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Visualizing the Citation Analysis of Scholarly Communication of Ayurveda Research During 1923-2018: An Exploratory Study

Manuelraj Peter

*Assistant Professor & Head of Library Systems, Deanship of Library Affairs
Imam Abdulrahman Bin Faisal University, Dammam, Kingdom of Saudi Arabia*

Mohamed Idhris

*Assistant Professor, Central Library, Deanship of Library Affairs
Imam Abdulrahman Bin Faisal University, Dammam, Kingdom of Saudi Arabia*

 <https://orcid.org/0000-0002-4823-3861>

Spurgeon Anandraj

*Lecturer & Serials Control Librarian, Deanship of Library Affairs
Imam Abdulrahman Bin Faisal University, Dammam, Kingdom of Saudi Arabia*

Abstract

The study aims to present a Scientometric analysis of scientific output of the Ayurveda research indexed to Scopus Database. In last two decades the ayurvedic studies clearly show the improvement in scientific research and development throughout the world, and the most of the ayurvedic research outputs are written by Indian authors and collaborated widely throughout different countries researchers. It is clearly showing that Ayurvedic research is well developed in India and significantly improved over the last two decades. This study was conducted from the data indexed from 1923 to 2018 in the multidisciplinary SCOPUS database. The analysis included analyzing total publishing patterns in terms of total articles, productive countries, organizations, Journals, productive writers, most cited articles along with citation and h-index effects. During the study period, the SCOPUS database published 2038 papers. Such papers have been further reviewed to explain findings. The main purpose of the study is to explain India's position in publishing top Ayurvedic research papers.

Keywords: Bibliometric analysis, Ayurveda research, Citation analysis and Research impact

Introduction

The oldest medical organization in the world is ayurvedic medicine. It started in India and went back some thousand years. It is thought that Ayurveda was bestowed by his Hindu gods by the ancient rishis or seer of India about 5000 years ago. Ayurveda is a scientific discipline with historical origins in the Indian subcontinent. Ayurveda traditions are one form of globalization and transformation of alternative medicine. Ayurvedic therapies and ayurvedic approaches were used in general health procedures in countries outside India and, in some cases, in medicinal usage.

The past of Ayurvedic medicine is interesting. Originally in an oral culture, Ayurveda was documented in Sanskrit in the four holy texts called Vedas more than five thousand years ago.

Ayurveda is commonly recognized as conventional medicine. Ayurveda was persistently mocked to Western minds for its ambiguity and its abstract scientific principles before the current upswing of western medicine from a regional viewpoint. This confusion has contributed to a lack of interest in Ayurveda in the West, which has robbed the planet of several potential benefits of conventions for the quality of life Ayurveda.

Contrary to the global scene, Ayurvedic schools in India strongly advocate the empirical basis of Ayurvedic values. A connotation of connecting science to Ayurveda is well viewed by Ayurvedic doctors in India, and this thinking has been pioneered by schools such as Banaras Hindu University (BHU). What made this thought impossible to become a reality? A weak scientific evaluation among the Indian scientific community of Ayurvedic concepts eventually resulted in poor interdisciplinary collaboration between science and Ayurveda. It eventually led to this thought's premature death until it was recently revived with stronger evidence to rely on. Recent realization is to think of the successful use of Ayurveda through a better understanding of its fundamentals. Luckily, this realization has provided as its eventuality a spurt of an impulsive and argumentative pro-Ayurvedic generation. In addition to reducing its linguistic barriers, the global diffusion of Ayurveda needed its scientific presentation to help it become accessible to people exogenous to it. Luckily, Other modern formats have encouraged us to experience this fact and serve as intermediaries, speak in a mutually comprehensible language while maintaining the original essence of Ayurveda and health science.

Current Problems in Ayurveda

Ayurveda is genuinely regarded as the most influential sciences by both the intelligentsia and the common folk. One would think that the Ayurvedic system's medical method of diagnosing and treating patients, rather than the patient's illness, was being developed to completely adapt to any condition and apply new technologies. The traditional medical system plays a vital role in the area of medical care and health services in third world countries, along with modern medicine. Although modern medicine

is evolving at great speed, the traditional medicine model in these countries continues to be neglected or even abandoned. At the same time, the traditional system is on the verge of extinction or even disintegration, mainly due to the scrupulous pillage by modern medicine of traditional knowledge and wisdom. In this model of medicine, therefore, there is an immediate need to conduct a very thorough and systematic study of the social application of information technology to modernize it to meet the challenges of the time.

In other words, medical informatics is a vast untapped area of study in the sense of the traditional medicine system, which could be built through the proper integration of information technology and the traditional medicine system without deviating from its fundamental principles. There is an urgent need to change the mindset and the thinking horizon of both practitioners and manufacturers to modernize the Ayurvedic system and change it to the traditional framework to modern lines. Then the practitioners and manufacturers understand the importance of modernizing and adopting innovations in Ayurveda and their international potential as the most useful alternative medicine method in this century. It is, therefore, important to follow the latest technical methods and scientific paradigm similar to modern medicine to convert Ayurveda from traditional to the global level.

In the sense of globalization, the fact that Ayurveda is not only a therapy but also a full medicine system must be taken into account. As such, the greatest challenge in its globalization is the lack of a skilled workforce with the communication skills needed, which can help to spread Ayurvedic knowledge as a science and process. Another issue in this project is the lack of good multilingual literature on Ayurveda suitable for the globalization of knowledge. Certain major issues are the lack of awareness of the trend of science globalization and its implementation, its legal and commercial implications, insufficient patent laws to protect traditional national heritage, legal barriers to the use of Ayurvedic drugs and formulations outside India. There are also problems with the sluggish and insufficient research and development activities and lack of economic and infrastructural resources in the field of Ayurveda,

lack of standardization and quality control of Ayurvedic drugs and semi-hearted industrialization, and lack of attention to the conservation and cultivation of medicinal plants. Now it's the age of knowledge-based industry and wisdom. Ayurveda is a philosophy that is centuries old. When fundamental changes are to be implemented, and then Ayurvedic medicine will flourish globally.

Objectives

The main aim of the objectives of the study are:

- To identify the Citation pattern of the Ayurvedic Research
- To identify the Authorship trend and Publication pattern
- To identify the top Twenty Highly Cited Journals
- To identify the top Twenty Highly citations productive Authors
- To identify the Citation wise top Twenty Countries in Ayurveda Research
- To identify the Co-occurrence Author Keywords.

Methodology

For the study, the Scopus (Elsevier) database (<http://www.scopus.com>) was searched to retrieve publications Ayurveda research and limited the analysis to publications from 1923-2018. The research has chosen Scopus as the world's biggest multidisciplinary data base for peer-reviews. The research used 'Ayurveda' as the search phrase, and restricted the definition to 'titles, abstracts or keywords' in the paper. The research contained only papers written between 1923 and 2018. A total of 2038 publications were received from the Scopus database. The records were downloaded to Excel and import to the Endnote software to analyses based on year of publication Citation counts received by the papers have been used as a qualitative measure. Cite score taken from the Scopus; Journal Impact Factor carried out from the website of a web of science, H-index, has taken form the SJR. The visualization and mapping of scientific collaboration are carried out by using VOS viewer software.

Table 1: Citation pattern of the Ayurvedic Research

Year	TP	TC	TCPP
>2000	367	706	1.92
2001	34	145	4.26
2002	23	238	10.35
2003	23	217	9.43
2004	32	277	8.66
2005	55	411	7.47
2006	46	445	9.67
2007	63	464	7.37
2008	81	612	7.56
2009	88	787	8.94
2010	106	1099	10.37
2011	147	1482	10.08
2012	163	1666	10.22
2013	147	1635	11.12
2014	146	1771	12.13
2015	117	1834	15.68
2016	145	1907	13.15
2017	111	1892	17.05
2018	144	1726	11.99
Total	2038	19314	9.48

Year	TP	TC	TCPP
>2000	367	706	1.92
2001-2005	167	1288	7.71
2006-2010	384	3407	8.87
2011-2015	720	8388	11.65
2016-2018	400	5525	13.81
	2038	19314	

Table 1 displays the year wise period, the number of publications and citations received in each year. Before 2000 there were no other major changes in the development. But the number of papers published gets growth in 2001 to 2018. A maximum number of articles were published in the 2011-15 year with 720 articles and 8388 total citations (11.65 citations per paper) The average citation per paper is calculated by dividing the number of citations with no. of papers. There were 2038 articles altogether, with an average of 9.48 citations per article. Individual year-wise, the maximum number of total publications published in the year of 2012 (163) in the year 2016, got the maximum number of

citation count 1907 (13.15%). The number of articles year by year it grows positively because, throughout modern years, there is a growing increase of people finding treatments without adverse effects because of their consciousness and, therefore, apprehension of risk with allopathic medicine and the rising costs of healthcare.

Table 2: Authorship trend and Publication pattern

No of Authors	No of Records	Percent	Cum Percent
1	497	7.71	7.71
2	840	13.03	20.74
3	1110	17.21	37.95
4	1144	17.74	55.69
5	855	13.26	68.95
6	714	11.07	80.02
7	497	7.71	87.73
8	320	4.96	92.70
9	162	2.51	95.21
10	70	1.09	96.29
More than ten	239	3.71	100.00
Total	6448		

Table 2 presents a detailed overview of the authorship pattern of papers published from 1923 to 2018. In this table, all the publications were divided into 11 categories. It is observed that out of 6448 contributions, a total highest number of 1144 (17.74%) publications have been contributed by four authors, followed by three authors 1110 (17.21%), more than ten authors 239 (3.71%), five authors 855 (13.26%), six authors 714 (11.07%), seven authors 497 (7.71%), eight authors 320 (4.96%), nine authors 162 (2.51%) respectively. During the period of study, only 70 publication was authored by ten authors. The majority of publications are multi-authored. It can be analyzed that there exists a collaborative research trend in the area of Ayurvedic research.

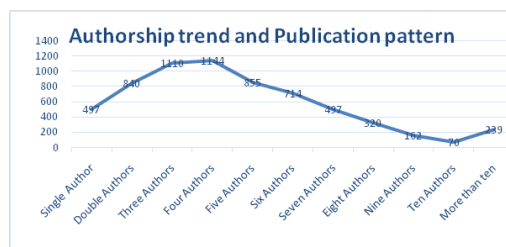


Table 3: Top 20 Highly Cited Journals

Journal Title	Cite score 2018	H-Index	IF	TP	TC	ACPP	Country
Journal of Ethnopharmacology	3.68	162	3.115	62	1907	30.76	Ireland
Phytotherapy Research	3.62	105	3.349	20	949	47.45	US
Journal of Alternative and Complementary Medicine	1.75	77	1.498	47	835	17.77	US
Evidence-based Complementary and Alternative Medicine	2.01	66	2.064	36	721	20.03	US
Jama - Journal of the American Medical Association	6.98	622	51.27	5	710	142.00	US
Indian Journal of Experimental Biology	1.57	63	1.475	33	615	18.64	India
Current Science	0.64	98	0.883	36	596	16.56	India
Journal of Ayurveda and Integrative Medicine	1.08	16	1.086	128	449	3.51	US
Indian Journal of Pharmacology	1.11	49	0.902	17	399	23.47	India
Phytochemistry	3.42	153	3.186	3	385	128.33	England
Tetrahedron	2.39	206	2.377	8	383	47.88	England
Chemical and Pharmaceutical Bulletin	1.41	81	1.276	4	365	91.25	Japan
Tetrahedron Letters	215	155	2.125	2	281	140.50	England
BMC Complementary and Alternative Medicine	2.69	66	2.109	11	216	19.64	England

Phytomedicine	4.09	98	3.61	2	216	108.00	Germany
Indian Journal of Medical Research	1.09	72	1.508	9	212	23.56	India
Alternative Therapies in Health and Medicine	0.89	61	1.011	19	203	10.68	US
Indian Journal of Traditional Knowledge	0.84	24	1.061	49	194	3.96	India
Indian Drugs	0.07	30	NA	40	186	4.65	India
pharmacological research	5.27	118	5.57	1	180	180.00	England

A list of Highly Cites Journals all over the world in the field of Ayurveda research listed above. The total citation received, average citation per paper, and h-index value is given below in Table 3. The papers were graded according to the overall number of citations each publication earned. In declining order of several citations, the names have been organized, and the number of quotes has been reducing. In this study, 721 journals have been noted, and out of these, only 20 journals are shown in this table based on citations. Among the tiles Journal of Ethnopharmacology occupies the top total citation 1907 (30.73%) with 8th rank followed by as per the ACPP Pharmacological research journal got 1st rank with 180 citations, it has 180 ACPP citation count. The highest impact of 51.27 citations per paper was scored by the Journal of the American Medical Association, followed by Pharmacological Research 5.574. The Journal of the American Medical Association(JAMA)has the highest h-index of 622, followed by the Tetrahedronjournal (602). The research productivity was the largest from the United States and India each (6 papers), followed by Ireland, Japan, and Germany each (1 paper).

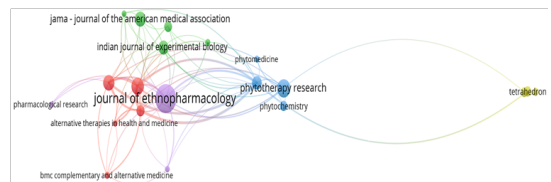


Fig. 1: Journals Citation Cluster Mapping

The citation mapping of source journals analyzed using VOS viewer (Fig.1), the minimum number of documents of a source has been set to one, and the minimum number of citations of the source was set to 171, there were 720 sources identified out of 20 source journals met the thresholds. There were five clusters formed for the graphical display. The journal of ethnopharmacology has the highest weightage on a total citation of 1907, with the document weight of 62. The journal physiotherapy research on the second-highest citation cluster formed with 949 citations with the document weight of 20. The journal of alternative and complementary medicine has a third highest citation cluster with an 835 citation with a document weight of 47. The Journal of American Medical Association (JAMA) and tetrahedron journal holds the fourth and fifth clusters.

Table 4: Top 20 Highly citations for productive Authors

Author	Institutions	TP	TC	Total Link	CPP	H-Index
Patwardhan. B	University of Pune, Pune, India	45	1447	111	32.16	34
Saper. R.B	Boston Medical Center, Boston, United States	7	776	56	110.86	18
Kales. S.N	Harvard School of Public Health, Boston, US	5	747	40	149.40	32
Davis R.B	Harvard School of Public Health, Boston, US	2	693	27	346.50	77
paquin J.	The United States Environmental Protection Agency, Washington, D.C., United States	2	693	27	346.50	2
Phillips R.S.	Flinders University, Adelaide, Australia	2	693	27	346.50	91
Yoshikawa.M	Kindai University, Higashiosaka, Japan	7	596	27	85.14	39
Mukherjee.P.K	Jadavpur University, Kolkata, India	17	537	13	31.59	44
Dev.S	Multi-Chem Research Centre, Vadodara, India	8	536	1	67.00	34

Govindarajan R.	National Botanical Research Institute, Lucknow, India	6	523	23	87.17	22
Pushpangadan.P	Amity Institute of Phytochemistry and Phytomedicine, Thiruvananthapuram, India	2	519	29	259.50	28
Matsuda.H	Kyoto Pharmaceutical University, Kyoto, Japan	3	481	19	160.33	73
Murakami.T	Kyoto Pharmaceutical University, Kyoto, Japan	2	471	16	235.50	48
Chopra.A	Center for Rheumatic Diseases, Pune, India	13	446	76	34.31	25
Naik.G.H	Bhabha Atomic Research Centre, Mumbai, India	3	442	11	147.33	8
Priyadarsini.K.I	Bhabha Atomic Research Centre, Mumbai, India	3	442	11	147.33	47
Burns.M.J	Beth Israel Deaconess Medical Center, Boston, United States	1	442	13	422.00	1
Eisenberg.D.M	Harvard School of Public Health, Boston, United States	1	442	13	422.00	55
Dahanukar.S.A	King Edward Memorial Hospital India, Mumbai, India	5	407	14	81.40	19
Thatte.U.M	Seth GS Medical College and KEM Hospital, Mumbai, India	5	407	14	81.40	22

In this table highly citations productive authors to draw the citation network of authors in Vos Viewer, the maximum number of authors per document has been considered fifty and the minimum number of published articles by authors has been considered one, Therefore from the total number of 4236 authors, a minimum number of citations of an author is 394 they have to meet these criteria, in the next step we have to choose top twenty authors with high citations.

Table-4 shows that the ranking of authors influenced in citations. The high citations authors are done according to their citations in decreasing order, during the period of the study, 6448 authors are contributed around the world to contribute 2038 papers in the research of Ayurveda. Generally, in this Table listed the top twenty prolific authors according to the number of citations they have made during 1923-2018.

It is clear from the study that Patwardhan.B has a first rank based on the total citations (n=1447) and highest total links (n=111), and he got 34 h- index. Saper. R.B got the second-highest citation score (n=776), Kales. S.N got third-highest citation score (n=747), Phillips R.S., Paquin J.and Davis R.B by

two articles with 693 citations and placed in the next level. Burns.M.J and Eisenberg.D.M got the first rank in the order of CPP with 422.

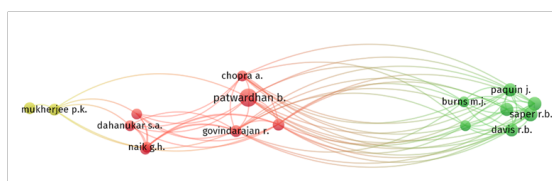


Fig. 2: Mapping of Author Citation

The author citation (Fig.2) mapping, maximum of 50 authors per document were considered in the Vos viewer, the minimum number of document of an author considered as one and the minimum number of citation of an author was considered 394 to get the top 20 highly ranked citation available authors out of 4236 total authors. There were four clusters created based on the VOS viewer mapping output. The author “Patwardhan b” has the highest citation with 1447 with total linkage strength of 111 with 45 documents in the first cluster, the second-highest citation was found with author “Saper r.b.” with 776 citations with the linkage weight of 10 and 7 documents, followed by author “Yoshikawa m.” with 596 citations and “Mukherjee p.k” with 537 citations to hold the third and fourth cluster leading.

Table 5: Citation wise Top 20 Countries in Ayurveda Research

Country	Total link strength	Documents	Citations	Avg. Citations
India	1178	1355	13578	10.02
United States	906	208	3747	18.01

Japan	114	39	946	24.26
United Kingdom	231	49	636	12.98
Germany	212	66	381	5.77
Italy	137	20	274	13.70
Australia	50	26	237	9.12
Canada	38	14	227	16.21
Malaysia	55	16	225	14.06
Sri Lanka	48	24	179	7.46
France	49	17	169	9.94
China	47	17	109	6.41
Netherlands	26	8	108	13.50
Bangladesh	55	25	75	3.00
Romania	13	3	68	22.67
Singapore	12	4	61	15.25
Switzerland	24	8	57	7.13
Hong Kong	6	5	40	8.00
Sciences	5	2	40	20.00
Cyprus	12	1	37	37.00

Table 5 reveals that the geographical distribution of contributions country-wise top twenty high citations. For avoiding a long list of up to 20 top citations, wise countries were considered in this study. India got (n=13578) citations and stood the first rank in the citation ranking followed by United States(n=3747) citations have received second-highest position. However, Cyprus (37%) got the first rank in the Avg citations with 1 document followed by Japan (24.26%). India got a highest total link strength (n=1178), highest document count (n=1355) and highest citations (n=13578) also however 12th rank in the Avg citations (n=10.02). The United States contributed 906 total link strength with the second-highest rank in the document count (n=208) citations (n=3747) and got 5th rank in the Avg citations.

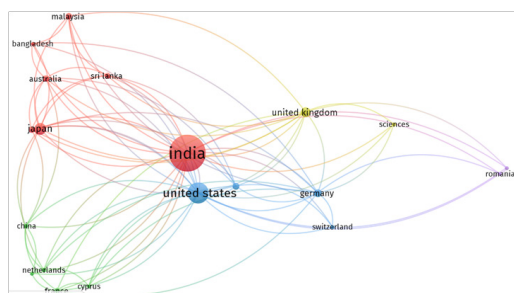


Fig. 3: Country-wise Citation Mapping

The country-wise citation mapping was analyzed and presented in Figure 3. The maximum number of countries per document was set to 50, the minimum number of documents of a country set to one and the minimum number of citations of a country were set to 38 to get the top 20 ranked highly citation countries documents out of total 95 countries. Five clusters were formed using these criteria. The first cluster with the lead of 13578 citations from India and holding 1355 documents with the weight linkages of 1178, the other co-cluster countries of Japan, Canada, Bangladesh, Australia, Srilanka, and Malaysia. The second leading countries are the United States with 3747 documents with the total linkages of 906 with 208 documents, and it has the co-cluster countries of Germany, Italy, and Switzerland. The third cluster with a lead of the United Kingdom with 636 citations with the 49 documents and 231 linkage weight. The other two clusters with the lead of China and Romania.

Table 6: Co-occurrence Author Keywords

Keywords	Total Strength Link	Document	Avg. Citations
Ayurveda	108	345	10.43
Hptlc	34	47	3.49

Ayurvedic Medicine	13	50	10.04
Ayurvedic Formulation	25	42	4.38
Standardization	30	40	3.90
Antioxidant	17	36	16.08
Ayurvedic	13	30	6.93
Medicinal Plants	20	25	10.40
Piperine	24	25	6.56
Traditional Medicine	27	25	23.48
India	19	24	5.17
Rasayana	26	24	31.75
Pharmacognosy	10	21	4.19
Triphala	16	21	39.24
Diabetes	13	20	7.15
HPLC	14	20	8.35
Rheumatoid Arthritis	12	16	14.13
Toxicity	9	15	8.87
Antioxidants	13	14	50.79
Quality Control	18	14	2.86

Table 6 examines the Co-occurrence Author Keywords. The findings of the study reveal that a large number of keyword terms are used in the Ayurvedic research, but in this table, we have to choose the top twenty keywords in this research. The term Ayurveda got 345 (10.43%) the first rank with the highest number of keyword terms and top Total strength link (n=108) used in the Ayurvedic research followed by Ayurvedic Medicine 50 (10.04%). The term Antioxidants (50.79%) got the first rank in the highest Avg citations, followed by the Triphala (39.24%).

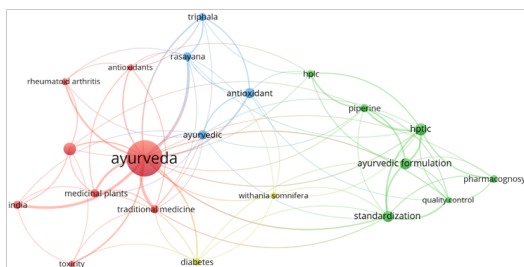


Fig. 4: Mapping of Citation based on Keyword

The keyword mapping based on highly cited documents were presented in figure 4, there were four

clusters formed, the keyword “Ayurveda” ranked first with 345 occurrences with the total link strength of 108 the co-cluster keywords were antioxidants, rheumatoid arthritis, ayurvedic medicine, medicinal plants, toxicity, traditional medicine, Rasayana and diabetes, this cluster was indicated in red color. The second highest cluster is “haptic” with 47 occurrences, and holding 34 total link strength, the co-clustered keywords are pipeline, quality control, standardization, ayurvedic, and HPLC, this cluster indicated in light green. The other two clusters were with “antioxidants and diabetes.

Findings

- The year 2012 shows the maximum number of total publication counts in the Ayurveda research, and the maximum number of citation count consists of the year 2016.
- Most of the articles were contributed by three and four authors; it occupies more than 17 % of the authors’ contribution to the total research output.
- It is clear from the study that Patwardhan.B has a first rank based on the total citations (n=1447) and highest total links (n=111), and he got 34 h-index.
- It is clear from the study that India got (n=13578) citations and stood the first rank in the citation ranking.
- It is clear from the study that keyword Ayurveda consists of the highest number of documents.

Conclusion

This citation analysis of Ayurveda’s research papers has revealed some interesting findings in India. There is rapid growth in Ayurveda research literature in the last ten years. One of the main reasons is Ayurveda is a system of medicine with historical roots in the Indian subcontinent. The study also showed that there is an increasing trend towards the publication count and citation count in this field

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Author Details

Dr. Manuelraj Peter, Assistant Professor & Head of Library Systems, Deanship of Library Affairs, Imam Abdulrahman Bin Faisal University, Dammam, Kingdom of Saudi Arabia

Dr. Mohamed Idhris, Assistant Professor, Central Library, Deanship of Library Affairs, Imam Abdulrahman Bin Faisal University, Dammam, Kingdom of Saudi Arabia, **Email ID:** lmidhris@gmail.com

Spurgeon Anandraj, Lecturer & Serials Control Librarian, Deanship of Library Affairs, Imam Abdulrahman Bin Faisal University, Dammam, Kingdom of Saudi Arabia