Bibliometric Analysis and Science Mapping of Scientific Publications of COMSATS University During 1998–2022

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This study aimed to conduct a bibliometric analysis and science mapping of the publications emerging from the COMSATS University Islamabad (CUI), Pakistan. Bibliometrics and visualization techniques were used in this study. The data were collected from the Web of Science database with the "COMSATS University Islamabad" query in the affiliation category.

A total of 26,841 documents were retrieved. VOSviewer, Biblioshiny, ScientoPy, and MS Excel software were used to analyze the data. The results showed that the number of publications, particularly articles, has progressively increased. COMSATS had the most national collaborations with Quaid-e-Azam University, and China was identified as the top-ranked country for international collaborations. Furthermore, Engineering was the most attractive area for the CUI authors. This study would guide the researchers regarding important research areas while conducting, collaborating, and submitting their research in international databases.

Keywords: Scientific publication; COMSATS University, Bibliometric study; Visualization, Science Mapping

INTRODUCTION

The quality and quantity of research publications are important criteria for determining the scientific performance of any university or institute (Romanelli et al., 2018). Universities and research institutes routinely produce research to contribute their share of the existing literature, and some organizations have initiated the process of ranking universities per their research outputs (Singh, 2017). The criteria for these outputs can be based on but not limited to publications within peer-reviewed journals, the impact factor of publishing journals, the number of authors, the diversity of authorship, the contribution to the existing literature, and the scope of the research product.

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Bibliometrics and science mapping are the latest methods for identifying the best research publications (Doulani,2020). Published research work is also gaining popularity worldwide, particularly in research rankings (Ali et al., 2022).Other than academic activities, research activities are also gaining popularity among the university communities, and this research work is also considered an important criterion for university rankings (Gupta &Sonkar, 2019).

Bibliometrics and scientometrics are the latest tools currently being used by many research analysts (Ahmed &Al-Reyaee, 2019; Darmadjiet al., 2018; Haq & al Fouzan, 2017; Şenel &Demir, 2018). These two methods have similarities in their approaches. Rousseau (2014) has claimed in his research that the Belgian librarian PaulOtlet was the first to coin the term "bibliometrics." In his book Traité de Documentation (1934), he called for the foundation of a new field, bibliométrie, which he defined as the "measurement of all aspects related to the publication and reading of books and documents."On the other hand, Baskaran (2013) claimed that the term "bibliometric" was coined for the first time in 1969, but different studies (Fosso, 2020; Ng et al., 2022) have contradicted this claim. Science mapping has also recently evolved as an emerging technique within scholarly literature. It is an essential component of a bibliometric study (Belussiet al., 2019). The science mapping technique facilitates researchers toknow the deep relationship among the various structures of science. This technique also provides an imaginary view to understand the phenomena under investigation easily (Pérez-Fuentes et al., 2021).Bibliometric analysis allows researchers to analyze research products such as articles, books, papers, and other research publications using statistical methods and to present the results meaningfully. On the other hand, scientometrics offers insights into scientific metrics and indicators. These two methods overlap, sometimes leading to a detailed exploration of the phenomenon under study (Umeokaforet al., 2022).

COMSATS University Islamabad (CUI) is a public sector university with seven (07) campuses in different cities of Pakistan. The COMSATS University Islamabad (CUI) was established in 1998 as the COMSATS Institute of Information Technology (CII). It was a project of the Commission on Science and Technology for Sustainable Development in the South (COMSATS), which is an inter-governmental organization with twenty-seven (27) member states in three continents (COMSATS University Islamabad, 2022a). The institute received its university charter in 2018 from the Government of Pakistan. It has been ranked number three in the General Category, number six in the Overall Universities within Pakistan category, and number two in the Research Productivity category among all universities of Pakistan (COMSATS University Islamabad, 2022b).Networking and sharing ideas create new platforms of thinking. Researchers from different regions share their thoughts, backgrounds, and experiences, leading to mature knowledge development.

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The current study has been designed to explore the phenomena in detail. The following six research questions have been formulated to achieve the research objectives:

1. What kind of scientific publications were published in the Web of Science database by the authors of COMSATS University Islamabad?
2. What is the number and historical trend of scientific publications of the researchers of COMSATS University in the Web of Science database?
3. What is the research ranking of the researchers of COMSATS University Islamabad as per their number of total publications, Average Growth Rate (AGR), Average Document per Year (ADY), and Percentage of Documents in the Last Years (PDLY)?
4. What are the co-occurrences of the keywords used in the scientific publications by the authors of CUI?
5. What is the status of national and international collaboration between researchers of COMSATS University Islamabad and other national and international scholars?
6. What is the research collaboration of scientific publications among global institutes?
7. What are the productive journals of COMSATS University publication?
8. What is the trend of scientific papers of researchers of COMSATS University in terms of subjects/fields?
9. Which are the most highly cited scientific publications with their publication year and journal name?

LITERATUREREVIEW

Bibliometric analysis and science mapping have garnered much attention from researchers recently. Different scholarly output metrics have been developed to investigate these emerging trends, research collaborations at the national and international levels, research networking, and emerging trends. Abbas et al. (2021) researched systemic mapping using bibliometric analysis. The authors used the Publish or Perish (PoP) software to retrieve and analyze the data, and articles related to Knowledge Management were assessed. As per their analysis of 217 articles, the most citations were seen in 2017, while the publication rate was highest in 2019. Moreover, “Knowledge Management” was the most used term in the titles. In a similar study (Kashyap &Singha, 2021), authors analyzed 190 research papers published during the 2015-2020 period. They concluded that there were 349total contributor’s to the articles. 121(63.68%) articles had multiple authors, and only 69 (36.31) had sole authors. Doulani (2020) conducted a bibliometric analysis of the scientific publications produced by the faculty members of Alzahra University, Iran. Articles published from 1986 to 2019 were retrieved and analyzed through the VOSviewer and CR Explorer software to investigate how Alzahra University researchers collaborated with other

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researchers at the national and international levels. It was found that most collaborations at the international level were with researchers based in the USA, Canada, and Germany. Doulani (2020) enlisted the main categories of scientific publications as “chemistry,” “physics,” “biology,” “psychology and educational sciences,” and “accounting sciences, management, and computer science.” Baskaran (2013) investigated the research productivity of Alagappa University during 1999-201. The bibliometric study highlighted that there had been significant growth in research publications. Furthermore, the Central Electrochemical Research Institute staff published the most articles, and the multi-author pattern showed a positive trend during the analyzed period.

The bibliometric analysis method of research has gained much attention from Pakistani researchers in recent years (Haq & Alfouzan, 2019; Qayyum & Naseer, 2013; Siddique et al., 2021). Hussain and Yar (2020) analyzed data from Google Scholar and found that 84 documents were published during the 2000-2020 period. They also concluded that the three-authorship pattern (28.571%) was the dominant authorship pattern in these papers. The papers received 372 citations, of which 90 (24.193%) were received in 2014. The results also showed that six authors had written three papers, each on knowledge management. Ali et al., (2021) retrieved data from research papers published between 1971 and 2020in the ISI Web of Knowledge. The authors concluded that “digital libraries” was the top research area, “proceeding paper” was the top type of document, and the “English language” was the most used medium of communication. The authors also concluded that the researchers published most papers from 2006 to 2010. In another study, Aslam et al., (2022) concluded that “in the digital age, reading habits are gradually declining and poor reading skills are causing various informational and social challenges, including lack of critical thinking and intellectual irresponsibility.” This conclusion was drawn based on data from the Web of Science; carrying out bibliometric analysis and then conducting visualization via VOS viewer software. They also concluded that “reading skills, behavior, habits, and factors” had been the most influencing factors in the reading culture.

After the review of the available literature, the current research trends of scientific publications, along with author collaborations, publication trends, networking, and subject directions, have been revealed. Knowledge of these trends allows different institutes/universities/research centers to know their progress regarding research performance and highlight areas where further research is needed. The results of this research would facilitate university researchers, particularly those from COMSATS University, to know the topical gap for further research. They also showcase new scholarly trends and highlight opportunities for national and international collaborations.

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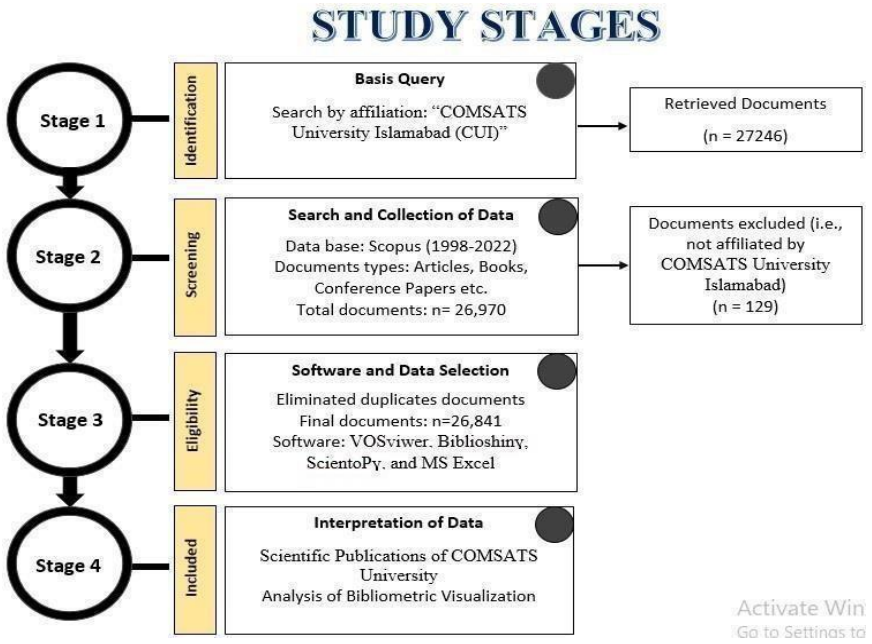
RESEARCHDESIGN

Bibliometrics and visualization techniques were used to perform this study. The period from 1998-2022 was selected for data collection because COMSATS University Islamabad (CUI) was established in 1998. All the papers that have at least one affiliation with CUI were selected. As per the record of COMSATS University Islamabad (2022c), most papers were published in the ISI Web of Knowledge, SCOPUS, and Pub Med databases. Consequently, the Web of Science database was selected to retrieve the data of the relevant published research work. The data was retrieved using the "COMSATS University Islamabad (CUI)" search query by affiliation. The data was extracted from the Web of Science database on 12th December 2022 at 6.35 pm. 26,841 results, including published articles, reviews, proceeding papers, book chapters, and reviews, were retrieved. Different applications like VOSviewer, Biblioshiny, ScientoPy, and MS Excel were used to analyze the data (see Figure 1).

Figure1

Flow diagram of data extraction and screening



DATA ANALYSIS

A total of 26,841 documents were retrieved from the Web of Science database. Data was downloaded and analyzed via different software applications. A comprehensive data analysis has been presented in pursuance of the study's research objectives.

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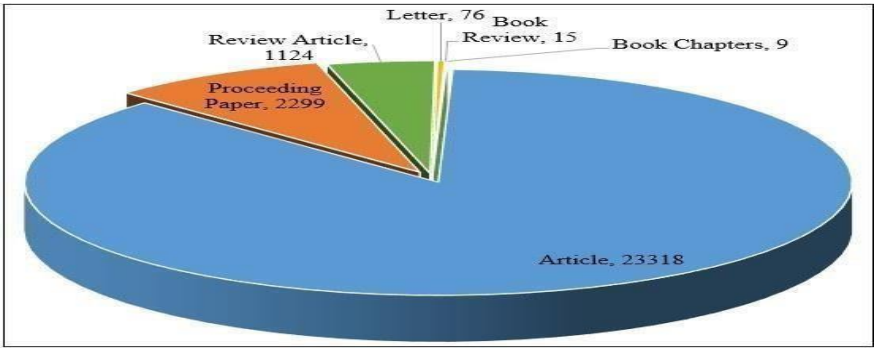
Distribution of publication types

As per the retrieved data shown in Figure2, the article with a count of 23,318 was the top-ranked type of scientific publication emerging from the COMSATS University Islamabad. The proceeding paper, with a count of 2,299, was the second highest ranked document in the type of publications, followed by review articles, with 1,124 counts; letters, with 76 counts; and book reviews, with 15 counts. On the other hand, the book chapter document type was the lowest ranked, with nine counts among all types of publications.

Figure2

Distribution of scientific publication types



Distribution of Scientific Publication by Year

The COMSATS University Islamabad (CUI)was established in 1998. Hence, the study covered the 1998-2022 in the Web of Science database. The researchers could not find any articles between 1998 and 2000 as per the data retrieved. Figure3 shows that most documents (13.73%)were published in 2021. The reason could be that 2022 was still ongoing during the study, and there must have been many documents in the publishing process. From 2018 to 2022, the percentage of published articles was more than 10%, but from 2009 to 2017, the publication percentage was between 1% and 9%. The percentage of scientific publications between the years 2008 to 2001 was below 1%.

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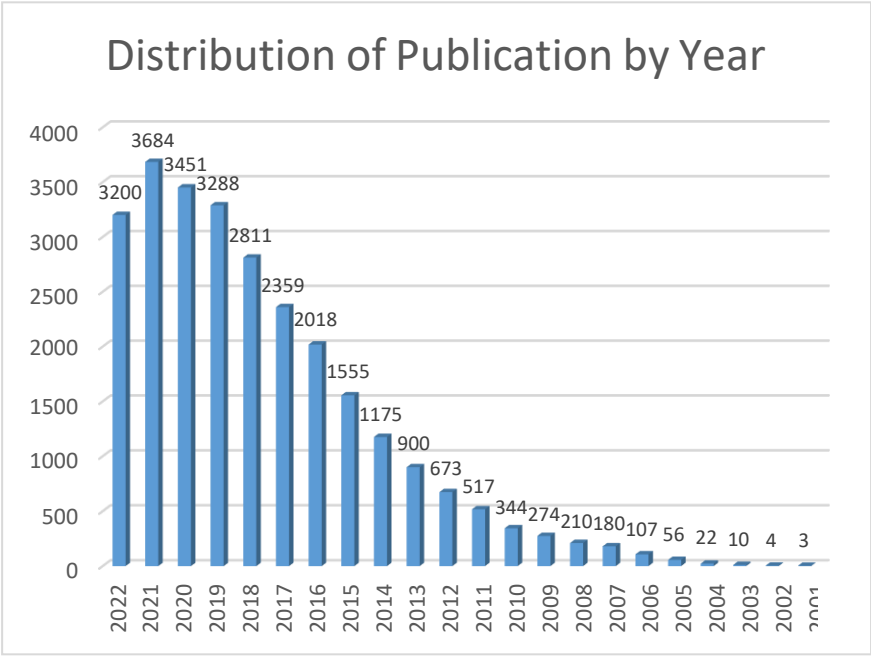
Figure3

Year -wise frequency of scientific publications



Most Productive Authors

Table 1lists the most productive CUI authors who published their research between 2001 and 2022. As per the data, Khan, A. was the most productive author with 760 scientific publications with AGR= -9, PDLY=23.8, and an h-index of 41. A total of 1956authors published over 100 scientific publications on the Web of Science database between 2001 and 2022. Regarding the Average Growth Rate (AGR), Khan, M.A was the most productive author with an AGR of 11. Khan, S. produced the most scientific publications per year, with a rate of 101 per year. The Percentage Document Per Year (PDLY) results showed that Ahmad, S. produced the most scientific publications with a PDLY of 39.1. Khan, S.A had an h-index of 64.

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Table1

Most productive authors of scientific publications in Web of Science from 2000 to 2022

Author	TP*	AGR*	ADY*	PDLY*	h-index
Khan,A.	760	-9	90.5	23.8	41
Javaid,N.	733	-14.5	36.5	10	45
Khan,S.	702	-11.5	101	28.8	41
Hussain,T.	695	-13	69	19.9	56
Khan,S.A.	587	-26	26	8.9	64
Khan,M.A.	552	11	83	30.1	51
Imran,M.	537	-7	73.5	27.4	48
Noor,M.A.	531	-5.5	39.5	14.9	44
Iqbal,J.	516	7	63	24.4	43
Ahmad,S.	511	8.5	100	39.1	40

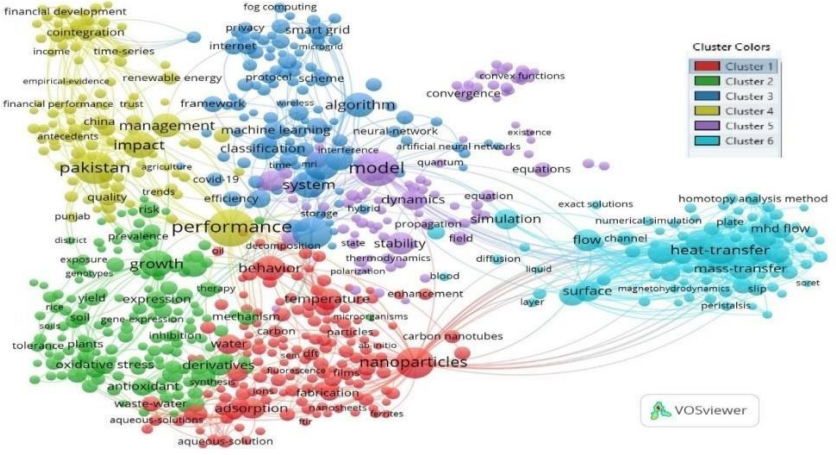
TP*=TotalPublication,AGR*=AverageGrowthRate,ADY*=AverageDocuments Per Year, PDLY*=Percentage of Documents in Last Years

Co-Occurrences of Keywords

Different keywords were used by the author(s) for the wide accessibility of the scientific publications. Data shows that 56,262 keywords were used in 26,841 scientific publications published between 2021 and 2022. Figure4 shows that “performance” was the most used term with 1,081 occurrences and total link strength of 3470. The second most used term was “Model,” with 975 occurrences and 3324 total link strength. The keyword “Pakistan” had 803 occurrences with 2488 total link strength. The other important keywords were “Design” (794),“Nano particles” (741), “Optimization” (611), and “Heat-Transfer” (600).

Figure4

Co-occurrence of the keywords



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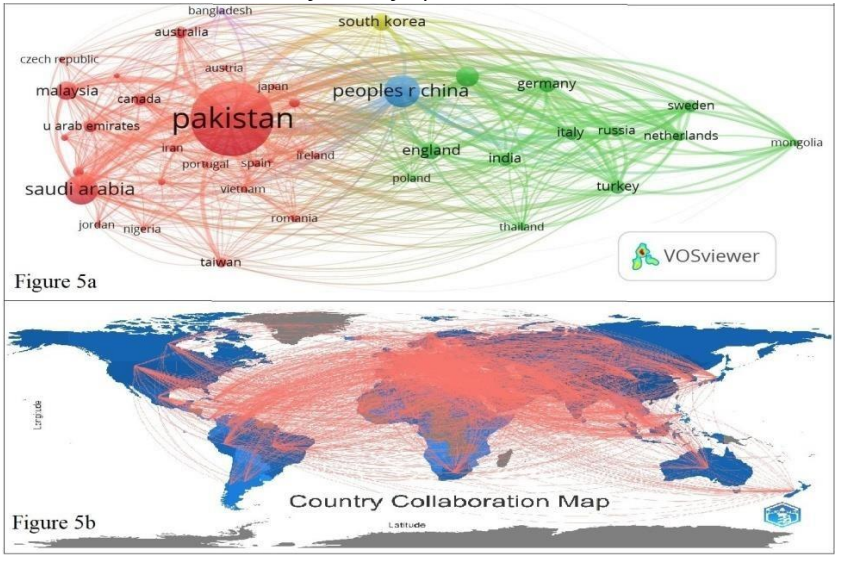
Research collaboration for Scientific Publications at the National and International Levels

Pakistan has been the hub of scientific publications due to the affiliation of authors from the COMSATS University Islamabad, Pakistan. Figure5 (a+b) revealed that 26,432 publications, with 366697 citations and a total link strength of 32645, were related to Pakistani authors collaborating with other researchers in different institutes. The People's Republic of China was the second region for collaboration for the CUI authors, resulting in 5146documents with 84439 citations. The CUI researchers also collaborated with researchers in Saudi Arabia, producing 434 documents with 60099 citations. The other countries identified for collaboration were the USA (1992 publications), Malaysia (1611 publications), South Korea (1579 publications), England (1475 publications), and Germany (1153 publications). The Pakistani authors also collaborated with other countries, which yielded less than 1000 scientific publications.

Figure 5

International collaboration of scientific publications



Research Collaboration of Scientific Publications among Institutes

Figure 6 presents the data retrieved from the Web of Science with three different titles of COMSATS University Islamabad, including "COMSATS Institute of Information Technology" (CIIT), "COMSATS University Islamabad" (CUI), and "COMSATS University. "The CIIT was established in 1998 and converted into a public sector university with the title CUI in 1998. This is why most documents (10,833) were retrieved with CIIT titles. CUI was in second place with 10,347 publications and 94,061citations. The COMSATS University is

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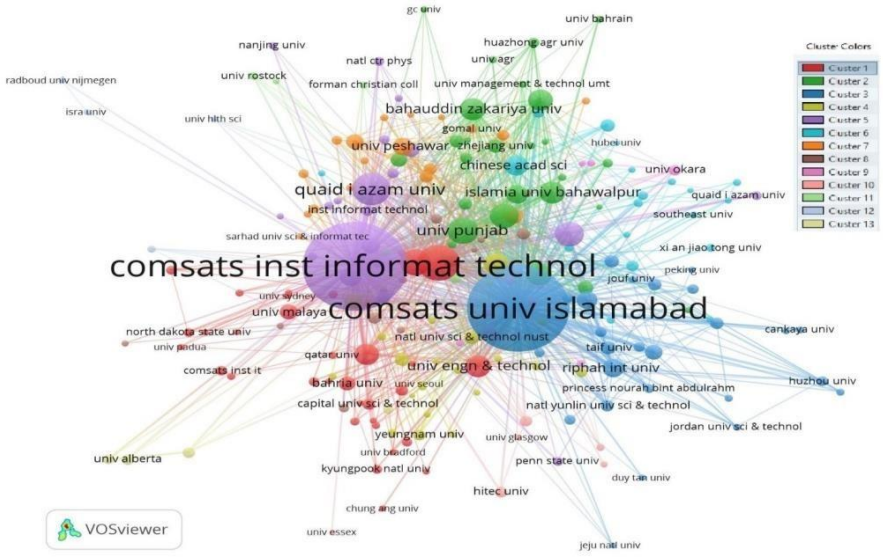
in the third position with 1,894 scientific publications and 14643citations. Besides COMSATS, Quaid-e- Azam University was the top-ranked university with 1496 scientific publications and 26213 citations. The collaboration of other universities was below 1000 scientific publications published on the Web of Science database.

Figure 6

Research collaboration of scientific publications among institutes



Productive Journals of Scientific Publications

Figure7 shows that "IEEE Access" is highly rated with 588 documents, followed by "Physical Review D" with 232 publications, "Environmental Science and Pollution Research" with 212 publications, and "Sustainability" with 291 scientific publications. All other journals are below 200 publications, published in Web of Science during 2001-2022. The journal named "Sensors" ranked high with an Annual Growth Rate (AGR) of 18 and IEEE Access is again rated high in Average Documents per Year (ADY) with a score of 103.5 and with h-index of 40.

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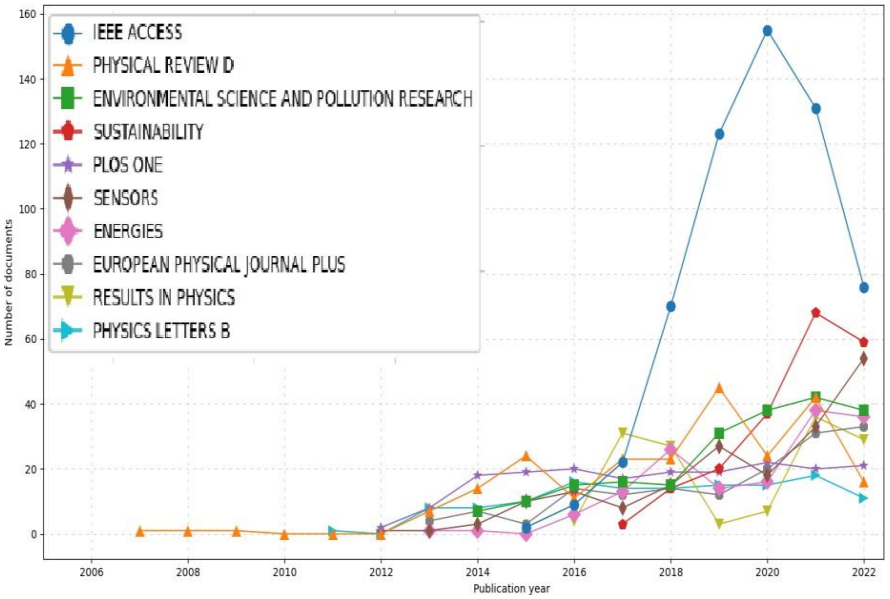
Figure 7

Productive journals of scientific publications



Productive Research Area of the Scientific Publications

Figure 8 revealed that Engineering has been the most attractive area for the researchers with a count of 5788 (21,56%), followed by Computer Science with 4355(16.22%),Physics with 4276 (15.98%), Chemistry with 2941(15.98%), Mathematics with 2585 (9.62%), Material Sciences with 2195 (8.17), Science Technology with 2160 (8.04), and Telecommunications with 2040 (7.59%) publications. All other research areas had below 2000 research publications.

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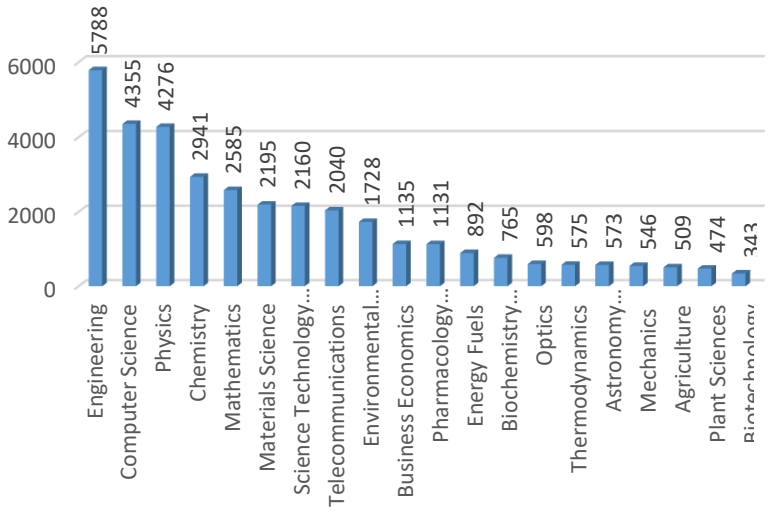
Figure 8

Productive research area of scientific publications



Highly Cited Scientific Publications

The first article published by COMSATS's author (H. A. Khan) was "Qureshi, A. A., Akram, M., Khan, M. A., Khattak, N. U., Qureshi, I. E., and Khan, H. A. (2001). Boron determination in tourmaline by neutron induced radiography. Radiation measurements,34(1-6), 345-348."

Table 2 shows that the article "Crop Production under Drought and Heat Stress: Plant Responses and Management Options" by Fahad S et al., had the most citations (901). This article was published in 2017 in the "Frontiers in Plant Science" journal. The second article entitled "Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia" by Shahbaz, Tiwari and Leitao is ranked second on the list with a citation count of 732. This article was published 2013 in the journal "Renewable and Sustainable Energy Reviews." The third-ranked article, "Quantum discord for two-qubit X states," by Ali, Rau, and Alber, with 733 citations, was published in 2010 in "Physical Review A." All other articles received below 600 citations.

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Table 2

Highly cited research scientific publications

5	Title	Author	Journal	Vol. (No.)	Publication Year
901	Crop Production under Drought and Heat Stress: Plant Responses and Management Options	Fahad, S; *et al.*	Frontiers in Plant Science	8	2017
732	Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia	Shahbaz, M; *et al.*	Renewable and Sustainable Energy Reviews	25	2013
733	Quantum discord for two-qubit X states	Ali, M; *et al.*	Physical Review A	81(4)	2010
581	Anisotropic flow of charged hadrons, pions and (anti-)protons measured at high transverse momentum in Pb-Pb collisions at root S-NN=2.76 TeV	Abelev, B; *et al.*	Physics Letters B	719(1-3)	2013
599	MicroRNAs: Synthesis, mechanism, function, and recent clinical trials	Wahid, F; *et al.*	Biochimica Et Biophysica Acta-Molecular Cell Research	1803(11)	2010
580	A comparison of technologies for remediation of heavy metal contaminated soils	Khalid, S; *et al.*	Journal of Geochemical Exploration	182	2017
535	Chromium speciation, bioavailability, uptake, toxicity and detoxification in soil-plant system: A review	Shahid, M; *et al.*	Chemosphere	178	2017
498	Centrality dependence of pi, K, and p production in Pb-Pb collisions at root s(NN)=2.76 TeV	Abelev, B; *et al.*	Physical Review C	88(4)	2013
493	Foliar heavy metal uptake, toxicity and detoxification in plants: A comparison of foliar and root metal uptake	Shahid, M; *et al.*	Journal of Hazardous Materials	325	2017
460	Performance of the ALICE experiment at the CERN LHC	Abelev, B; *et al.*	International Journal of Modern Physics A	29(24)	2014

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DISCUSSION and CONCLUSION

Universities have a significant impact on human life and society. They play a pivotal role in the progress of the economic, social, cultural, and technological development of the various sections of society. Therefore, it is imperative to know the research the universities produce and their research trends (Doulani,2020). The primary objective of this study was to analyze the scientific publications emerging from the COMSATS University Islamabad, indexed in the Web of Science database and published between 1998 and 2022. The study's findings have shown that authors affiliated with the COMSATS University Islamabad have published six types of documents."Article" was the most counted document type in the WoS database. This result is slightly different from previous studies where Ali et al., (2021) and Aslam et al., (2021) analyzed different numbers of and different types of publications and reported 17 and 5 types of publication, respectively, as compared to the current study, which had claimed six types of documents. However, both studies have also reported that research articles were the top-ranked type of publications. The findings also showed that scientific publications have risen over the years. This finding is aligned with previous studies (Ali et al., 2021; Aslam et al., 2021; Naveed et al., 2005).

Regarding the collaboration for scientific publications at the national and international levels, it was found that CUI researchers collaborated the most with researchers from Quaid-e-Azam University, a top-ranked university in Pakistan. The CUI authors collaborated internationally with scholars from China, Saudi Arabia, and the USA. This result shows that Pakistan and China have strong research and academic ties, consistent with previous studies results (Baskaran, 2013; Doulani, 2020). The results related to the product research areas are also aligned with the previous studies (Aslam et al., 2022; Mokhtari et al., 2019), and the results have shown that Engineering is the most attractive area for the CUI authors who have produced 5,788 scientific publications in the engineering domain. The other important research areas have been Computer Science, Physics, Chemistry, and Mathematics. According to the citation analysis, the citations have gradually risen. This study result aligns with other studies (Gupta & Sonkar, 2019; Kappi, 2019). The results have also highlighted that the publications have received more citations in the last few years, particularly in 2021.

The scope of the study has been to investigate the scientific publications originating from the COMSATS University Islamabad, also previously known as "COMSATS Institute of Information Technology," and the papers published during the 1998-2022 period. This study has been limited to one database, the Web of Science. The authors recommend that future studies on similar topics should enhance the study's scope by including other databases and a longer time frame.

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