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Growth of Science Research and Its Reflections on Academic Performance at the University of Kerala

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ABSTRACT

This study explores the science research output of the University of Kerala based on data derived from the web of science. By limiting the number of articles published in journals under the science citation index- expanded from 2013 to 2022, the study brings insights into the various patterns of academic publishing in an Indian university. The study also identifies the impact of the university's academic publishing on its performance in different academic rankings and accreditation processes in India- a total of 1877 journal articles published during this period. The analysis highlights the contributions of the top ten authors, with Anirudhan T.S. leading in citations with 3217 and H-index with 34. The productivity metrics show a fluctuating citation impact over the years, reaching a peak in publications in 2021 with 327 articles. The top 20 journals by research output reveal diverse fields of publication, with significant contributions to journals like the Journal of Molecular Structure and the Journal of Alloys and Compounds. Geoscience Frontiers has the highest average citations per article, at 77.82. Despite the modest number of publications, these articles have significantly enhanced the university's academic reputation and ranking. The findings suggest the need for strategic measures to boost research output, particularly in the social sciences and humanities departments.

Keywords : University of Kerala; Scientific productivity; Scientometrics; Bibliometrics; Academic excellence; NIRF ranking; Web of science

1. INTRODUCTION

As universities worldwide strive to enhance their research output and global visibility, understanding the scientometric dimensions of academic publications becomes crucial. The quality and quantity of an institution's research productivity have been and will continue to be necessary measures and metrics of academic excellence[1]. In the rapidly evolving landscape of academic research, scientometric analysis plays a pivotal role in assessing the impact and influence of scientific publications. Scientometric studies involve quantitatively analysing scientific output to uncover patterns, trends, and relationships within a particular research domain. It provides researchers with various concepts, models, and techniques that may be applied to an academic discipline to explore its foundations, state, intellectual core, and potential future development[2].

The University of Kerala's rich history and commitment to scholarly pursuits significantly contribute to the scientific discourse. This study endeavors to shed light on the scientific publications of the University of Kerala, which are indexed in the Science Citation Index- Expanded (SCIE). The SCIE is part of the web of science database, covering around 9500 core journals across various disciplines worldwide. The primary objectives of this study are the systematic examination of the trends in scientific publications by the University of Kerala and its impact on the university's performance in the Indian ranking and accreditation process by employing rigorous analytical methods, including citation analysis, publication trends, and collaboration patterns.

2. UNIVERSITY OF KERALA

Established in 1937, the University of Kerala, India, stands as one of the oldest academic institutions in Kerala, India, boasting a storied history and offering diverse academic programs. The University of Kerala has 150 affiliated colleges and a robust infrastructure comprising sixteen faculties and 43 teaching and research departments focusing primarily on post-graduate (master) programs and doctoral research. Under the faculty of science, the university has eleven departments. It has seven departments under the faculty of applied sciences and technology, six each under Arts and Social Sciences, eight under Oriental Studies (Languages), and one each under Commerce, Education, Fine Arts, Law, and Management Studies. It also has several study centers in specialised areas that offer Certificate / Diploma / Master / PhD programs. It is one of the top hundred universities in India as per the National Institutional Ranking Framework (NIRF).

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The university has also achieved the remarkable status of university accreditation by the national agency. Given this esteemed standing, a keen interest has arisen in evaluating the research performance of the university's faculty and scholars over a specific period. Consequently, a scientometric study was undertaken to scrutinise the scientific productivity of the university's science faculty members and research scholars spanning 2013 to 2022.

3. LITERATURE REVIEW

Rostami[3], *et al.* investigated the scientific publications of the Iran University of Medical Sciences (IUMS) from 1980 to 2020, employing bibliometric analysis and scientific network visualisation. Through quantitative research methods utilising bibliometrics and visualisation techniques, the study explores the entirety of IUMS's scientific output indexed in the Web of Science Core Collection (WOSCC). WOSCC data was extracted using advanced search techniques focused on IUMS affiliation: identified publication frequency, international collaborations, citation clusters, and keyword co-occurrence among researchers' publications. The study underscores the efficacy of bibliometric methods and visualisation tools in depicting and analysing the scientific landscape of researchers, publications, journals, universities, and countries. Furthermore, the research serves as a model for analysing bibliometric indices of other universities and research institutes in Iran and beyond, offering valuable insights for policymakers at IUMS to inform future scientific development strategies. Integrating alternative metrics (altmetrics) can address potential data reporting and presentation limitations. Future research may explore indexed articles from IUMS in the Scopus database to conduct similar analyses, further enriching the understanding of the institution's scientific contributions.

Veldandi[4] asses the research productivity of agricultural scientists at PJTSAU in the year 2021. A sample of 120 agricultural scientists with a minimum of 3 years of research experience after the formation of PJTSAU in 2014 was purposively selected. The research productivity index was developed and standardised for validity and reliability, comprising six indicators: publication behavior, research activities, guidance and mentoring, awards and recognition, technologies/knowledge generated, and intellectual property rights. Findings revealed that most agricultural scientists exhibited medium research productivity, followed by very low, low, high, and very high productivity levels. The research productivity index scores ranged from 0.11 to 0.88, indicating scope for improvement among scientists with low productivity levels. The study highlights the areas for enhancement and optimisation to promote greater efficiency and impact in research endeavors.

In a study by Kalfópulos[5], articles from 2004 to 2021 were examined to characterise the output of spine surgeons in Latin America (LA) worldwide. In February 2022, a thorough search was carried out emphasising publications in indexed journals, utilising the Scopus and PubMed databases. A total of 1447 articles were found in the data, indicating a significant rise over the decades under evaluation- from 58.3 publications annually to 108 publications annually- and a 1.79-fold increase between the most productive years in each decade. With 51.14 % of publications, Brazil was the most significant contributor, followed by Mexico and Argentina. Interestingly, Columna published the most papers in any journal. The University of Campinas in Brazil ranked first among the top ten universities and generated at least 32.82 % of the articles. The majority of articles were classified as Level of Evidence 4 despite this productivity rise, highlighting the necessity for ongoing research development to raise the standard of research in the area. Papers published in the *Indian Journal of Chemistry-Section A (IJCA)* and the *Indian Journal of Chemistry-Section B (IJCB)* from 2015 to 2020 were analysed by Garg and Kumar[6]. Both journals demonstrated a consistent average number of articles published per year, with IJCB having a slightly higher average than IJCA. Indian and international academic institutions were the primary contributors to both journals, although their respective shares varied**.**

The scientometric analysis conducted by Janen offers a comprehensive insight into the research landscape of the University of Jaffna[7] (UoJ) from 2000 to 2019. The study provides valuable findings for stakeholders in academia and research governance with a focus on understanding publication trends, authorship dynamics, citation impact, communication patterns, journal preferences, international collaborations, and funding sources. The analysis reveals a notable growth trajectory in UoJ's research output, particularly post-2014, underscoring the institution's increasing scholarly contributions. Multi-authorship emerges as a prevalent practice among UoJ researchers and indicates collaborative endeavors within the academic community. Moreover, the dominance of publications in Multidisciplinary Sciences underscores the interdisciplinary nature of research at UoJ. The study highlights extensive international collaborations, with significant partnerships observed, notably with the United Kingdom. Furthermore, the identification of highly cited publications, exemplified by Ravirajan P's article garnering 480 citations, showcases the impact of UoJ's research on the global scholarly community. Additionally, insights into funding sources, including support from the National Science Foundation of Sri Lanka and international entities like UK Research Innovation (UKRI), underscore the diverse financial backing facilitating UoJ's research endeavors.

Mahala & Singh[8] conducted a scientometric analysis focusing on the research output of selected Indian universities in the sciences from 2015 to 2019, using data from the SCI-E of the Web of Science core collection. The study evaluated publication data from the University of Delhi, Banaras Hindu University, Anna University, Jadavpur University, and Punjab University. The findings highlighted substantial growth in science research output, with the University of Delhi leading in total publications. Multi-

authored papers showed greater research impact, and the study identified significant collaborations with countries such as the USA, South Korea, and Germany. This research underscores the international engagement of top Indian universities and offers insights for policymakers and institutions aiming to enhance research strategies and impact.

Using data from the Web of Science (WoS) core collection platform spanning 1985-2020, Rocchi[9], *et al.* conducted a bibliographic analysis of the literature on Sustainable Agricultural Systems. The analysis employed CiteSpace ver. 5.7, a Java-ba application for visualising and analysing citations and scientific literature content. The study observed a growing trend in the number of published research articles during the specified timeframe. Additionally, the report highlights sustainable agriculture as a prominent topic in current literature, albeit without a definitive solution. Among various approaches, robust ecological modernisation emerges as one of the most promising strategies.

The study conducted by Khanna[10], *et al.* examine the research contributions of Guru Nanak Dev University, Amritsar, in the field of physics and astronomy from 2006 to 2015, utilising data extracted from Scopus. It delves into various aspects such as year-wise research productivity, national and international collaborations, top collaborating institutions, prolific authors, preferred journals for communication, and citation impact received by the university during the specified period. The findings reveal that the university published 652 papers in physics and astronomy with an average citation impact per paper of 7.01 %. Notably, six publications garnered between 51 to 100 citations. In comparison to other Indian universities, GNDU ranked 23rd in publication output and h-index, 16th in average citation per paper, 18th in the share of highly cited papers, and 19th in terms of international collaborative papers. Furthermore, the study highlights that a significant portion (68.71 %) of the university's publications in physics and astronomy stemmed from national collaborations with various Indian organisations. The research underscores the predominant preference for journals as the primary medium for disseminating research findings among the university's researchers.

Galyani[11], *et al.* shed light on a significant gap between national and international scholarly publications among faculty members affiliated with Allameh Tabataba'i University. The findings reveal extensive international collaboration, with the United States and Switzerland being the most frequent partners in Scholarly publications by faculty members of Allameh Tabataba'i University. Notably, significant collaboration occurred within Iran, particularly with institutions such as Islamic Azad University, Tehran University, and Amir Kabir University of Technology. The study highlighted a substantial gap between national and international publications, with the majority of scholarly papers by Allameh Tabataba'i University faculty being published at the national level. The study also suggested a need for solutions to include national papers in international databases. The paper also discuss the low interconnectivity of the collaboration network, indicating room for increased international collaboration at Allameh Tabataba'i University.

Gopikuttan & Aswathy[12] conducted a comprehensive evaluation of research productivity at the University of Kerala using data from the Web of Science from 2000 to 2012. This study aims to assess the overall performance of faculty members in the Science Departments of the University of Kerala. The analysis considers parameters such as the types of publications, annual trends, subject-specific classifications of published papers, identification of most productive authors, and preferred journals for publication, among others. Impact factors and citation metrics were also scrutinised to gauge scholarly influence. The findings indicate that Chemistry emerges as the leading discipline in publication volume, with significant contributions from multi-author collaborations. The study identifies Indian journals as the primary choice for publication, followed closely by those from the UK, highlighting regional publication preferences. Additionally, collaborative patterns vary across different subjects. The research underscores the University of Kerala's recognised international standing in research productivity.

4. OBJECTIVES OF THE STUDY

The present study aims to examine the science research output of the University of Kerala and its reflections on the university's academic achievement. The main objectives of the present study are;

- To quantify the University of Kerala's research output indexed in the Web of Science, SCIE, from 2013 to 2022
- To identify the prolific authors at the University of Kerala during the period of study
- To evaluate annual research productivity and citation trends
- To identify top journals and assess their impact
- To examine the impact of science research output on the academic performance of the university

5. LIMITATIONS OF THE STUDY

This study is limited to articles published in SCIE journals by the community of research scholars and faculty members of the University of Kerala during 2013-2022. The data collection process was conducted at 4:00 p.m. IST on 8th November 2023. Documents may have been added to the Web of Science database on the same day after this time. This timing discrepancy could impact the accuracy and comprehensiveness of the study's findings, particularly regarding the most recent publications or updates to existing records.

6. METHODOLOGY

The study investigating the science research output of the University of Kerala utilised a data-driven approach

leveraging the Web of Science database. A focused search was conducted using the keyword "affiliation-university of Kerala" within the Science Citation Index Expanded from 2013 to 2022 to capture a comprehensive ten-year period of research activity. The search specifically targeted research articles, filtering out other document types to ensure a robust dataset of scholarly publications. The data thus obtained resulted in 1877 records for ten years. Data extraction from the Web of Science records were carefully processed and cleaned to maintain accuracy and consistency. Microsoft Excel was employed for initial data organisation, and further analysis was carried out using BiblioShiny, a bibliometric analysis tool, to delve into publication trends, authorship patterns, and citation impact. The study encompassed statistical analysis, including descriptive statistics, to present key findings effectively. Data regarding the performance of the University on NIRF ranking and accreditation were obtained from respective websites.

7. TOTAL RESEARCH OUTPUT OF THE UNIVERSITY

Table 1 provides a comprehensive overview of the total publication productivity of the University of Kerala from 2013 to 2022, indexed in the Web of Science (WoS).

Over this decade, the university has steadily grown its research output. 2013, there were 121 publications, constituting 5.99 % of the share, which slightly decreased to 118 publications in 2014. However, from 2015 onwards, there was a noticeable upward trend in publication numbers, with 134 publications in 2015 and 111 in 2016. The growth trajectory steepened notably in 2017, significantly increasing to 184 publications, representing 9.109 % of the share. This positive momentum continued in the subsequent years, with 193 publications in 2018, 188 in 2019, and a remarkable surge to 275 publications in 2020.

The university's research output pinnacle was observed in 2021, with 351 publications constituting 17.376 % of the share. Although there was a slight dip in 2022 to 344 publications, the overall trend underscores a consistent and impressive growth trajectory in research productivity over the past decade. Of the total 2019 publications, 1877 are articles indexed in SCIE, indicating a substantial contribution to the scholarly discourse. Notably, the university's focus has been more concentrated on science subjects than humanities and social sciences, a trend evident in the dominance of articles indexed in SCIE among its publications.

7.1 Annual Scientific Productivity

Figure 1 provides the annual scientific productivity of the University of Kerala as per the data collected from SCIE from 2013-2022. From 2013 to 2016, there appears to be a relatively stable level of scientific productivity, with the number of articles fluctuating in a narrow range (between 109 and 121). A substantial increase was observed in 2017, marking a noteworthy spike in productivity compared to the preceding years. This surge may be indicative of increased research activities, collaborations, or a strategic focus on publishing. The trend continued upward in the subsequent years, reaching a peak in 2021 with 327 articles, signifying a substantial growth in research output over the analysed period.

7.2 Prolific Authors and Comparative Analysis of Their Contributions

Table 2 provides the data on the top 10 prolific authors from the University of Kerala, along with their number of publications, citations,H-Index, and the measure of Articles Fractionalised, which indicates their relative role as co-authors.

The publication productivity of faculty members at the University of Kerala from 2013 to 2022 reveals significant variations in author contributions, citation impact, scholarly influence, and fractionalised article output. Sankararaman, S. emerges as a prolific contributor with 92 articles, garnering 695 citations and attaining a commendable H-index of 15. Anirudhan, T S demonstrates remarkable productivity with 90 articles and an impressive citation count of 3217, resulting in a notable H-index of 34. Pillai, V.P. Mahadevan, and Kumar ABiju exhibit consistent scholarly output, each contributing 72 articles, although with comparatively lower citation counts and H-index of 1204 and 667 for Pillai and 13 for Kumar, respectively. Swapna MS, Shibli SMA, and Gopchandran KG present balanced profiles, each contributing a substantial number of articles (ranging from 50 to 67) with corresponding citation counts and H-index reflective of their scholarly impact. Notably, Ganesanpotti, Subodh, and Raj, V contribute fewer articles yet maintain respectable citation counts and H-index, suggesting focused and impactful research endeavors.

Nair, Achuthsankar, S demonstrates notable citation impact relative to the number of articles contributed, suggesting concentrated scholarly contributions. The fractionalised article output provides additional insight into the distribution of authorship among faculty members, highlighting collaborative efforts and interdisciplinary research pursuits within the university. Overall, this comprehensive analysis underscores the diverse publication productivity and scholarly impact of faculty members at the University of Kerala, illuminating the multifaceted nature of academic contributions within the University of Kerala during the specified period.

7.3 Productivity Measure Based on Citations

A comprehensive analysis was undertaken to explore the research landscape, examining scholarly output data and the corresponding citations spanning the period from 2013 to 2022. This analysis centers on four key metrics: the total number of publications (N), total citations received (Times Cited), the average number of citations per article (MeanTCperArt), and the average number of citations received per year (MeanTCperYear). Table 3 presents a detailed overview of these findings.

Table 1. Total research output of the University of Kerala

S. No.	Year	Publications	% of Share
1	2013	121	5.99
2	2014	118	5.842
3	2015	134	6.634
4	2016	111	5.495
5	2017	184	9.109
6	2018	193	9.554
7	2019	188	9.307
8	2020	275	13.614
9	2021	351	17.376
10	2022	344	17.079
	Total	**2019**	

Table 3. Productivity measure based on citations

Year	N	Times cited	MeanTC perArt	MeanTC per year
2013	114	2655	22.2	2.02
2014	111	2372	20.2	2.02
2015	121	2392	18.56	2.06
2016	109	2273	19.07	2.38
2017	175	3268	17.12	2.45
2018	182	3129	15.37	2.56
2019	174	2388	11.95	2.39
2020	252	2785	9.33	2.33
2021	327	3072	7.37	2.46
2022	312	1527	3.52	1.76

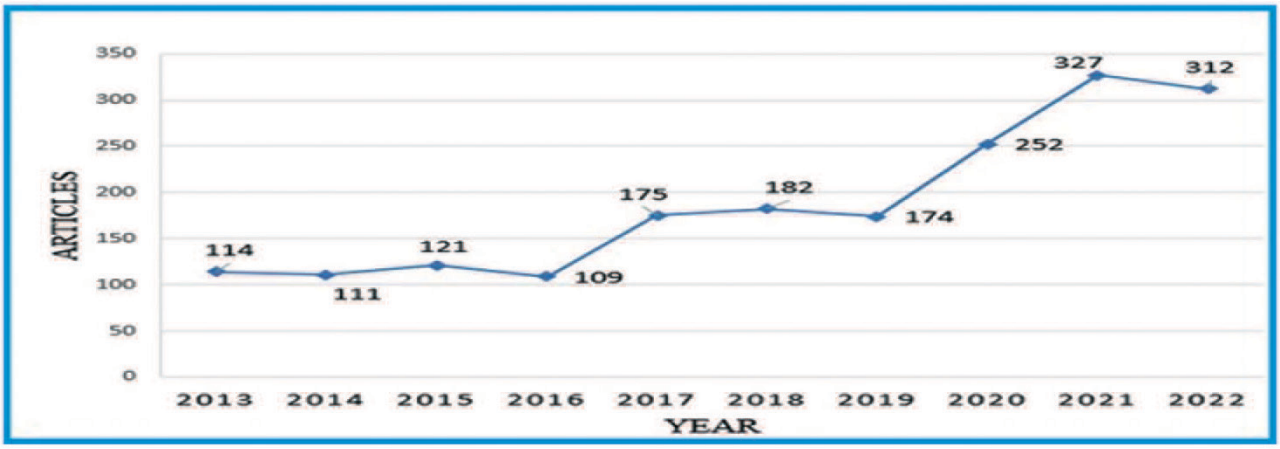

Figure 1. Distribution of articles over time of University of Kerala (2013-2022).

Table 2. Top 10 authors and comparative analysis of their contributions

Authors	Department	Articles	Citation	H-index	Articles fractionalised
Sankararaman, S.	Dept. of Optoelectronics	92	695	15	37.25
Anirudhan, T.S.	Dept. of Chemistry	90	3217	34	33.61
Pillai, V.P. Mahadevan	Dept. of Optoelectronics	72	1204	20	14.77
Kumar, Abiju	Dept. of Aquatic Biology and Fisheries	72	667	13	14.77
Swapna, M.S.	Dept. of Optoelectronics	67	584	15	15.88
Shibli, S.M.A.	Dept. of Chemistry	56	948	17	14.51
Gopchandran, K.G.	Dept. of Optoelectronics	50	1132	19	17.38
Ganesanpotti, Subodh	Dept. of Physics	42	665	16	10.98
Raj, V.	Dept. of Optoelectronics	42	392	12	9.68
Nair, Achuthsankar S.	Dept. of Computational Biology & Bioinformatics	39	234	9	10.69

MeanTCperArt provides insights into the average citation impact per article, offering a qualitative measure of the influence and visibility of the university's research within the academic community. Mean Times Cited per Year(MeanTCperYear) is a metric used in scientometrics to assess the average number of citations by a set of publications receives yearly.

Figure 2 shows the inverse relationship between the number of publications and MeanTCperArt. Generally, an increase in the number of publications might lead to a decrease in the average citations per article and vice versa. The peak in the number of publications in 2021 is accompanied by a notable decrease in MeanTCperArt. This could be attributed to a surge in the number of publications without a proportional increase in their citation impact. While a higher number of publications can showcase productivity, researchers and institutions often strive for a balance between quantity and quality.

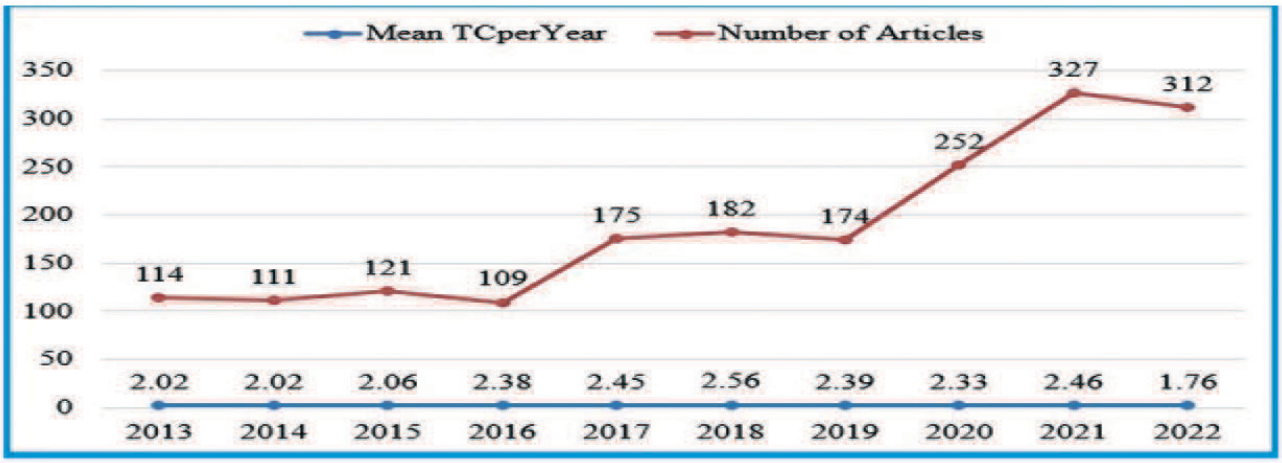

Figure 2. Number of publications and meanTCperArt overtime for University of Kerala (2013-2022).

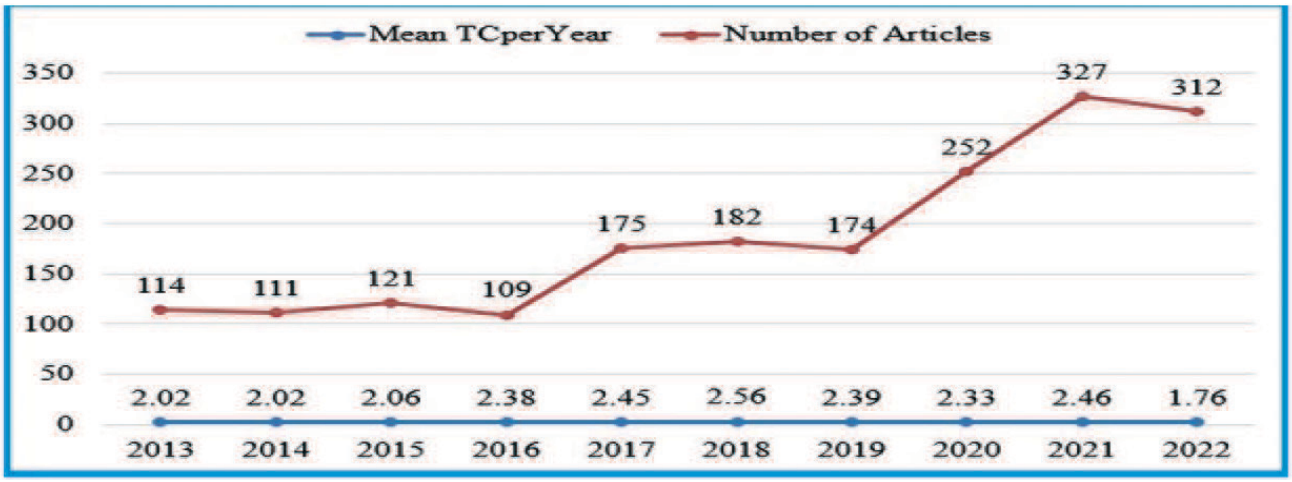

Figure 3. Number of publications and meanTC per year overtime for University of Kerala (2013-2022).

Understanding the factors influencing citation impact can help tailor strategies to enhance the visibility and impact of research.

Figure 3 shows the MeanTCperYear values having a consistent range from 2013 to 2021, fluctuating between 2.02 and 2.46. This suggests a stable average citation impact per year during this period. There is a noticeable increase in MeanTCperYear in 2018, reaching 2.56. This might indicate a year with a higher average citation impact compared to the surrounding years. It is worth investigating if there were specific influential publications or research activities during this period. The MeanTCperYear drops to 1.76 in 2022, the lowest value in the provided data. This decrease might be attributed to a decline in the average citation impact of publications during this year.

7.4 Most Relevant Sources (Journals)

The data analysis revealed that scholars of the University of Kerala used a core list of journals to publish their research reports. They are listed in Table 4.

The table includes the number of articles published in various journals, the percentage share of these articles relative to the total publications, publication country, the total number of citations received, and the impact factor(IF). Among the top 20 journals, the *"Journal of Molecular Structure"* stood out with 30 articles, accounting for 1.597 % of the share and accumulating 234 citations with an impressive impact factor of 7.8. Similarly, the "Journal of Alloys and Compounds," garnered significant attention with 28 articles, 561 citations, and an impact factor of 20.04. Journals like *"Applied Surface Science"* recorded 20 articles but remarkably accumulated 539 citations with an impact factor of 26.95. "Geoscience Frontiers" demonstrated exceptional citation impact with 856 citations and an astounding impact factor of 77.82, reflecting its significant contribution to the field. *"The Journal of Biomolecular Structure & Dynamics"* and *"European Physical Journal Plus"* exhibited relatively lower citation impact despite publishing a moderate number of articles. Similarly, *Applied Surface Science* has 20 articles but a high impact factor of 26.95.

7.5 Top 10 Collaborative Countries

Table 5 presents a collaborative landscape of scientific publications associated with the University of Kerala from 2013 to 2022.

The United States is a significant contributor, with 87 publications constituting approximately 4.633 % of the overall share. The People's Republic of China, Australia, and Japan each present notable contributions,

Table 4. Top 20 journals by research output and citations

S. No.	Publication titles	Publisher & country	Articles	% of share	Times cited	I F
1	Journal of Molecular Structure	Elsevier, Netherlands	30	1.597	234	7.8
2	Journal of Alloys and Compounds	Elsevier, Netherlands	28	1.491	561	20.04
3	Journal of Materials Science-Materials in Electronics	Springer, Germany	27	1.438	179	6.63
4	Zootaxa	Magnolia Press, New Zealand	27	1.438	195	7.22
5	Communications in Statistics-Theory and Methods	Taylor & Francis, United Kingdom	26	1.384	149	5.73
6	Applied Surface Science	Elsevier, Netherlands	20	1.065	539	26.95
7	Ceramics International	Elsevier, Netherlands	19	1.012	336	17.68
8	SpectrochimicaActa Part A-Molecular and Biomolecular Spectroscopy	Elsevier, Netherlands	19	1.012	372	19.58
9	International Journal of Biological Macromolecules	Elsevier, Netherlands	17	0.905	402	23.65
10	Journal of Biomolecular Structure & Dynamics	Taylor & Francis, United Kingdom	16	0.852	79	4.94
11	Marine Pollution Bulletin	Elsevier, Netherlands	14	0.745	279	19.93
12	European Physical Journal Plus	Springer, Germany	13	0.692	129	9.92
13	Discrete Applied Mathematics	Elsevier, Netherlands	12	0.639	22	1.83
14	International Journal of Hydrogen Energy	Elsevier, Netherlands	12	0.639	258	21.5
15	Materials Chemistry and Physics	Elsevier, Netherlands	12	0.639	180	15
16	Optik	Elsevier, Netherlands	12	0.639	109	9.08
17	Phytotaxa	Magnolia Press, New Zealand	12	0.639	23	1.92
18	Applied Physics A-Materials Science & Processing	Springer, Germany	11	0.586	137	12.45
19	Geoscience Frontiers	Elsevier, Netherlands	11	0.586	856	77.82
20	Journal of Electronic Materials	Springer, Germany	11	0.586	94	8.55

with 44 publications comprising around 2.343 % of the distribution individually. Germany, Singapore, and South Africa follow suit, each contributing 30, 26, and 21 publications, respectively, representing approximately 1.597 %, 1.384 %, and 1.118 % of the total. Meanwhile, England and Saudi Arabia also play significant roles, with 20 and 19 publications, respectively, each contributing around 1.065 % and 1.01 % to the comprehensive collaborative output.

8. REFLECTIONS OF SCIENCE RESEARCH ON ACADEMIC PERFORMANCE OF THE UNIVERSITY OF KERALA

This part of the article examines how the science research articles published by the university in quality journals influence its ranking process, accreditation, and other academic performance. It examines the position of the university among the top universities in the country, the accreditation status of the university, and the contribution of the faculty members to world-class research activities.

8.1 NIRF Ranking

The Government of India introduced the National Institutional Ranking Framework (NIRF) in 2015 under the Ministry of Human Resource Development (MHRD) to rank its higher education institutions[14]. The NIRF parallels world university ranking schemes in terms of parameters for measuring the performance of the universities. The University of Kerala has been one of the top 100 universities in India since 2017, as per data from the NIRF (https://www.nirfindia.org/2021/Ranking.html). Figure 4 shows the position of the university among the top hundred universities in India since 2017, the year the university started participating in the ranking process.

Figure 4 shows that the University of Kerala ranked 22 among the top hundred universities in India in 2019. The university stood at 23 in 2020. It received the 27th position in 2021 and the 29th and 30th positions in 2017 and 2018, respectively. However, the university received a lower rank of 40 compared to its previous higher positions out of 100 in 2022.

Table 5. Collaborative distribution of articles by country

Country	Articles	% of share
INDIA	1877	100
USA	87	4.633
PEOPLES R CHINA	44	2.343
AUSTRALIA	40	2.13
JAPAN	40	2.13
GERMANY	30	1.597
SINGAPORE	26	1.384
SOUTH AFRICA	21	1.118
ENGLAND	20	1.065
SAUDI ARABIA	19	1.01

Further analysis of the science research output of Kerala University and the scores obtained by the university for the RPC parameter in the NIRF ranking shows a relationship between the two. Figure 5 shows the performance of the University of Kerala with regard to RPC parameters from 2017 to 2022.

Figure 5 shows that even though the University of Kerala does not get high marks for the RPC out of 100, the scores have increased over the years, along with an increase in the number of documents in quality journals. It further shows that increasing the number of articles in quality journals would influence the university's performance in the national ranking process.

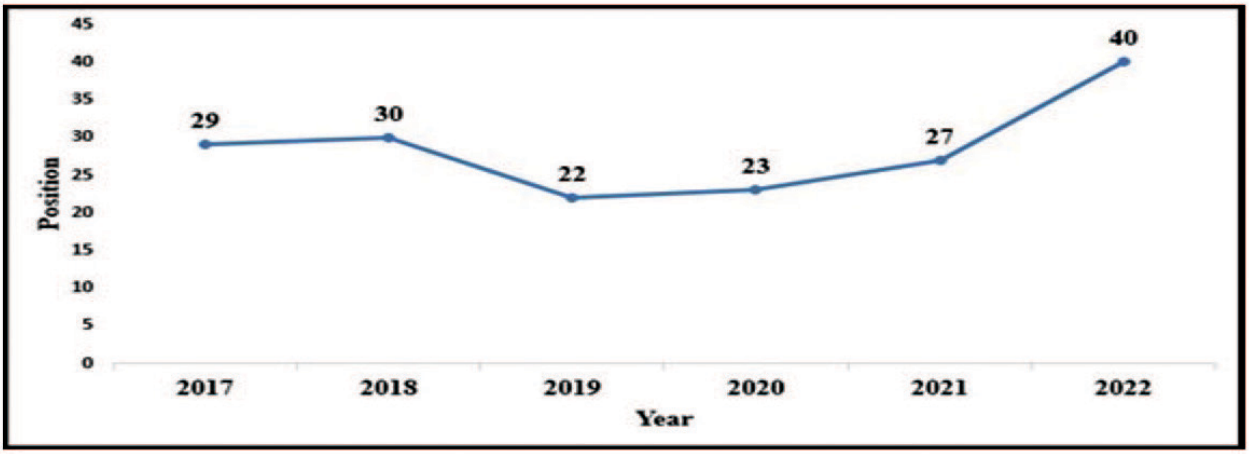

Figure 4. Position of University of Kerala on NIRF Ranking, India.

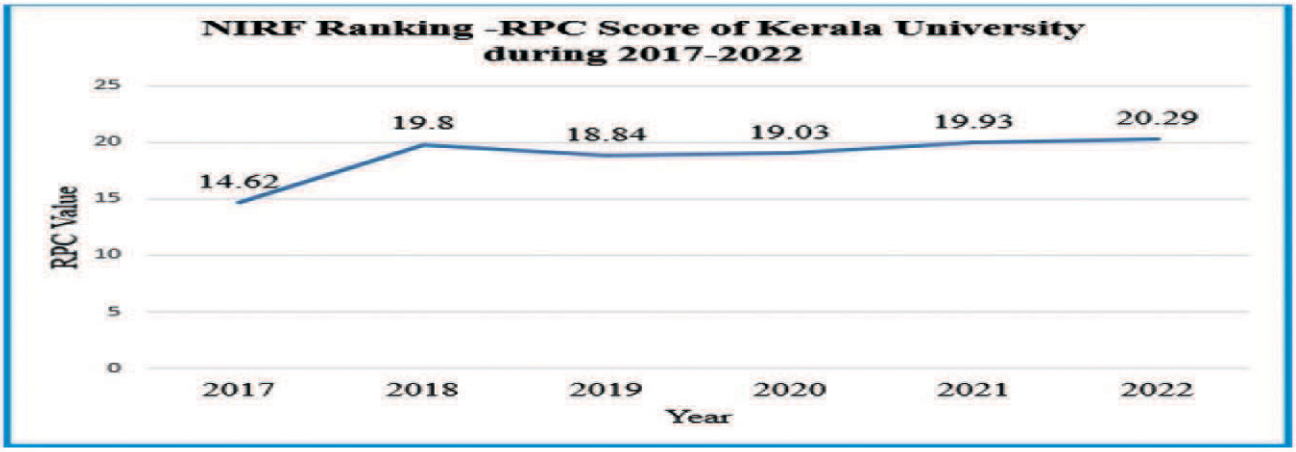

Figure 5. Scores obtained by the University of Kerala for the RPC parameter of NIRF ranking.

The NIRF ranking is based on scores obtained for five parameters. The parameters include Teaching and Learning (TLR), Research and Professional Practice (RPC), Graduate Outcome (GO), Outreach and Inclusivity (OI), and Peer Perception. Among these, the RPC scores of a university come from the Combined metric for Publications (PU), the Combined metric for Quality of Publications (QP), Intellectual Property Rights and Patents (IPR), and Footprint of Projects and Professional Practice (FPPP). The number of articles published in quality journals is important in scoring more marks for the RPC parameter.

8.2 Accreditationof the University

The National Assessment and Accreditation Council (NAAC), established in 1994, is an autonomous institution of the University Grants Commission (UGC) of India to conduct assessment and accreditation of Higher Educational Institutions (HEI) such as colleges, universities or other recognised institutions to derive an understanding of the 'Quality Status' of the institution. NAAC evaluates the institutions for their conformance to the standards of quality in terms of their performance related to the educational processes and outcomes, curriculum coverage,

teaching-learning processes, faculty, research, infrastructure, learning resources, organisation, governance, financial well-being, and student services.

The University of Kerala underwent the re-accreditation process in June 2022. It received an A++ grade with a Cumulative Grade Point Average (CGPA) of 3.67 on a four-point scale. A++ is the top accreditation status of an Indian university. NAAC identifies a set of seven criteria to serve as the basis of its assessment procedures. The quality of science articles produced by the university over the years would have supported score marks under the Research, Innovations, and Extension criteria of NAAC.

9. FINDINGS

The study delved into the science research output of the University of Kerala from 2013 to 2022, focusing on publications indexed in the Web of Science database. It revealed that out of a total of 2019 documents produced during this time frame, 1877 articles were categorised under Science subjects, reflecting a predominant emphasis on scientific research. The analysis highlighted a fluctuating but overall increasing trend in scientific productivity, with a notable surge in publications in 2017 and a peak in 2021 with 327 articles. Among the top contributors, Anirudhan T.S. led in citations with 3217 and an H-index of 34, while Sankararaman S. published the most articles, totaling 92. The productivity metrics indicated variations in citation impact over the years, with an inverse relationship observed between the number of publications and the average citation impact per article. Noteworthy journals such as "*The Journal of Molecular Structure,*" *"Journal of Alloys and Compounds,"* and *"Geoscience Frontiers"* emerged as significant contributors with high citation impact, reflecting their influence in their respective fields.

Furthermore, the study demonstrated a correlation between the university's research output and its performance in national rankings, particularly in the Research and Professional Practice (RPC) parameter of the National Institutional Ranking Framework (NIRF). The university's achievement of the top accreditation status (A++) from the National Assessment and Accreditation Council (NAAC) in 2022 further underscored the quality and impact of its research activities. Overall, the findings underscored the university's substantial contributions to scientific research and its positive reflections on academic performance, ranking, and accreditation, emphasising the importance of continuous efforts to enhance research productivity and quality for sustained academic excellence.

10. CONCLUSION

Even though this study is focused on an Indian university located in the state of Kerala, several key findingsemerged from the analysis of the data that would generally help all universities across the world, specifically Indian universities. The conduct of scientific research and the publishing of these results in reputed journals help the university to be recognised globally. The university has produced several articles with universities in the United States, China, Australia, Japan, and many other countries. That shows the potential of the university to be a global research center in science subjects. Prof Anirudhan T S, one of the top authors from the university, has been listed as one of the top 2 % of scientists in the world in the field of Chemical Engineering by a study conducted by Stanford University. This shows that world-class scientists are emerging from small state universities in India, and they are recognised based on publications in reputed journals. Hence, Indian universities and universities worldwide must focus on selecting quality journals for publishing science, Humanities, and social science articles.

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