	114	251	918	705	27	6	14	92	86	33	1036	8
Bangladesh University of Engineering and Technology (BUET)	712	3415	4677	953	1428	494	2146	385	1753	704	102	938	318	765	712	115	1151	52	286	412	171	48	33	50	88	13	0
University of Chittagong (CU)	33	10	86	62	11	11	57	10	9	68	54	49	41	34	32	22	40	34	39	24	11	28	52	68	76	95	0
Jahangirnagar University (JU)	22	11	11	59	10	10	73	85	77	84	83	44	12	44	46	13	32	93	34	24	72	18	11	23	10	89	11
Shahjalal University of Science and Technology (SUST)	652	602	891	434	1409	714	514	1437	570	632	131	209	142	479	333	181	335	248	557	118	78	37	58	62	14	32	0
Khulna University (KU)	818	779	907	328	907	795	447	106	470	403	576	279	129	279	274	126	247	180	284	149	15	40	64	27	18	94	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	4858	65	62	114	140	845	32	113	26	71	283	4	7	19	0	12	0	452	333	0	12	154	116	148	49	23	42
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	363	116	217	181	608	867	89	1390	124	239	122	28	23	136	149	47	143	393	206	15	11	0	25	47	0	195	0
Patuakhali Science and Technology University (PSTU)	346	199	257	229	507	368	97	787	98	133	170	52	30	56	196	52	111	190	221	68	8	29	55	30	7	167	0

Dhaka University Institutional Repository

Appendix 9 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Khulna University of Engineering and Technology (KUET)	400	1548	1749	285	406	126	766	56	647	197	54	471	135	292	155	33	594	36	124	284	23	4	16	15	37	0	0
North South University (NSU)	284	181	133	543	502	748	479	472	255	196	533	620	337	141	168	191	430	787	354	414	57	102	165	148	35	54	0
Rajshahi University of Engineering and Technology (RUET)	180	912	1255	171	291	110	847	97	636	594	12	303	61	280	107	14	530	0	82	131	2	0	5	16	7	3	0
BRAC University (BRACU)	684	157	122	106	395	301	429	272	106	108	250	441	155	106	127	166	636	162	219	340	90	582	278	196	47	19	5
Chittagong University of Engineering and Technology (CUET)	177	1055	1248	191	311	80	754	86	431	188	27	387	57	222	144	31	534	145	42	106	27	5	6	11	6	0	0
East West University (EWU)	544	683	589	217	150	240	254	130	145	96	310	255	166	60	41	136	234	106	76	166	26	56	10	56	8	0	0
American International University-Bangladesh (AIUB)	301	1858	1609	219	185	32	565	58	285	56	11	888	107	113	29	42	858	13	50	273	27	8	4	23	0	19	0
United International University (UIU)	265	893	694	199	94	114	241	51	106	27	4	218	139	26	24	79	269	29	33	144	48	16	0	48	21	7	0
Ahsanullah University of Science and Technology (AUST)	120	1027	1128	203	241	45	528	54	428	111	0	428	148	138	31	36	425	14	33	251	10	9	7	4	11	0	0
University of Asia Pacific (UAP)	41	51	56	12	14	14	23	63	17	75	30	14	84	57	34	16	17	63	80	79	19	16	22	54	23	16	0
International Islamic University Chittagong	424	826	812	232	200	385	397	319	322	161	362	212	98	91	41	95	456	138	95	128	57	11	60	27	33	38	0
Daffodil International University (DIU)	684	1646	1493	343	233	294	610	123	404	178	272	578	309	214	61	101	393	23	82	591	61	46	13	41	21	13	0

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Appendix 9 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Independent University, Bangladesh (IUB)	1280	567	520	303	329	512	299	136	133	112	23	196	62	59	144	26	263	97	305	95	20	75	126	28	35	6	0
Dhaka University of Engineering and Technology (DUET)	265	893	694	199	94	114	241	51	106	27	4	218	139	26	24	79	269	29	33	144	48	241	5	48	21	7	0
Islamic University, Bangladesh (IU)	397	283	0	87	291	458	168	286	181	249	235	115	48	180	45	35	86	193	130	32	10	23	31	45	17	13	0
Stamford University Bangladesh (SU)	292	145	145	37	100	1014	55	147	49	49	159	25	20	28	35	8	46	46	50	12	6	4	8	0	68	9	0
Jagannath University (JnU)	45	33	48	25	41	49	40	49	30	38	31	12	82	21	17	89	25	22	71	68	63	12	55	10	14	13	0
Sher-e-Bangla Agricultural University (SAU)	325	107	204	160	615	777	26	1278	64	188	185	0	36	119	70	58	56	250	85	10	7	0	33	15	18	147	0
Southeast University (SEU)	36	34	25	14	12	53	11	12	13	15	50	12	12	83	5	41	43	80	35	34	60	40	37	13	4	41	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	273	319	452	137	395	410	17	881	127	222	108	124	95	181	92	61	188	165	95	77	12	6	8	0	13	145	0
Noakhali Science and Technology University (NSTU)	646	362	337	212	529	530	270	595	220	230	378	125	82	134	177	117	99	168	226	68	6	0	63	68	16	85	0
University of Science and Technology Chittagong (USTC)	236	218	194	38	42	221	87	117	24	117	166	104	8	84	13	0	80	46	39	31	3	0	21	0	10	31	0

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Appendix 10. Local Co-Authorship %

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	51.02	61.96	56.05	56.87	38.46	43.81	55.24	58.91	54.09	39.19	67.54	48.41	44.31	39.88	40.85	51.59	61.75	43.62	45.28	47.87	65.79	39.08	42.65	29.17	40.91	31.03	18.18
University of Rajshahi (RU)	42.74	69.57	65.98	58.45	40.3	36.76	62.63	43.49	54.24	37.79	41.1	54.82	52.42	54.72	50	48.72	71.13	36.54	44.12	74.19	64.1	53.85	15.79	25	23.08	29.63	0
Bangladesh Agricultural University (BAU)	23.42	16.18	29.76	23.66	22.48	24.04	3.57	35.37	17.86	16.67	31.51	50	41.18	23.4	23.96	33.33	29.58	23.45	25.71	60	50	100	33.33	0	50	57.43	0
Bangladesh University of Engineering and Technology (BUET)	69.92	70.85	71.7	55.76	47.13	47.17	73.83	50.85	64.8	51.02	39.13	57.9	52.94	58.33	48.97	31.03	68.19	33.33	66.2	72.11	62.5	25	33.33	53.85	56	0	100
University of Chittagong (CU)	77.78	54.58	49.89	60.29	38.4	41.45	52.2	26.92	50	34.06	53.02	47.11	41.59	38.82	46.49	47.75	50.68	46.88	53.95	55.56	72.22	54.17	61.54	16.67	33.33	57.14	100
Jahangirnagar University (JU)	40.52	60.5	63.18	64.29	49.47	29.82	65.54	50.2	30.32	21.35	42.41	46.71	57.81	34.82	54.05	49.18	69.61	29.13	40.74	71.28	63.89	20.93	28	16.98	36.84	64.29	0
Shahjalal University of Science and Technology (SUST)	46.11	70.82	55.77	56.5	43.37	40.1	54.55	41.69	29.15	11.79	39.47	55.29	53.62	20.51	51.24	47.5	47.46	48.28	44.33	72.92	73.17	50	46.15	11.11	66.67	33.33	100
Khulna University (KU)	54.36	67.54	52.52	51.33	40.79	34.9	50.24	41.79	43.11	25.24	41.72	61.95	61.43	37.5	43.21	59.02	45.45	45.45	32.84	78.95	69.23	50	60	37.5	80	35.29	100

Dhaka University Institutional Repository

Appendix 10 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Bangabandhu Sheikh Mujib Medical University (BSMMU)	67.43	38.46	42.86	25	40	48.7	50	47.37	0	25	61.67	100	100	40	100	50	100	22.22	38.64	100	50	55	35	48.28	60	33.33	36.36
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	35.71	5	33.96	18.46	30.29	27.32	16.67	37.55	11.76	15.56	28.57	11.11	0	16.67	16.67	15.38	18.52	34.48	26.67	0	0	100	0	0	100	54.17	100
Patuakhali Science and Technology University (PSTU)	34	47.31	30.56	36.11	20.65	14.94	15.22	28.93	10.26	6.25	5.13	33.33	54.55	25	26.23	28.57	51.61	12.5	20	54.55	0	12.5	37.5	0	0	38.89	100
Khulna University of Engineering and Technology (KUET)	66.24	74.61	70.93	66	58.28	44.44	69.61	36.36	45.82	40.32	40	70.64	72.73	61.62	48.33	50	74.92	20	39.39	76.23	87.5	0	0	42.86	25	100	100
North South University (NSU)	58.84	77.96	71.96	53.96	45.78	50.32	65.96	48.08	46.84	30.23	61.06	67.56	44.81	51.52	61.7	39.42	73.89	42.31	56.9	82	72.97	37.5	59.38	25	50	14.29	100
Rajshahi University of Engineering and Technology (RUET)	73.91	80.79	68.27	49.15	42.5	52.94	68.33	43.48	60.87	74.92	33.33	71.21	57.14	50	45	25	63.42	100	72.73	86.05	100	100	100	50	0	100	100
BRAC University (BRACU)	32.1	76.45	77.3	52.17	42.11	39.18	73.08	49.02	52.17	26.32	38.1	75.17	49.33	69.23	30	47.76	80.85	40	26.32	78.45	58.33	29.03	20.69	9.38	15.38	50	0
Chittagong University of Engineering and Technology (CUET)	66.13	72.66	67.62	59.42	45.24	52	69.9	39.13	61.93	37.7	37.5	67.83	52.38	47.37	57.81	71.43	62.55	56.92	41.67	76.74	62.5	0	0	0	0	100	100

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Appendix 10 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
East West University (EWU)	57.5	77.53	64.94	60.83	35.29	45.65	67.33	38.71	50	11.11	54.93	56.44	51.81	58.82	43.75	34.33	65	25	50	87.5	70	40	0	0	50	100	100
American International University-Bangladesh (AIUB)	72.37	78.34	73.75	68	50	33.33	60.7	46.67	43.01	35.71	50	77.01	62.75	36.84	14.29	43.48	75.9	0	16.67	75.53	66.67	0	100	40	100	66.67	100
United International University (UIU)	61.25	69.59	72.95	45.45	48.28	36.11	89.61	43.75	59.26	33.33	100	66.22	43.21	66.67	75	26.67	80.53	33.33	50	79.17	56.52	37.5	100	9.09	50	0	100
Ahsanullah University of Science and Technology (AUST)	87.18	77.43	69.1	67.74	39.19	36.36	71.36	53.85	51.01	47.22	100	51.01	72	41.67	60	60	65.28	0	72.73	90.698	83.33	100	0	100	0	100	100
University of Asia Pacific (UAP)	78.52	56.18	53.38	62	60	57.14	52.87	46.67	45.76	26.32	86.05	53.33	46.15	36.84	54.55	50	61.43	36.36	64.71	42.86	87.5	100	80	62.5	25	33.33	100
International Islamic University Chittagong (IIUC)	60.19	69.49	63.68	67.37	37.78	37.97	64.88	49.25	55.63	22.86	45	59.15	51.11	56.52	20	62	63.33	36.36	52.63	75.68	74.19	0	44.44	0	0	20	100
Daffodil International University (DIU)	78.74	75.34	73.47	58.87	51.39	45.21	70.07	45.45	55.86	27.03	76.67	81.86	62.22	52.63	72.73	45.24	75.76	25	50	82.42	62.5	84.62	25	81.82	50	0	100
Independent University, Bangladesh (IUB)	32.43	73.81	72.32	58.23	26.39	41.38	65.31	29.63	54.84	4.17	25	70.59	27.27	5.88	27.78	33.33	81	61.9	26.67	67.86	55.56	37.5	0	20	0	100	100

Dhaka University Institutional Repository

Appendix 10 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Dhaka University of Engineering and Technology (DUET)	61.25	69.59	72.95	45.45	48.28	36.11	89.61	43.75	59.26	33.33	100	66.22	43.21	66.67	75	26.67	80.53	33.33	50	79.17	56.52	89.61	100	9.09	50	0	100
Islamic University, Bangladesh (IU)	44.54	20.69	100	44.83	23.6	25.66	32.61	54.65	27.59	25.4	30.91	40.48	35	15.38	20	26.67	16.67	32.5	55.56	30.77	40	50	100	14.29	66.67	0	100
Stamford University Bangladesh (SU)	84.34	71.05	68	94.118	66.67	74.07	68.18	80.49	41.67	41.67	79.03	66.67	64.29	37.5	55.56	66.67	84.62	84.62	75	75	75	100	100	100	0	0	100
Jagannath University (JnU)	54.63	61.27	56.67	50.63	45	35.19	51.63	66.67	49.55	21.95	45.95	50	32.35	29.69	45.28	41.03	46.67	46.34	63.16	54.17	50	31.58	37.5	22.22	33.33	50	100
Sher-e-Bangla Agricultural University (SAU)	12.31	0	26.76	21.05	17.93	13.08	0	20.5	10	3.12	10.34	100	40	0	14.29	33.33	27.27	15.56	36.84	0	50	100	0	0	0	30.77	100
Southeast University (SEU)	35.35	42.74	52.87	47.62	17.24	12.61	74.29	55	29.17	9.09	22.96	55.32	55.32	35.71	66.67	44.44	81.25	25	50	63.64	75	25	42.86	13.95	0	25	100
Hajee Mohammad Danesh Science and Technology University (HSTU)	33.96	52.59	41.55	29.27	23.86	12.64	0	29.52	37.14	19.57	7.14	55.32	35.14	25	66.67	22.73	47.83	9.09	18.18	54.84	25	0	0	100	0	44.83	100
Noakhali Science and Technology University (NSTU)	70.83	48.25	36.54	48.28	36.43	51.56	33.33	43.79	35.59	33.96	68.63	34.38	41.67	35.48	31.91	36	34.78	51.52	66.04	50	66.67	100	50	30	100	50	100

Dhaka University Institutional Repository

Appendix 10 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Science and Technology Chittagong (USTC)	65.38	69.15	71.43	41.67	62.5	42.5	65.52	52.38	37.5	52.63	58.82	58.06	50	33.33	50	100	67.86	33.33	66.67	100	100	100	66.67	100	0	0	100

Dhaka University Institutional Repository

Appendix 11. International Co-Authorship (%)

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	48.98	38.04	43.95	43.13	61.54	56.19	44.76	41.09	45.91	60.81	32.46	51.59	55.69	60.12	59.15	48.41	38.25	56.38	54.72	52.13	34.21	60.92	57.35	70.83	59.09	68.97	81.82
University of Rajshahi (RU)	57.26	30.43	34.02	41.55	59.7	63.24	37.37	56.51	45.76	62.21	58.9	45.18	47.58	45.28	50	51.28	28.87	63.46	55.88	25.81	35.9	46.15	84.21	75	76.92	70.37	100
Bangladesh Agricultural University (BAU)	76.58	83.82	70.24	76.34	77.52	75.96	96	64.63	82	83.33	68.49	50	58.82	77	76.04	66.67	70.42	76.55	74.29	40	50	0	66.67	100	50	42.57	100
Bangladesh University of Engineering and Technology (BUET)	30.08	29.15	28.30	44.24	52.87	52.83	26.17	49.15	35.2	48.98	60.87	42.1	47.06	41.67	51.03	68.97	31.81	66.67	33.8	27.89	37.5	75	66.67	46.15	44	100	0
University of Chittagong (CU)	22.22	45.42	50.11	39.71	61.6	58.55	47.8	73.08	50	65.94	46.98	52.89	58.41	61.18	53.51	52.25	49.32	53.12	46.05	44.44	27.78	45.83	38.46	83.33	66.67	42.86	0
Jahangirnagar University (JU)	59.48	39.5	36.82	35.71	50.53	70.18	34.46	49.8	69.68	78.65	57.59	53.29	42.19	65.18	45.95	50.82	30.39	70.87	59.26	28.72	36.11	79.07	72	83.02	63.16	35.71	100
Shahjalal University of Science and Technology (SUST)	53.89	29.18	44.23	43.5	56.63	59.9	45.45	58.31	70.85	88.21	60.53	44.71	46.38	79.49	48.76	52.5	52.54	51.72	55.67	27.08	26.83	50	53.85	88.89	33.33	66.67	0
Khulna University (KU)	45.64	32.46	47.48	48.67	59.21	65.1	49.76	58.21	56.89	74.76	58.28	38.05	38.57	62.50	56.79	40.98	54.55	54.55	67.16	21.05	30.77	50	40	62.5	20	64.71	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	32.57	61.54	57.14	75	60	51.3	50	52.63	100	75	38.33	0	0	60	0	50	0	77.78	61.36	0	50	45	65	51.72	40	66.67	63.64
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	64.29	95	66.04	81.54	69.71	72.68	83.33	62.45	88.24	84.44	71.43	88.89	100	83.33	83.33	84.62	81.48	65.52	73.33	100	100	0	100	100	0	45.83	0

Dhaka University Institutional Repository

Appendix 11 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Patuakhali Science and Technology University (PSTU)	66	52.69	69.44	63.89	79.35	85.06	84.78	71.07	89.74	93.75	94.87	66.67	45.45	75	73.77	71.43	48.39	87.5	80	45.45	100	87.5	62.5	100	100	61.11	0
Khulna University of Engineering and Technology (KUET)	33.76	25.39	29.07	34	41.72	55.56	30.39	63.64	54.18	59.68	60	29.36	27.27	38.38	51.67	50	25.08	80	60.61	23.77	12.5	100	40.62	100	57.14	75	0	0
North South University (NSU)	41.16	22.04	28.04	46.04	54.22	49.68	34.04	51.92	53.16	69.77	38.94	32.44	55.19	48.48	38.3	60.58	26.11	57.69	43.1	18	27.03	62.5	40.62	75	50	85.71	0	0
Rajshahi University of Engineering and Technology (RUET)	26.09	19.21	31.73	50.85	57.5	47.06	31.67	56.52	39.13	25.08	66.67	28.79	42.86	50	55	75	36.58	0	27.27	13.95	0	0	0	50	100	0	0	0
BRAC University (BRACU)	67.9	23.55	22.7	47.83	57.89	60.82	26.92	50.98	47.83	73.68	61.9	24.83	50.67	30.77	70	52.24	19.15	60	73.68	21.55	41.67	70.97	79.31	90.62	84.62	50	100	50
Chittagong University of Engineering and Technology (CUET)	33.87	27.34	32.38	40.58	54.76	48	30.1	60.87	38.07	62.3	62.5	32.17	47.62	52.63	42.19	28.57	37.45	43.08	58.33	23.26	37.5	100	100	100	100	0	0	0
East West University (EWU)	42.5	22.47	35.06	39.17	64.71	54.35	32.67	61.29	50	88.89	45.07	43.56	48.19	41.18	56.25	65.67	35	75	50	12.5	30	60	100	100	50	0	0	0
American International University-Bangladesh (AIUB)	27.63	21.66	26.25	32	50	66.67	39.3	53.33	56.99	64.29	50	22.99	37.25	63.16	85.71	56.52	24.1	100	83.33	24.47	33.33	100	0	60	0	33.33	0	0
United International University (UIU)	38.75	30.41	27.05	54.55	51.72	63.89	10.39	56.25	40.74	66.67	0	33.78	56.79	33.33	25	73.33	19.47	66.67	50	20.83	43.48	62.5		90.91	50	100	0	0
Ahsanullah University of Science and Technology (AUST)	12.82	22.57	30.9	32.26	60.81	63.64	28.64	46.15	48.99	52.78	0	48.99	28	58.33	40	40	34.72	100	27.27	9.302	16.67	0	100	0	100	0	0	0

Dhaka University Institutional Repository

Appendix 11 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Asia Pacific (UAP)	21.48	43.82	46.62	38	40	42.86	47.13	53.33	54.24	73.68	13.95	46.67	53.85	63.16	45.45	50	38.57	63.64	35.29	57.14	12.5	0	20	37.5	75	66.67	0
International Islamic University Chittagong (IIUC)	39.81	30.51	36.32	32.63	62.22	62.03	35.12	50.75	44.37	77.14	55	40.85	48.89	43.48	80	38	36.67	63.64	47.37	24.32	25.81	100	55.56	100	100	80	0
Daffodil International University	21.26	24.66	26.53	41.13	48.61	54.79	29.93	54.55	44.14	72.97	23.33	18.14	37.78	47.37	27.27	54.76	24.24	75	50	17.58	37.5	15.38	75	18.18	50	100	0
Independent University, Bangladesh (IUB)	67.57	26.19	27.68	41.77	73.61	58.62	34.69	70.37	45.16	95.83	75	29.41	72.73	94.12	72.22	66.67	19	38.1	73.33	32.14	44.44	62.5	100	80	100	0	0
Dhaka University of Engineering and Technology (DUET)	38.75	30.41	27.05	54.55	51.72	63.89	10.39	56.25	40.74	66.67	0	33.78	56.79	33.33	25	73.33	19.47	66.67	50	20.83	43.48	10.39	0	90.91	50	100	0
Islamic University, Bangladesh (IU)	55.46	79.31		55.17	76.4	74.34	67.39	45.35	72.41	74.6	69.09	59.52	65	84.62	80	73.33	83.33	67.5	44.44	69.23	60	50	0	85.71	33.33	100	0
Stamford University Bangladesh	15.66	28.95	32	5.882	33.33	25.93	31.82	19.51	58.33	58.33	20.97	33.33	35.71	62.5	44.44	33.33	15.38	15.38	25	25	25	0	0		100	100	0
Jagannath University (JnU)	45.37	38.73	43.33	49.37	55	64.81	48.37	33.33	50.45	78.05	54.05	50	67.65	70.31	54.72	58.97	53.33	53.66	36.84	45.83	50	68.42	62.5	77.78	66.67	50	0
Sher-e-Bangla Agricultural University (SAU)	87.69	100	73.24	78.95	82.07	86.92	100	79.5	90	96.88	89.66	0	60	100	85.71	66.67	72.73	84.44	63.16	100	50	0	100	100	100	69.23	0
Southeast University (SEU)	64.65	57.26	47.13	52.38	82.76	87.39	25.71	45	70.83	90.91	77.04	44.68	44.68	64.29	33.33	55.56	18.75	75	50	36.36	25	75	57.14	86.05	100	75	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	66.04	47.41	58.45	70.73	76.14	87.36	100	70.48	62.86	80.43	92.86	44.68	64.86	75	33.33	77.27	52.17	90.91	81.82	45.16	75	100	100	0	100	55.17	0

Dhaka University Institutional Repository

Appendix 11 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Noakhali Science and Technology University (NSTU)	29.17	51.75	63.46	51.72	63.57	48.44	66.67	56.21	64.41	66.04	31.37	65.62	58.33	64.52	68.09	64	65.22	48.48	33.96	50	33.33	0	50	70	0	50	0
University of Science and Technology Chittagong (USTC)	34.62	30.85	28.57	58.33	37.5	57.5	34.48	47.62	62.5	47.37	41.18	41.94	50	66.67	50	0	32.14	66.67	33.33	0	0	0	33.33		100	100	0

Appendix 12. Co-Authors per Document

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
University of Dhaka (DU)	19.8	4.08	4.21	3.1	5.85	10.6	4.52	5.52	5.01	5.94	5.86	3.81	2.96	4.72	4.95	2.7	4.38	9.37	10.5	4.16	2.41	9.6	4.93	17.3	3.95	8.41	7.55
University of Rajshahi (RU)	24.6	3.96	4.15	2.91	4.86	14.2	4.47	5.41	4.87	6	7.04	3.7	2.9	5.05	4.64	3.18	3.8	10.5	5.24	3.44	2.64	16.1	5.26	28.9	5.38	7.59	8
Bangladesh Agricultural University (BAU)	7.51	29.4	7.22	4.75	6.48	10.60	6	6.97	5.07	6.13	6.19	6	3.71	6	6.51	4.24	5.01	7.25	8.46	5.8	3	4	5.24	7.16	5.67	6.4	8
Bangladesh University of Engineering and Technology (BUET)	4.2	3.48	3.545	4.31	4.93	4.5	3.63	4.36	3.91	4.31	4.96	3.48	3.85	4.05	4.68	5.28	3.81	3.83	4.8	3.37	4.2	6.25	6	4.54	4.6	13	0
University of Chittagong (CU)	4.11	4.24	3.71	3.5	5.72	6.78	3.96	5.27	4.5	5.81	6.42	5.45	4.8	5.34	4.18	3.25	3.91	6.92	6.66	7.42	2.87	13	4.69	12.5	4.89	8	0
Jahangirnagar University (JU)	8.44	4.41	4.63	3.66	5.4	6.86	4.23	5.64	6.66	6.44	6.89	4.38	2.83	6.72	4.52	2.93	4.56	11	6.09	3.99	2.64	6.65	5.8	5.98	6.26	7.14	11
Shahjalal University of Science and Technology (SUST)	6.16	3.67	4.26	3.46	7.05	5.76	4.47	7.21	5.36	5.84	4.76	3.4	3.2	5.47	4.17	3.41	4.09	5.84	7.6	3.52	2.78	6.33	5.15	10.9	4.67	6.5	0
Khulna University (KU)	5.65	3.97	4.15	3.53	5.03	7.27	4.24	5.94	5.06	6.34	7.21	3.75	2.77	4.90	4.69	2.98	3.9	6.55	5.84	4.04	2.08	4.6	5.13	3.88	4.2	6.47	0
Bangabandhu Sheikh Mujib Medical University (BSMMU)	8.5	7.54	6.64	5.9	8.55	9.83	5.88	6.05	10.5	9.38	6.15	4	7	3.8	0	6	0	10	9.32	0	6	5.35	6.2	6.28	10.6	7.67	4.18

Dhaka University Institutional Repository

Appendix 12 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	6.61	6.2	5.13	4.65	5.79	6.82	9.17	5.74	8.82	7.42	6.9	3.56	4.17	7	6.31	4.38	6	6.82	5.45	3.75	5.5	0	5.4	6.86		5.88	0
Patuakhali Science and Technology University (PSTU)	5.79	4.33	4.67	4.6	5.41	6.83	4.8	5.58	5	6.25	7.15	4.4	3.36	6	5.07	4.29	4.68	7.15	6.85	4.36	4	7	7.5	6.29	7	6.08	0
Khulna University of Engineering and Technology (KUET)	4.1	3.47	3.49	3.77	4.03	4.89	3.51	3.55	4.19	4.92	6.5	3.41	3.36	4.08	3.63	5.5	3.32	7.2	4.76	3.29	3.12	4	8	2.86	4.88	0	0
North South University (NSU)	14.9	4.25	4.27	3.38	4.87	7.14	4.16	6.34	5.05	6.33	7.46	4.46	3.29	4.94	4.7	2.99	3.86	16.9	8.55	3.99	2.51	5.29	7.19	7.12	6	8.43	0
Rajshahi University of Engineering and Technology (RUET)	4.78	3.58	3.72	4.02	4.08	4.56	3.86	3.72	4.29	3.32	4	3.62	3.29	4.13	3.62	3.75	3.66		4.5	3.47	2	0	5	4.25	7	3	0
BRAC University (BRACU)	50	4.17	4.15	4.73	5.12	47.5	3.97	6.53	4.73	6.63	7.16	4.23	2.91	4.88	4.3	3.04	5.48	42.2	36.8	4.2	3.19	19.7	9.24	66.1	4.08	9.5	5
Chittagong University of Engineering and Technology (CUET)	4.02	3.52	3.7	3.62	4.22	3.8	3.99	4.57	4.55	4.75	4.75	3.89	3.67	4.18	3.39	4.71	3.89	3.42	3.58	3.21	3.88	5	6	5.5	6	0	0
East West University (EWU)	6	3.72	3.63	2.87	4.18	6.13	3.63	5.26	4.02	6	6.15	3.65	3	4	3.12	3.1	3.96	7.38	4.83	4.16	2.05	4.27	6	9.86	4	0	0

Dhaka University Institutional Repository

Appendix 12 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
American International University-Bangladesh (AIUB)	4.86	4.04	4.07	3.77	4.09	3.78	4.16	4.4	4.54	4.5	5.5	4.04	3.2	4.08	4.57	2.48	4.25	6.5	3.89	3.85	3.56	8	4	5.6		6.33	0
United International University (UIU)	4.89	4.38	4.37	3.3	3.86	5.17	4.58	4.25	4.74	5	3.5	4.41	2.9	4.5	3.88	2.87	3.65	4.78	4.9	3.85	2.78	2.62	0	5.82	3.83	7	0
Ahsanullah University of Science and Technology (AUST)	3.77	4.06	4.13	4.15	4.58	4.73	4.23	4.46	4.88	4.08	0	4.88	3.64	4.29	4	3.9	4.28	4.67	3.36	3.81	2	3.33	7	4	5.5	0	0
University of Asia Pacific (UAP)	5.35	4.04	4.06	3.36	3.85	6.54	4.31	4.67	4.42	4.84	5.56	4.11	3.81	4.58	3.45	2.62	3.96	7.64	6.53	4.14	3.12	4.17	4.6	7.75	6	7	0
International Islamic University Chittagong (IIUC)	6.5	4.08	4.2	3.38	5.51	8.76	4.46	7.63	4.72	7.23	8.14	4.31	3.31	4.26	9.4	3.14	4.3	8.45	6.32	4.59	2.45	11	8.00	9	8.5	7.8	0
Daffodil International University (DIU)	4.7	4.38	4.47	3.82	4.1	6.14	4.48	4.12	5.06	6.03	5.32	4.41	3.96	4.61	3.55	3.6	4.27	6.25	5.39	4.26	2.92	4.69	4.25	5.45	4	13	0
Independent University, Bangladesh (IUB)	22.9	4.13	4.05	4.94	6.17	19.9	4.91	5.56	5.23	6.46	5.75	4.16	3.64	5.65	9.78	2.67	4.46	6	36.1	4.39	3.11	9.75	20.5	5.8	26.5	6	0
Dhaka University of Engineering and Technology (DUET)	4.89	4.38	4.37	3.3	3.86	5.17	4.58	4.25	4.74	5	3.5	4.41	2.9	4.5	3.88	2.87	3.65	4.78	4.9	3.85	2.78	4.58	5	5.82	3.83	7	0

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Appendix 12 Continued

University name and abbr.	Medicine	Computer Science	Engineering	Social Sciences	Environmental Science	Biochemistry, Genetics and Molecular Biology	Physics and Astronomy	Agricultural and Biological Sciences	Materials Science	Chemistry	Pharmacology, Toxicology and Pharmaceutics	Mathematics	Business, Management and Accounting	Chemical Engineering	Earth and Planetary Sciences	Economics, Econometrics and Finance	Energy	Immunology and Microbiology	Multidisciplinary	Decision Sciences	Arts and Humanities	Psychology	Nursing	Neuroscience	Health Professions	Veterinary	Dentistry
Islamic University, Bangladesh (IU)	5.66	5.32		3.66	6.09	6.65	4.98	5.34	4.93	5.78	6.65	4.33	3.65	5.08	5	3.33	5.39	6.8	5.74	4.38	2.6	6	4.6	8	6.33	6.5	0
Stamford University Bangladesh (SU)	5.23	4.21	3.46	2.65	4.3	73.6	3.27	5.1	4.33	4.33	4.42	4.17	2.5	4.62	3.89	2	4.08	4.08	4.75	3.25	2.25	4	3.2		68	9	0
Jagannath University (JnU)	5.87	4.44	4.44	4.19	5.19	6.44	4.59	5.08	5.01	5.44	6.3	4.03	3.06	5.23	4.66	3.03	4.75	7.27	4.47	3.71	5.57	7.74	7.38	12.3	4.67	6.5	0
Sher-e-Bangla Agricultural University (SAU)	7.2	7.61	5.17	5.63	5.93	6.25	7	5.94	6.7	7.47	7.83	0	4.8	6.78	5.93	3.94	5.36	7.02	5.16	5	4	0	16.5	7.5	9	7.42	0
Southeast University (SEU)	6.11	4.22	3.86	3.33	6.66	8.7	3.8	8.45	5.92	9.27	7.8	4.02	4.02	6.93	2	2.72	3.06	7.67	8	3.91	5.58	6.5	6	7.49	4	19.5	0
Hajee Mohammad Danesh Science and Technology University (HSTU)	6.72	4.79	5.3	4.37	6.7	7.11	8.5	6.09	4.89	6.46	9.21	4.02	3.86	5.85	5.83	3.86	5.17	6.45	8.64	3.39	3.25	6	8	0	4.33	6.07	0
Noakhali Science and Technology University (NSTU)	6.27	4.83	4.9	4.62	6.01	6.73	6.57	5.64	6.03	6.4	6.24	4.81	4.17	6.1	5.55	5.12	5.35	6.58	6.19	4.33	3	0	5.79	7.8	6.5	5.72	0
University of Science and Technology Chittagong (USTC)	5.79	4.49	4.53	4.58	5.88	7.25	4.79	6.86	5	7.53	6.41	4.84	2.25	7.58	6.5	1	4.36	7.67	6.5	5	3	0	7	0	10	10.3	0