

# Decoding Scholarly Publication Dynamism in Oman Using Data Mining Exploration

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## Abstract

*The purpose of this study is to understand and analyze the quantitative data on the trend of academic publications produced by researchers across all disciplines, from science to humanities using bibliometric analysis affiliated with the Sultanate of Oman. During the study, a cross-country comparison was also conducted in order to determine and gauge the contributions of various higher education institutions with a special focus on Oman. For the extraction of bibliometric data between January 1970 and November 2021, databases like Web of Science (WoS) and Scopus were taken into consideration. The results indicate the highest productivity years between 2012 and 2015, with elevated citation scores earned in the year 2012. Sultan Qaboos University in Oman emerged as the most notable contributor among higher education institutions in the Sultanate. Thus, this exhaustive bibliometric research depicts and abridges over 50 years of research work. This paper also outlines active higher education institutions in Oman involved in research and publication, the citations on their work, and productive years with respect to scholarly publications.*

**Keywords:** *Bibliographic Analysis, Higher Education Institutions, Oman, Scholarly Publications, Quantitative Data, Cross-Country Comparison.*

## INTRODUCTION

### The Education Drive in the Sultanate of Oman

Higher education in the Sultanate of Oman (also known as Oman) began in 1986 with Sultan Qaboos University (SQU), as the country's first public university (S.Q.U, n.d.). Prior to 1970, the availability of higher education was limited. In the past, before the establishment of SQU, the higher education ministry used to sponsor students to pursue their further education in countries like UAE and Kuwait and in western nations such as the United States of America and the United Kingdom. During late nineteen nineties, foreign courses were introduced, taught, and administered in Oman through privately owned Higher Education Institutions(HEI). Currently, the new system entails the application of a new set of policies and procedures in the educational system. Oman's higher education sector has grown rapidly in a short period of time. This was initiated to consolidate the outcome of all the HEIs in terms of standard quality assurance and augmentation process that would lead to the twin objective of an effective and efficient education system (Carroll et al., 2023). Certainly, importing and adapting western programs has been a successful strategy for achieving rapid growth in the education sector. In 2008, there were approximately 60 HEIs operating for a population of about 2.34 million people (Ministry of Higher Education, Research & Innovation, Oman, 2021). Around two-thirds of these were government-owned institutions managed by ministries, most notably Manpower, Health, Defense, and Higher Education. In the year 2021-2022, The HEI has a total enrollment of 28,941 students, with 55.6% of them being female. The highest enrollment is in the specialization of management and commerce, with 28.3%. So far this year, 417 students have received grants and scholarships to pursue higher education abroad (Ministry of Higher Education, Research & Innovation, Oman, 2021).

The government's effort towards higher education and skill development through vocational education has been echoed in developing policies, setting up the statute, and updating programs. The goal of the higher

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education ministry is to facilitate knowledge dissemination through higher education by utilizing cutting-edge programs, research, technology, and innovation in order to develop skilled, trained, and qualified Omani nationals (The Education Council, Sultanate of Oman, 2018). The HEIs are classified into different administrative bodies and authorities, and therefore the expenditure on this sector is not very transparent. However, it is understood that the government of Oman completely funds public institutions, and that is the reason there are absolutely no fees to graduate from these Government owned institutions. Students studying in these institutions also get financial support in the form of remittances (Al Kalbani & Bintouq, 2021). Apart from achieving a good number in gross enrollment in the higher education sector; in a knowledge-driven economy, scientific research, innovations, and technological developments are regarded as the push factors in developing a nation (Peters et al., 2016). The Government has been creating a fund for research and skill development that has direct relevance to employment generation and employability. Global and local reports on the quality of education have depicted that HEI in Oman is going through several challenges, one of which is research (Al-Lamki, 2002). There is a need to improve educational institutions' contributions to social and economic development through relevant research. Here in Oman, the role of the Ministry of Higher Education, Research, and Innovation (MoHERI) emerges to promote the HEI system as well as ensure its quality to align with the goals of Oman Vision 2040 which emphasizes on National Talents, Learning, Education, Scientific Research as the top national priorities for the Sultanate (Ministry of Higher Education, Research and Innovation, Oman, 2021). Therefore, the National Strategy for Education 2040 focuses on building research capacities in the education sector. Below are some of the important excerpts from policy recommendations on research and development for HEIs in Oman:

Consistency of research and postgraduate programs in HEIs with a focus on upgrading the quality and quantity of research and benchmarking according to international standards.

Allocation of a separate budget for research in HEI and emphasizing the role of universities in the R & D.

Promoting incubators and centers of excellence in HEI to strengthen the relationship with manufacturing sectors and implement the research for economic growth.

Supporting innovation projects developed by students and adopting these projects by public and private institutions. Also, prepare technology and science researchers to enable competitive advantage and innovation in the Sultanate.

Fostering communication between HEIs, and local and global institutions in the sector of education in order to collaborate on research and knowledge sharing. Raising awareness among all stakeholders.

Development of national capacities in research genres by providing student scholarships in prestigious institutions and upgrading postgraduate programs at par with international standards. A roadmap to develop research skills at various stages of education to encourage and motivate the enactment of the National Research Strategy in Oman (The Education Council, Sultanate of Oman, 2018).

The rapid development at a global and local level necessitated the development of knowledgeable, market-ready generations of young Omanis. The Omani youth need to be empowered with international standards and technical know-how in business, commerce, manufacturing, biology, and social sciences. Higher education in the Sultanate is focused on developing graduates, scientists, researchers, and entrepreneurs who can contribute to industry growth, knowledge advancement, and community development both locally and globally (The Education Council, Sultanate of Oman, 2018). Recently, in a conversation with Oman news daily, Dr. Bakhit Ahmed Al Mahri, Undersecretary in the Ministry of Higher Education, Scientific Research, and Innovation, stressed on merging of three departments, namely, scientific research, higher education, and vocational institutions under one group (Singh, 2020). Thus, the government has merged with the University of Technology and Applied Sciences to form the Ministry of Education, Scientific Research, and Innovation (HESRI) to upgrade the Higher Education Institutions (HEI) standards. There are sixty-two HEIs, with nine private universities, nineteen private colleges, and thirty-four government HEIs. The ministry is now based on higher education, scientific research, and vocational institutions (Singh, 2020). The sector's priority is to

improve quality in accordance with international standards in order to develop productive citizens capable of contributing to the growth of a diverse post-oil Omani economy (HSBC & EY, 2021).

### **Bibliometric Studies and Their Scope**

The quantitative study of literature as they appear in bibliographies is known as bibliometrics. Its task is to provide evolutionary models in the field of science, technology, and others (White & McCain, 1989). Thus, bibliometrics is an evaluative technique that can observe the state of research and publications in the desired field. It uses quantitative techniques to analyze various publications like books, research articles, reviews, cases, blogs etc. It can also be used to compare research and innovation across nations. It could be a fashion in research in various areas over a period (Finardi & Buratti, 2016). It uses statistical methods to analyze and review a series of literature to divulge the historical advancement in any area of subjects and traces the pattern of publication, authorships, institutions, and geography (Levine-Clark & M. Carter, 2014). Alternatively, it is a stream of research techniques used in the discipline of library and information science to analyze patterns in a scholarly publication on a given topic or area of study. Investigators can also use bibliometric techniques to assess the impact of an author or the collaboration of multiple authors or their research work.

The bibliometric analysis is also conducted to understand the authors' association within their universities as well as foreign collaborations. In fact, there is a similarity between bibliometrics, citation score, and meta-analysis. Bibliometrics has been criticized for having created a system of mania in the publishing industry by delivering a publish-or-perish atmosphere that might lead to deteriorating quality in research (Giles & Council, 2004). The work on scientific bibliographies can be tracked to the twenties, where this has been applied in various forms (Sandison, 1982). Sengupta (1992) mentioned that Campbell, in the year 1896 (Campbell, 2015) published the initial study on bibliometrics using statistical methods for understanding subject scattering in publications. Hulme worked on document calculations to provide insight into the trend of science and technology (Edward Wyndham Hulme, 2016). Alfred (1926) conducted a study on the frequency distribution of scientific productivity. Around that period, Gross & Gross (Gross, 1928) published a citation analysis report. The authors analyzed 3633 citations from the Journal of the American Chemical Society. This work was considered a pioneer in citation analysis. Later in the year 1934, Bradford, using bibliometric analysis, established an association between the frequency distribution of research papers and journals. The author discovered that if academic journals were arranged in descending order of productivity on a given subject, they could be divided into a nucleus of journals more specifically devoted to the subject, several groups containing the same number of articles, and a geometric series formed by the numbers of periodicals in the center and the succeeding zones (Figueiredo et al., 2019). This work remained undetected due to the traditional way of information retrieval. Hood and Wilson (2001) and Shapiro (1992) refer to bibliometrics, a topic that historians of information science have largely ignored. The application of citation indexes has existed since 1743, and publications have been identified in legal writings since around 1817. Weinberg (1997) in his study writes that Hebrew citation indexes are even earlier, about the 12th century. When data collection was manual in the 1970s, the field of bibliometrics was considered to be the personality of enthusiastic academics. Begun as a hobby, it evolved into an interdisciplinary approach by combining physical and mathematical models on one side and psychological and sociological methods on the other. Later on, bibliometrics progressed into a scientific discipline with a specialized research area from the eighties onward. The publication of *Scientometrics*, the first periodical devoted to Scientometric topics in 1978 was a significant step toward the field's institutionalization. Ravichandra Rao (1985) published several comprehensive books on bibliometrics, followed by handbooks edited by several authors like Van, Moed and Glanzel (Van, 1988). The fact that bibliometric methods are already applied implies the rapid development of the branch of learning. Bibliometrics became a standard tool in science and management studies during the 1990s. In this regard, almost all compilations of science indicators relied on publication and citation statistics and more sophisticated bibliometric techniques.

The American physicist Jorge E. Hirsch presented the "h-index," a novel metric based on publication activity and citation impact that assesses a scientist's research performance (Hirsch, 2010). The research community became interested in Hirsch's work, the physics community and the *Scientometrics* literature both responded favorably to it. Hirsch's index also signifies a change in the micro-level application and technique of bibliometrics, i.e., the assessment of research groups and individual scientists. At this level, there are enormous

requirements for the validity of results and findings, data quality, indicators, and technique reliability that cannot be addressed by bibliometrics alone. Within this approach, bibliometrics might function as just one element or instrument within a larger system (Wouters, 1999). Finocchi (2023) opined that indexes such as the number of citations or h-index are often, and not without argument, used in research evaluation throughout the world. These are used at the level of research institutions for purposes of funds allocation and at the level of individual researchers for career advancement (Camil Demetrescu et al., 2020). Web(o)metrics is a new sub-discipline that emerged from the Web's application of bibliometric methods. Due to the fundamental distinctions between print and online media, this area of study developed into a distinct informetric subdiscipline (Ingwersen, 1992). In addition to offering biblio- and informetric applications and other pertinent information sources, the online provider also makes visible and quantifiable the influence and utilization of scientific publications in a variety of web-based forms. In the meantime, a new set of measurements known as altmetric indicators now includes views and downloads of abstracts, full texts, bookmarks, readership, blog posts, comments, reviews, social media, and citations (Breitzman, 2021). Researchers anticipate that these metrics will be a significant contribution to the measurement of the wider impact of scientific research in the near future. Interpretation, reliability, and fields of applicability of altmetrics are not yet clear, and their possible use in an evaluative context is, at least in their present form (Gorraiz & Gumpenberger, 2015).

There are several platforms that provide access to articles and journals via the internet. Technological burst led to the concept of a completely online journal, which created a boom in academic publishing. This glut sometimes makes it difficult to quantify scholarly contributions. The Web of Science (WoS) is a paid-access academic platform that is a collection of multiple databases that provide references as well as citations from various journals, conference proceedings, and other peer-reviewed documents. It was earlier produced by the Institute for Scientific Information (ISI). Presently owned by Clarivate (previously the Intellectual Property and Science business of Thomson Reuters). In 2016, around One million articles were published in over 5500 journals on Pubmed, 8,802 journals were included in the Journal Citation Report of 2015, the Web of Science (WoS) platform indexed more than 1.6 million articles, and in Scopus, more than 2.5 million documents (articles, books, etc.) were published in over 22000 journals. Bibliometrics is a tool to analyze the impact of a paper, journal, or research, which facilitates us to do a hierarchy, objectively and statistically, of various journals, research institutes, universities, and even researchers. With this tool, scientific research productivity is linked to countries' intellectual wealth and economic progress (Jaffe et al., 2020). One of the key indicators to examine the productivity of research is through publication of articles in indexed databases (Albers, 2015). Most of the world's research output is mainly generated by developed countries. Approximately 47% of the research in the world comes from the European Union and the United States (Dóra, 2016). A report by the economic times states that China accounts for 20.07% of all global publications in scientific articles. The purpose of this paper, therefore, is to examine trends in research articles cutting across all disciplines using bibliometric analysis. Identify, analyze, and compare the research output of various HEIs in Oman using secondary source of information from the database of 'The Web of Science', 'Scopus', Google scholar to extract bibliometric data from January 1970 through November 2021.

### **Objectives of the Study**

Recognize peer-reviewed research output at the global level over time.

Compare the trend of publication and citations of Oman vis-à-vis middle Eastern countries from 1970-2021.

Examine and analyze the trend and pattern of publications of peer-reviewed research articles in Oman from 1970-2021

Analyze the peer-reviewed research articles HEIs in Oman from 1970-2021.

### **LITERATURE REVIEW**

The first part of the literature review examines the scholarly work from the Sultanate of Oman and the second part focuses specifically on past contributions made toward bibliometric studies in various fields.

## **Contribution of Scholarly Publications in Oman**

Globalization has encouraged nations all over the world to actively engage in cross-border trade. Nowadays, countries are shifting their focus to a knowledge-based economy as knowledge is a pivotal contributor to a nation's economic growth. Knowledge has a unique characteristic that can be passed on from user to user without losing its utility (Barkhordari et al., 2018). Oman is part of the Middle East and North Africa (MENA) region. The countries in this region have similar heritage and traditions, with variations in economic development and natural resource endowments. The countries in this region are now investing heavily in ambitious projects in education, innovation, and public health (Barro & Lee, 2013). The Global Innovation Index (GII) report states that countries of the MENA region like Saudi Arabia, Qatar, and UAE recognized the importance of research & innovation in economic development and invested in the four pillars of a knowledge-based economy (Cornell University et al., 2016). Over the years, the economic growth of these countries has been highly correlated with oil exports, however the countries realized that oil alone will no longer be able to support economic development and growth. Like other OECD countries, the MENA region countries need to switch to a knowledge-based economy to boost economic growth to sustain national development.

In a knowledge-driven economy, scientific research, innovations, and technological developments are the push factors in developing a nation (Ingwersen, 1992). Recent research states that there are three key enablers of the knowledge economy. One of the factors at a national level is research output (Al-Busaidi, 2020). The Governments have been creating a fund for research and skill development that has direct relevance to society and employment and does have a significant contribution to improving the quality of standard of life of its citizens (Al Rawahi et al., 2021). In the leadership of His Majesty Sultan Qaboos Bin Said, Oman has dedicated attention to human resources development. The Omani government invested in training and upgrading the qualification of Omani youth to contribute to the development and growth of society and humanity at large (Altbach, 2015). For improvement of the human development index, education and training are vital, and both have received focus in developmental plans (Al-Shukaili & Al-Maniri, 2017). The governments' efforts are visible in fixing legislation, policy development, and upgrading institutions (Al-Lamky, 2007). Oman's vision for 2040 strives for economic diversification, and one of the pillars for this is an investment in the knowledge economy. According to the World Intellectual Property Organization (WIPO), Oman has risen eight places in the Global Innovation Index (GII) for 2021 and is now ranked 76th globally. This progress in the ranking reflects the assimilation achieved by the respective ministries of Oman and the other related stakeholders in the national innovation system. One of the indicators that require attention is research competence in the manufacturing and private sectors. It depicts the importance of the private sector's engagement as a major and strategic partner in the research and innovation system by financing research activities. The Ministry of Higher Education, Research, and Innovation developed the Oman Research Portal to build an integrated system to provide various electronic platforms and corresponding tools to enhance Oman's research outcomes. The portal provides research assistance to scholars motivating them to submit their research proposals within the programs of the Ministry (Ministry of Higher Education, Research, and Innovation, 2016). The researcher can present their research proposal anywhere through the portal and follow up on the evaluation results of the submitted proposal. They can access the portal if they are registered as independent researchers or are affiliated with the ministry. The portal also offers statistics or data on a variety of topics, such as publications, journals, registered scholars, and the number of proposals submitted and approved. Nasser bin Ali Al Mandhari, head of the Oman Research Portal project, states that the portal facilitates strong communications between scholars and institutions and quick access to research journals, publications, research statistics, projects, and more. Regarding the efficiency of the Research Information Management System (RIMS) service during the COVID-19 and remote working, it played an important role in enhancing research and publication in Oman. Scholars from various educational institutes in Oman submitted around 738 research applications through RIMS for the Block Funding Program. Of these, around 400 research proposals were specifically in the area of COVID-19 in a very short span of time (Jose et al., 2022). The statistics show that there are 57 beneficiaries, 16560 registered researchers, 4956 arbitrators, and 1229 funded projects. The Oman Research Portal contains 1711 publications, 1374 scientific journals, and 561 research projects (Ministry of Higher Education, Research, and Innovation, 2016). The Oman Digital Academic Library (ODAL) has been created to provide free access to college and

school students and open high-quality university-level educational content. It also enables access to existing and emerging technologies. TRC is a member of the Open Courseware Consortium (OCW), a global body of higher education institutions and associated organizations. OCW is an open digital publication consisting of high-quality higher educational materials. These contents are organized in the structure of various courses and often include course planning materials, evaluation tools and thematic content (The Open Education Consortium, 2023). Apart from OCW content, the TRC library includes video lectures on technology, engineering, mathematics, science, and management concepts and dissertations, journals, and e-books covering academic, creative, and scientific developments at all levels (Ministry of Higher Education, Research, and Innovation, 2016). The government aims to spread knowledge, use technology, and stimulate research and innovation to produce a wise generation capable of positively contributing to the country's development and engaging effectively in the international arena. According to local and international studies and reports, the Sultanate of Oman's education sector faces a number of challenges, one of which is discussed in this research (Al-Lamky, 2007).

### **Bibliometric Studies**

The word 'bibliometric' is referred from the Greek and Latin words 'Biblio' and 'metrics'. This in turn refers to the application of math in any subject area. Bibliometrics establishes one of the thrust areas of research in the field of library and information science. It uses numerical analysis to explain trends and patterns of publications within a given area or body of literature. The term 'Statistical Bibliography' was first used by E.W. Hulme in 1923 for use of quantitative techniques to libraries. A Bibliometric analysis evaluates scientific research that quantitatively presents the research hotspots and trends. These kinds of studies clarify scientific researchers; and provide a reference for research cooperation (Durieux & Gevenois, 2010). The recent bibliometrics study was mainly founded by Derek J. de Solla Price and Eugene Garfield (Noruzi, 2005). They developed the Science Citation Index and were the founder of the Institute for Scientific Information which in turn is prominently used for bibliometric studies (Ahmed, 2012). An academic journal named 'Bibliometrics' was established in 1978. The industrialization of science led to growth in the number of publications and the rise of computer-based technology paved the way for practical data analysis (Giles & Council, 2004). Later, the assessment and ranking of institutions came into the focus, and the academic ranking of world universities was first published in 2004 by Shanghai Jiao Tong University, China. It was followed by the order of academic journals and impact factors, and citations became an influential tool for choosing between different journals. The h-index became an essential indicator of the authors (Noruzi, 2005). These measures attracted the attention of the Government in evaluating the research for the allocation of funds (Hasan & Singh, 2015). Kumar (2013) used the Transformative Activity Index (TAI) to study the research and publication output of Indian authors in human-computer interaction in the period of 1987-2011. The author observed that India is in the 16th position across the globe in the area of Human Computer Interaction research publications, with 2656 papers by 3691 Indian authors from 693 institutions from India. Further adds that the highest number of papers are contributed by the Indian Statistical Institute, with an average impact factor of 1.4 and citations of 9.8 per paper. Indian authors also preferred to publish in journals originating from the Netherlands, the United Kingdom, the USA and Germany. A comparative study on research outcomes between BRIC (Brazil, Russia, India, and China) countries and N-11 (Next-11 countries, namely, Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, Turkey, South Korea, and Vietnam countries) was conducted during 1999-2007 in the field of limnology (Fachrurrozi et al., 2022).

It is crucial to have other techniques to analyze high-quality research other than peer-review technique. Poland follows parametric method to assess the quality of research which is based on the impact factor of scientific journals. However, this technique was questioned, and it became important to improve the method. Currently Ministry of Science and Higher Education in Poland follows an approach based on three factors, i.e., the impact factor, the institutional h-index, and the institutional number of citations, was proposed (Pilc, 2008). The United Kingdom research assessment evolved from a peer-review-based process to one with a well-quantified assessment method. After 2008, the assessment process shifted to indicators based on publication and citation information. There was a need to establish a relationship between publication metrics and other research quality perceptions thoroughly tested and reviewed (Adams, 2009). A broad overview of the leading traditional impact

metrics was used to evaluate scholarly output and their impact by Butler and team. Their research shows that no single conventional metric can accommodate all aspects of research impact in the modern era. Academicians need to be informed of the advantages and disadvantages of traditional metrics. They should be cautious when selecting metrics for an assessment of scholarly output and research impact (Butler et al., 2017). A researcher's success is evaluated by the quantity of publications in high-impact indexed and peer-reviewed journals. , and. The work examines a broad overview of the wide range of metrics used in academia and research. The authors recommend quantitative and qualitative evaluation using specific metrics to examine the scholarly output and research impact accurately (Agarwal et al., 2016). Ani, Ngulube & Onyancha (2014) used bibliometrics to study trends in the publication in the area of library and information science (LIS) in Nigerian universities from the year 2000-2014. Using the WoS as a source of information to find the most visible universities, authors, citations, and publication sources. Their findings revealed volatile trend in the publications of LIS research in Nigeria. The Delta State University, University of Ibadan and the University of Nigeria were found to be the most leading and productive universities in LIS. A recommendation was made to increase the investment in LIS research by Nigerian universities to increase in quality of research output. Gopikuttan & Aswathy used Scientometric analysis to understand the pattern of publications in Spacecraft Propulsion during 1999-2012 (A. Gopikuttan & S. Aswathy, 2014). The authors used the WoS database in terms of year, language, document type and country-wise analysis that gave percentage of Indian share to this subject. Baskaran & Sivakami (2020) carried out a quantitative analysis to understand the literature growth, collaboration, pattern of authorship, and available journals on Swine influenza disease. The data was collected from Pubmed for a period from 2006-2010. A total of 2360 articles were analyzed using the search term "Swine" and subjected to bibliometric data analysis techniques. Fernandes & Cortez (2020) used bibliometric study to examine trends in the use of alphabetically ordered authors in scholarly publications for 27 scientific areas. The study used two datasets that had two and more than two authors to measure the degree of order of the authors. They found that Economics, Mathematics, Management and Accounting have a strong alphabetic ordering usage compared to other scientific areas.

The economic growth in the Middle East is different from other countries and moving towards a knowledge economy is very important. Like other GCC (Gulf Cooperation Council, political and economic alliance of Saudi Arabia, Kuwait, the United Arab Emirates, Qatar, Bahrain, and Oman) countries, Oman is transitioning to a knowledge economy. Oman's knowledge economy status has improved since 1995, but there is still much scope for improvement. The need for Oman to equip and empower its economy with knowledge cannot be understated. Therefore, one of the National Strategy for Education 2040 focuses on building research capacities in the education sector. The literature study reveals that Oman's scholarly output lacks a specific narrative. This bibliometric analysis work, thus, tracks the scholarly contributions from Oman. The outcome will ascertain the scope and nature of research conducted in Oman.

## **MATERIALS AND METHODS**

This study encompasses publications from the Science Citation Index (SCI) available online (Web of Knowledge), Web of Science (WoS) Core Collection (WoS, 2022). The WoS is platform provided by Thomson Reuters (the former Thomson Scientific emerged from the Institute for Scientific Information (ISI) in Philadelphia). WoS contains over 21,640 peer-reviewed scholarly journals published worldwide in over 250 disciplines within sciences, social sciences, and arts and humanities. The availability of citation data makes WoS data suitable for bibliometric analyses, including co-citation analysis. SCI database is also a thorough database covering all areas of science. This paper aims at analyzing the scholarly publications from educational institutions of Oman. The growth of output in terms of research productivity is analyzed from 1996-2020. However, wherever data was available for 2021, we tried to incorporate the same during the process of analysis. The institution-wise research performance was analyzed to identify the best-performing institutions in Oman during the study period. A search was performed on WoS for all documents with "Oman" as a keyword to identify all documents with the publication from "Oman ". We further filtered the documents and selected only peer-reviewed research articles. Other document types such as meeting proceedings, book reviews, and letters were excluded from the search as well as from the database. A similar process was carried out from an international database, Scopus (Elsevier, 2019). Bibliographic data were exported as "full records with cited

references” from the archives of Scopus databases from 1990-2022. Descriptive analyses were used to summarize information about the most prominent HEIs in Oman, country-wise citation analysis, and the year-on-year growth in research outputs.

## **RESULT AND DISCUSSION**

### **Analysis Of Research Output Based On Regional Clusters From 1996- 2020**

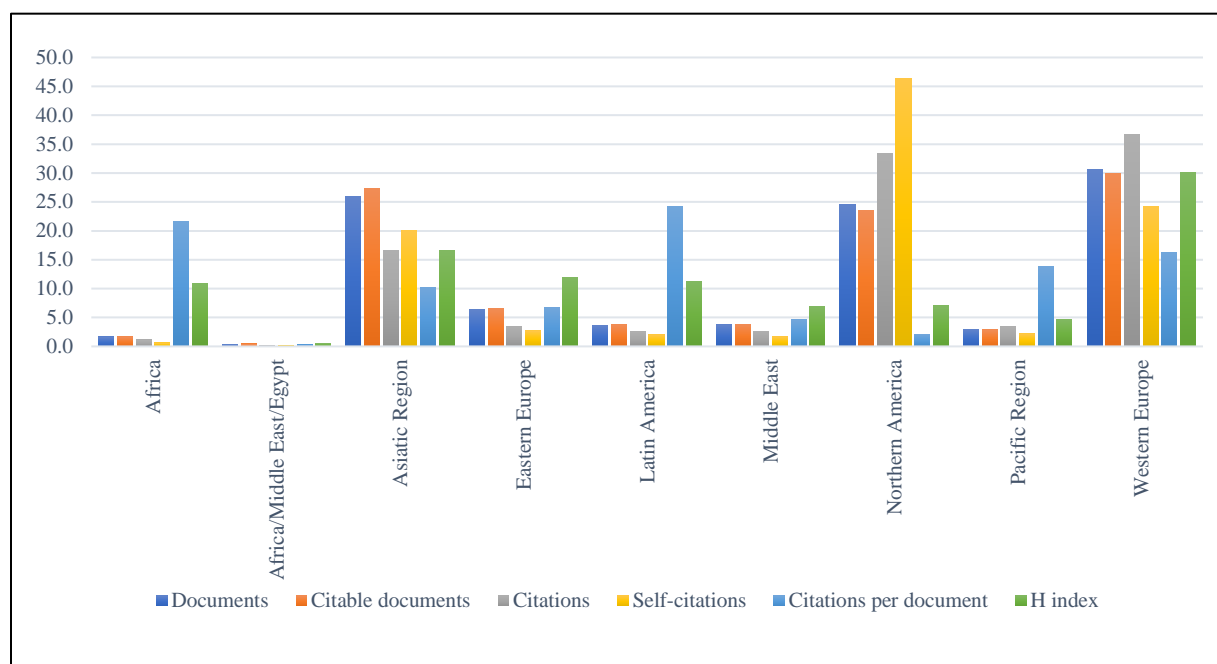
The secondary information was extracted from the Scopus database from 1996-2020 across various countries. All 240 countries are clustered based on their region to understand and analyze the total contribution of peer-reviewed research articles. The details of the country and their region are provided in the appendix for reference in Table A-1.

**Table 1: Research output clusters across regions from 1996- 2020 in absolute values.**

<b>Regions</b>	<b>Documents</b>	<b>Citable Documents</b>	<b>Citations</b>	<b>Self-citations</b>	<b>Citations per Document</b>	<b>H-index</b>
Africa	1064248	975241	14670801	2490120	926.4	6056
Africa/Middle East/Egypt	264543	252794	3041277	609601	11.5	322
Asiatic Region	16804820	15978659	217550953	76222914	436.68	9187
Eastern Europe	4105012	3876820	45412393	10378948	287.3	6651
Latin America	2385477	2203080	33594593	7754109	1037.49	6259
Middle East	2418415	2243870	34474355	6537627	196.97	3875
Northern America	15855265	13783151	437224593	177072020	91.57	3890
Pacific Region	1940149	1688056	44852956	8376773	593.16	2605
Western Europe	19850044	17484069	481190729	92205328	695.23	16731

Source: Data retrieved from SCIMAGO database 1996- 2020 and compiled with by authors (SCOPUS, 2019).





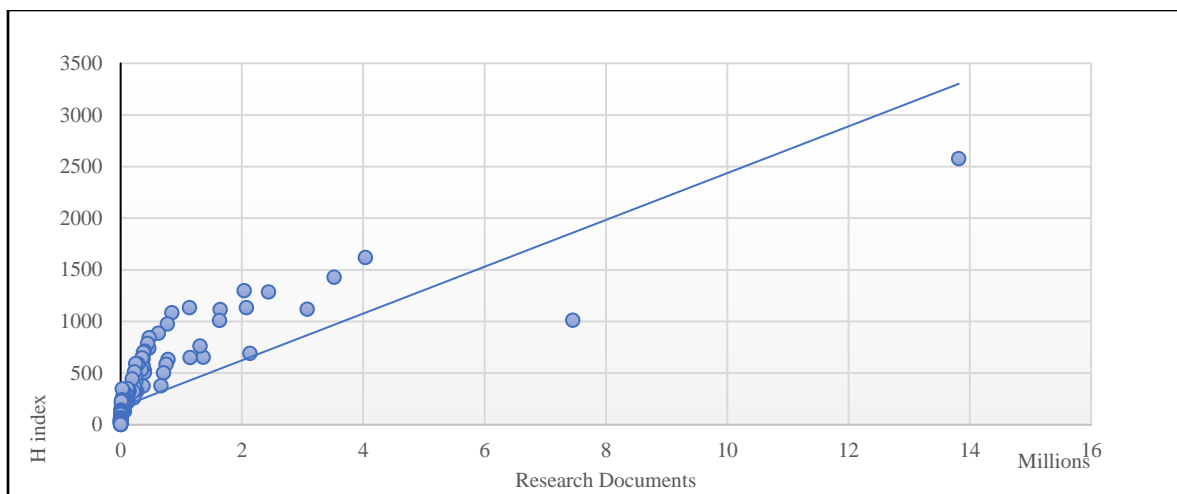
**Fig. 1.** Research output clusters across regions from 1996-2020 in percentage, compiled by authors and data extracted from Scimago Institutions Rankings (SCOPUS, 2019).

The number of documents, citations as well as citable documents are th

e highest in Western Europe, followed by North America and Asian countries. Citable documents include articles, reviews, and conference papers published by a journal in the three previous years (selected year documents are excluded). Western Europe, followed by Asiatic countries, has shown the highest number of citable documents during 1996-2020. Citations refer to a number of documents cited at least once in the three previous years where Western Europe and North America took the lead. The United States and Canada contribute the lion's share to all fields of higher education in North America, while the United Kingdom, Germany, France, Italy, and Spain contribute to Western Europe. Brainard et.al (2021) demonstrated in their paper that elite research papers across the globe using a number of citations and references from where top researchers draw for their knowledge base. The resultant credit of top-cited papers is persistent since it does not reflect the frontiers but the archive. The authors show the determined position held in the archive by the United States, the rise of the recognition of Chinese papers, and a stable stronghold for Switzerland, the Netherlands, and the United Kingdom. In terms of using national research in their work, the Netherlands, Sweden, and Switzerland far exceeded expectations, possibly indicating a strong return on investment. However, we know from other research that these rather smaller nations are also strong in collaborating with other nations. Thus, it seems that smaller nations' investments in research are especially effective in fostering (own) top-level research if they are open to foreign research (Nicolás Robinson-García et al., 2019). Citations per document have been highest in Latin America and Africa. Possible reasons for the former could be due to advancement in higher education institutions, research activities, and incentives for the same. The authors in these regions also prefer to publish in open-access journals with a wider presence in social media like ResearchGate, SSRN, LinkedIn, and other social platforms. This social network facilitates international collaborations and thus increases the probability of articles getting read and cited in peer-reviewed journals. Self-citations are highest in North America, followed by Western Europe and Asiatic countries. Self-citation occurs in an article when an author references another of their own publications. This can be a legitimate way to reference earlier findings, but self-citations can sometimes be unduly made in an attempt to inflate an individual's citation count.

The H-index has been highest in Western Europe, followed by Asiatic countries. It quantifies both journal scientific productivity and the scientific impact of the article as well as journals. This measure is further extended

to groups of scientists, such as a department or university, or country (Jones et al., 2011). In other words, it gives an idea of a researcher's individual productivity and influence. The figure is based on the number of papers published by a researcher and the number of citations those papers receive (Varian, 2014). Fig. 2 provides a correlation between the H-index and the number of publications of research articles. There is a highly positive correlation between them. Higher H-index is also due to the global shift towards making research findings available free of charge for readers, the so-called 'open access'. Open access is reaching the tipping point, with around 50% of scientific papers published in 2011 now available for free. This is about twice the level estimated in previous studies, explained by a refined methodology and a wider definition of open access (Enago Academy, 2019). By making research results more accessible, open access can contribute to better and more efficient and to innovation in the public and private sectors. Free availability of the majority of articles has been reached in the fields of general science and technology, biomedical research, biology and mathematics, and statistics. Countries with higher H-indexes include the United States of America, Europe, France, Poland, China, and India, owing to collaboration with more experienced researchers.



**Fig. 2.** Relationship between research documents and H-index at a global level from 1996-2020, compiled by authors and data extracted from Scimago Institutions Rankings (SCOPUS, 2019).

### **Analysis Of Research Output Across Middle East Nations From The SCIMAGO Database From 1996- 2020 With Special Reference To Oman**

The lands nearby the southern and eastern shores of the Mediterranean Sea, surrounding the Arabian Peninsula, Iran, North Africa, and the Middle East. There are 15 countries categorized as the Middle East, except for Egypt. For our analysis, we have included data from Egypt (Arab Republic of Egypt) with the Middle East (Brainard, 2021). The United Arab Emirates (UAE), or simply the Emirates, is a country in Western Asia that includes seven emirates, namely, Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al-Quwain, Fujairah, and Ras Al Khaimah (Department of foreign affairs and trade, 2018). Fig. 3 explains the number of research documents published by the Middle east region. A maximum number of publications has been depicted by Turkey, Iran, and Israel. According to the analysis done by Clarivate analytics firm, the Middle East and North Africa have boosted their share of scholarly articles in international journals during the past four decades. From 1981 to 2019, the region quadrupled its share of research articles and reviews to 8%. Clarivate's report, based on its Web of Science bibliometric database, notes the "outstanding relative growth" of papers from the Middle East and North Africa came despite international sanctions against Iran and violent conflicts in Iraq and elsewhere. Iran led the way with 188,163 papers from 2015-2019; its output from 2000-2019 rose 30-fold. At least some of Saudi Arabia's expansion may have come from non-Saudi researchers affiliated with Saudi institutions. Clusters of the region's papers focused on sustainable development, including soil erosion, and other areas of applied science, Clarivate said (Brainard, 2021).

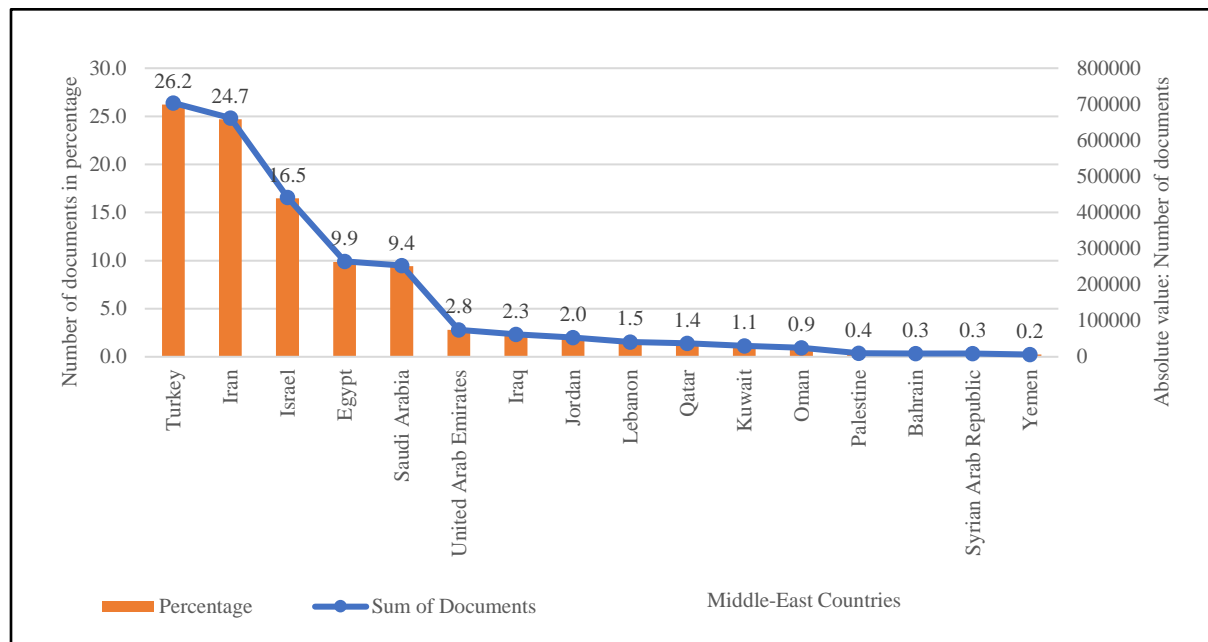


Figure 3: Number of documents published from Middle East countries from 1996- 2020, compiled by authors, and data extracted from Scimago Institutions Rankings (SCOPUS, 2019).

Table 2: Number of citations and self-citations from Middle East countries from 1996-2020.

Country	Citations	Citations In percentage	Self-citations	self-citations in percentage
Turkey	8337138	22.22	1762372	24.66
Iran	7048776	18.79	2395956	33.52
Israel	11648614	31.05	1415261	19.80
Egypt	3041277	8.11	609601	8.53
Saudi Arabia	3459949	9.22	533241	7.46
United Arab Emirates	830119	2.21	85398	1.19
Iraq	299797	0.80	65395	0.91
Jordan	586003	1.56	72216	1.01
Lebanon	599190	1.60	52425	0.73
Qatar	529099	1.41	54492	0.76
Kuwait	381763	1.02	36108	0.51
Oman	290036	0.77	29148	0.41
Palestine	147080	0.39	12985	0.18
Bahrain	111679	0.30	5496	0.08
Syrian Arab Republic	126853	0.34	10030	0.14
Yemen	78259	0.21	7104	0.10
Total	37515632	100	7147228	100

Table 2 depicts total citations and self-citations in absolute and percentage terms from 1996 to 2020. It is evident that Israel has the highest number of citations, followed by Iran and Turkey. But in self-citations, Iran takes the lead, followed by Turkey and Israel. Turkey has a maximum of 703732 documents with Yemen being the lowest at 6256 documents. Turkey and Iran have noticeably higher documents. Oman has 24857 documents which are 12th position among the 16 selected countries. Again, Israel has the highest H- index of 19% among 15 Middle Eastern countries during the study period. Oman has 4% of the total H-index, falling in the category of fast-moving countries in research and publication.

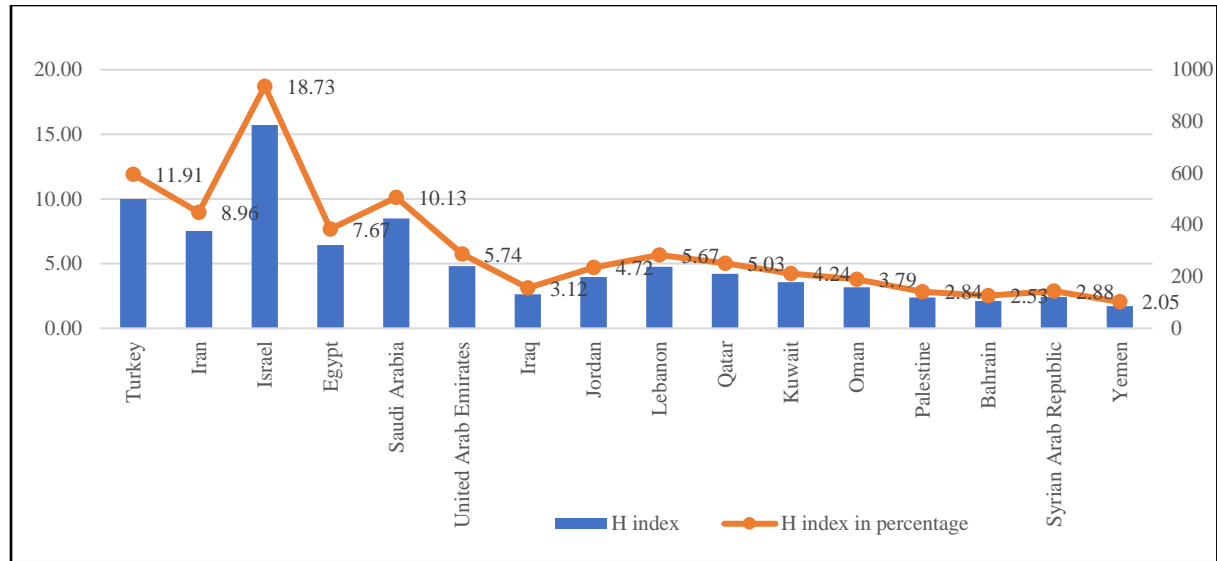


Fig. 4. H-index for Middle East countries from 1996- 2020 (SCOPUS, 2019) [61].

### Analysis of Research Output in The Sultanate of Oman with Micro Coverage on Higher Education Institutions

The result of the demographic analysis of HEI in Oman during the study period was generated by the National Center for Statistics and Information (NCSI) of Oman (National Centre for Statistics and Information, n.d.). NCSI provides official statistics and reliable information that are important to enable the decision-makers to formulate and adopt policies and programs on national, regional, and international levels, considering the different economic and social variables. The frequency of data with NCSI is annual, with a range of 2002 to 2019. The data on the NCSI website was updated till Oct. 21, 2021, during our period of study. The number of universities, colleges, and institutes is the total number of higher education institutions in the Sultanate. Students admitted are the number of students admitted to higher education institutions that had previously attended and had not previously attended higher education. Graduate students are the number of students who have completed their studies successfully, including diplomas, bachelor, master, and Ph.D. Higher education institutions include a total of all universities, institutes both government-owned and funded and private-owned and funded. Complete data is available only from 2015 to 2019. The chart details the HEIs in Oman and compares the students enrolled and students who graduated in a specific year. We see a maximum enrolment of 36,609 in 2018 across 70 institutions. The maximum number of students who graduated was 27,651 in 2017. Overall, based on the data available, 172460 students have graduated as of 2019. It is noticed that formed 2017 to 2019, and there has been a 5% decline in education institutions. Pre Covid-19, it is observed that there was a 5% decrease in the number of educational institutions from 2017 onwards. Muscat has the maximum number of active students, and it exceeds the other governorates by a large margin. Therefore, the cluster of active students belonging to HEIs in Oman is from Governorates like Muscat, Salalah, Ibra, Nizwa, Musanna, Ibri, Shinas, and Alseeb, respectively. Table 3 depicts nine HEIs in Oman with 139018 active students. The private educational institutions have the maximum number of students (66739) and the minimum number of students with the Ministry of Defense (420). Individually considered, private institutions have a higher percentage of active students, but when compared in total, all the government HEIs have a higher rate of active students. Table 4 provides the institution break-up of citations extracted from the Scopus database from 1970 to 2021. Only citations for research articles indexed by Scopus are included in a compilation of the table. During the process of analysis, research papers without proper mention of year and articles without a complete title were deleted. In publication types, only research articles were retained, and book reviews, documents, conference papers, and book chapters were eliminated. Sultan Qaboos University has been publishing good research papers consistently during the study period followed by the Higher Colleges of Technology in Oman. Fig. 6 describes

the total number of citations till the study period is 23276, with maximum numbers generated from 2015-2020. The minimum citation of zero occurred from 1983-1986, and the maximum of 2603 happened in 2020.

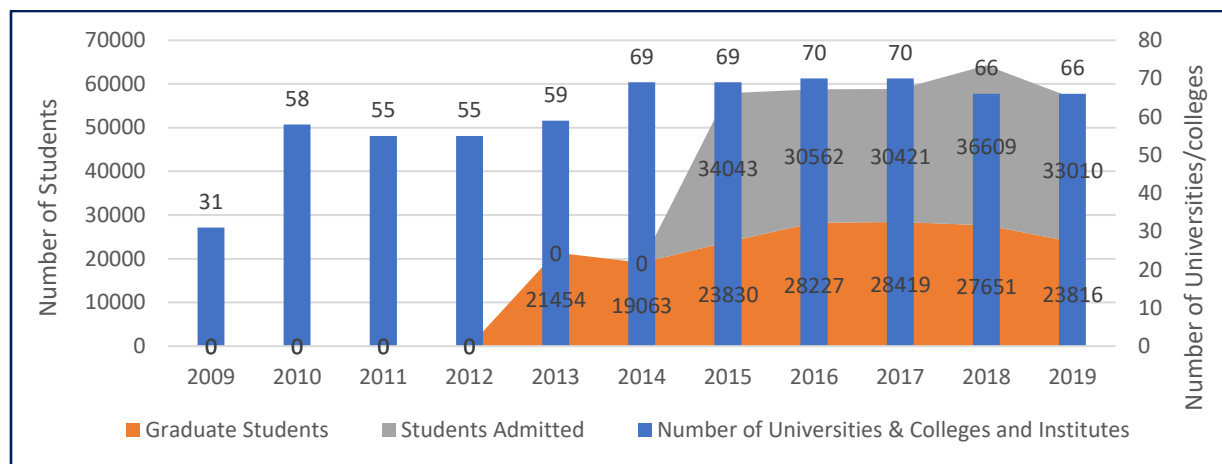


Fig. 5. Graduated students in Oman from 2009-2019 (National Centre for Statistics and Information, n.d.).

Table 3. Higher Education Institutions (HEI) in Oman and its affiliations.

Higher Education Institutions	Active Student in the year 2021
Associated with Private Higher Education	66739
Associated with the Ministry of Manpower	38758
Sultan Qaboos University	14428
Associated with the Ministry of Higher Education	13178
Associated with the Ministry of Health	2141
Associated with the Central Bank of Oman	2028
Associated with the Ministry of Awqaf and Religious Affairs	737
Military Technological College	589
Ministry of Defence	420
Grand Total	139018

Source: Compiled by authors and data extracted from the Ministry of Higher Education, Research and Innovation, Oman (MOHERI) (Ministry of Higher Education, Research, and Innovation, 2016).

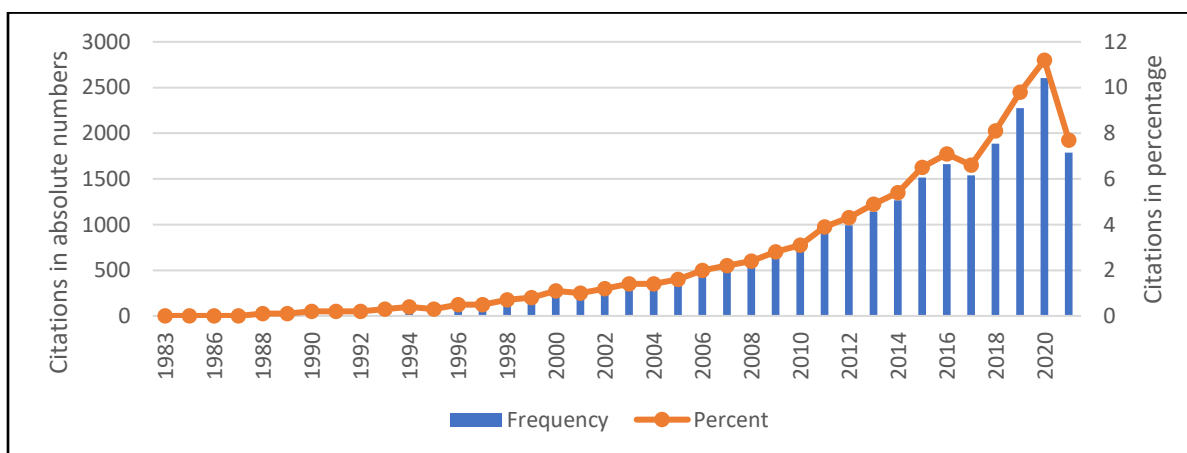


Figure 6: Citations trend for HEIs in Oman from 1983-2021. Source: Compiled by authors and data extracted from National Center for Statistics and Information, Oman (NCSI), last accessed Apr. 27, 2022 (National Centre for Statistics and Information, n.d.).

**Table 4. Citations analysis for institutions in Oman 1970- 2021 from Scopus database.**

S. No.	Higher Education Institutions	number of citations	Percent
1	Sultan Qaboos University	15111	64.9
2	Higher College of Technology	1708	7.3
3	University of Nizwa	1402	6
4	Dhofar University	1029	4.4
5	Sohar University	731	3.1
6	Oman Medical College	609	2.6
7	The College of Engineering (formerly known as Caledonian College of Engineering)	609	2.6
8	Middle East College	361	1.6
9	German University of Technology	327	1.4
10	Salalah College of Technology	153	0.7
11	Al- Buraimi College	151	0.6
12	Buraimi University	93	0.4
13	Sur University College	93	0.4
14	Military Technological College	91	0.4
15	Shinas College of Technology	89	0.4
16	Muscat College	76	0.3
17	Modern College of Business	74	0.3
18	Musanna College of Technology	72	0.3
19	Gulf College	67	0.3
20	Ibra College of Technology	60	0.3
21	Majan College	60	0.3
22	International Maritime College	58	0.2
23	Ibri College of Technology	48	0.2
24	Nizwa College of Technology	41	0.2
25	Mazoon College	39	0.2
26	Arab Open University	37	0.2
27	International College of Engineering and Management	29	0.1
28	Oman College of Management	24	0.1
29	College of Banking and Financial Studies	18	0.1
30	Oman Tourism College	12	0.1
31	Scientific College of Design	4	0
	Total	23276	100

Source: compiled by authors, data extracted from Scopus, last accessed Apr. 27, 2022 (SCOPUS, 2019).

Table-5 shows the number of times the articles from Oman were cited in Web of Science and all the other databases. It indicates the publications and their citations from 1970 to 2021. It is evident that there has been a steady increase in publications across the years. But about the citations, there is no consistent pattern that can be observed as the citations are fluctuating across the years. The citations have considerably increased over the years, but it is observed that in some years, it is very low. The above table shows the average citations per publication from 1970 to 2021. The inference is that the citations per research vary across the years. The highest is seen in 1973, with an average of 70 citations for every publication. The least citations are observed in the year 1971, with three citations per publication. The average citations are not indicative of steady growth but depict high and low points with variations across the study period.

**Table 5: Citations analysis trend in Oman 1970- 2021 from Web of Science database.**

Publication Year	Total Citation	Number of publications	Average citations per document
1970	82	10	8.2
1971	9	3	3.0
1972	181	7	25.9
1973	280	4	70.0
1974	58	5	11.6
1975	98	4	24.5
1976	137	11	12.5
1977	336	13	25.8
1978	206	15	13.7
1979	247	10	24.7
1980	267	22	12.1
1982	1139	27	42.2
1983	623	22	28.3
1984	809	23	35.2
1985	715	27	26.5
1986	1225	36	34.0
1987	946	30	31.5
1988	2684	75	35.8
1989	890	52	17.1
1990	1236	68	18.2
1991	2591	99	26.2
1992	2859	109	26.2
1993	4274	124	34.5
1994	2853	154	18.5
1995	4142	166	25.0
1996	5067	184	27.5
1997	6667	211	31.6
1998	7649	267	28.6
1999	7799	308	25.3
2000	9390	320	29.3
2001	8191	300	27.3
2002	11245	341	33.0
2003	13836	356	38.9
2004	11429	350	32.7
2005	15493	417	37.2
2006	13510	468	28.9
2007	13863	501	27.7
2008	16836	542	31.1
2009	15208	622	24.5
2010	16399	701	23.4
2011	17823	814	21.9
2012	17167	864	19.9
2013	18506	985	18.8
2014	21014	1105	19.0

2015	31603	1265	25.0
2016	23871	1381	17.3
2017	23442	1470	15.9
2018	15376	1579	9.7
2019	10815	1769	6.1
2020	7115	2107	3.4
2021	941	1297	0.7

Source: compiled by authors, data extracted from Web of Science (Web of Science Group, 1997).

## **CONCLUSION**

Bibliometrics analysis provides indexed information on scholarly documents that investigates the sources of articles through the identity and affiliation of authors and also their reach across the globe. Groos & Pritchard (1969) has made an attempt to provide the relevance of the peer-reviewed research articles by analyzing the citations per document at the global and country level. We found that the number of documents, citations as well as citable documents are the highest among Western Europe, followed by North America and Asian countries during 1996-2020. The USA and Canada contribute the maximum in all the fields of higher education publications. The top-cited papers that reflect publications in archives have been the highest in the USA. The Netherlands, Sweden, and Switzerland exceeded expectations in terms of using national research in their work. Citations per document have been highest in Latin America and Africa, indicating a preference to publish in open-access journals with a wider presence in social media like ResearchGate, SSRN, LinkedIn, and other research networks. Self-citations are highest in North America, followed by Western Europe and Asiatic countries. The H-index has been highest in Western Europe, followed by Asiatic countries. Again H- index is influenced by the free availability of the majority of articles, particularly in the fields of general science and technology, biomedical research, biology and mathematics, and statistics. Countries like the USA, Europe, France, Poland, China, and India have more H- index due to their collaboration with more mature researchers.

Among Middle East countries, a maximum number of publications has been shown by Turkey, Iran, and Israel. According to Clarivate Analytics, the Middle East and North Africa have boosted their share of scholarly articles in international journals during the past four decades. Some of Saudi Arabia's expansion may have come from non-Saudi researchers affiliated with Saudi institutions. This region's papers focused on sustainable development, including soil erosion and other areas of applied science. On citations, Israel has the highest number of citations, followed by Iran and Turkey. In self-citations, Iran takes the lead, followed by Turkey and Israel. Oman has 24857 documents which are 12th position among the 16 selected countries. On H-index, Israel has the highest H- index of 19% among 15 Middle Eastern countries during the study period. Oman has 4% of the total H-index, falling in the category of fast-moving countries in research and publication. The demographic analysis of HEI in Oman generated from NCSI, Oman shows the maximum number of citations generated from 2015-2020. The minimum citation of zero occurred from 1983-1986. Sultan Qaboos University has been publishing quality research papers consistently during the study period, followed by the Higher Colleges of Technology in Oman. The analysis from the Web of Science depicted a steady increase in publications across the years in Oman. However, the citations per document have been fluctuating over the years. The highest citation was observed in the year 1973, with an average of 70 citations per document.

## **LIMITATIONS**

The limitation of our study comes mainly from the exclusion of books, book chapters, patents, podcasts, conference papers, and other social media research outcomes. This research can be extended to GCC or MENA region countries with the inclusion of all scholarly submissions in social media platforms as well, apart from peer-reviewed journals.

## **CONFLICT OF INTEREST**



This study has been conducted by Dr. Mythili Kolluru and Dr. Vidya Suresh in partial fulfillment of the requirements of the research grant by the College of Banking and Financial Studies, Oman. There is no other conflict of interest.

### Author Contributions

Dr Mythili Kolluru contributed to the literature review and data collection phase including reviewing various versions of the paper. Critical analysis and final editing were conducted by Dr Kolluru. Dr Vidya Suresh analyzed the data and contributed to research design.

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