Bibliometric Evaluation of the South African Scientific Output Performance

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Abstract
This paper reports the preliminary findings on South Africa's highly productive authors, journals and research universities. The result shows that 4 of the most cited authors representing 40.80% of the total counted are; Bilic N (16.40), Michael JP (6.36), Sacht C (6.00), and Marques HM (4.60) and the majority belongs to chemistry department with 37.0% followed by Physics (26.0%), Medicine (7.40%) and Biology (7.40%). Out of the 18 journals indexed in JCR only SA J OF GEOLOGY had impact factor above one. The journal with the largest numbers of original papers was S AFR J SCI with 89 articles and 1397 total citations in 2003. The result of the appropriate statistical Pearson's correlation coefficient analysis also point toward that there are significant correlation between journal productivity and citation frequency, and between citation frequency and immediacy index with p-value <0.05.

1. Introduction

Bibliometrics offers a powerful set of methods and measures for studying the structure and process of scholarly communication. Citation analysis, the best known of bibliometric approaches, has become more sophisticated, and the advent of networked information technologies has led to quantitative and qualitative advances in other bibliometric methods (Christine, Borgman & Jonathan, 2002). Bibliometrics thus enable librarians to contribute to a detailed analysis of the research activities of the institution they belong to. This can be achieved by searches in bibliographic databases and subsequent assignment of the individual papers retrieved to scientific sub fields, followed by citation analysis including co-citation analysis and bibliographic coupling (Osareh, 1996)

The structural approach used in this paper identifies published works and then reviews citation patterns in the literature. This paper further reveals patterns relating to publishing activity by year for each and for total number of publications, comparative analysis among different fields of study, and most influential authors and cited works. It also tried to view and analyze journals according the impact factor, immediacy index and median impact factor. In our study, we have been analyzing seven main disciplinary fields within medicine, the natural &physical sciences and technology. However, fields within social sciences have been excluded.

2. Objectives

The following are the main objectives of the study:

- To identify highly productive authors, their contributions and categories
- To evaluate and identify the top South African journal performance based on their productivity
- To investigate if there is a significant relation ship among productivity, citation frequency, impact factor and cited half-life of South Africa main journals
- To compare the development of South African relative citation impact for most productive institutions

3. Methodology

The analysis presented in this paper has been accessed from Scientific articles published in journals processed online, CD-ROM and Web versions of the Science Citation Index (SCI), and South Africa studies databaes. All papers recorded in the annual volumes of the Science Citation Index (SCI) of the Institute for Scientific Information (ISI) and in the South Africa studies, as article, note, or reviews

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were taken into consideration for the period of 1994-2003. For each paper, the reference data was retrieved from ISI's Web of Science resulting in uniform format and journal abbreviations.

The data for citation frequency, Journal impact factors and cited half life are taken from the *Journal Citation Reports* (*JCR*), an ISI product published annually in two editions (science and social sciences) in print and on CD-ROM. Citations have been checked from database of SCI up to the period of June 2003 and identified highly cited journals, highly cited field and highly cited institutions. The impact analysis is restricted to citations received from ISI covered research papers. The relative citation scores are based on five-year citation windows and self-citations have been excluded.

In the NSI-data base one of the standard indicators is a 5-year citations indicator using overlapping periods. The data were analyzed using Microsoft excel and the SPSS statistical software package; Pearson's correlation coefficient was used to investigate the association among productivity, citation frequency, impact factor and cited half-life. A one-tailed test was used and it was carried out at the 95% and 99% level of confidence.

4. Findings and discussions

Most cited authors and works

The major area of bibliometric research uses various methods of citation analysis in order to establish relationships between authors and their work. As can be seen, Table 1, there were 27 authors during 2000-2003 each with at least 2 papers and 2 citations. Even though there were so many other scientists who published during the given period, only the top 27 South Africa authors who had been cited above the threshold (greater than or equal to 0.25 cited per paper) were selected. The total numbers of papers produced during the given period ranged between 2 and 34 respectively. Similarly, the number of citations counted varied from 2 to 210.

Table.1 Authors ranked according to citation per paper

Rank	Authors	No.Paper	No. Cited	Cited per paper	Rank	Authors	No. Paper	No. Cited	Cited per paper
1	Bilic N	5	82	16.4	15	Carlton-L	9	23	2.56
2	Michael JP	33	210	6.36	16	Myers TG	7	16	2.30
3	Sacht C	4	24	6.00	17	Munyaneza-F	2	4	2.00
4	Marques-HM	27	123	4.60	18	Chinake-CR	2	4	2.00
5	Gutzmer J	16	72	4.50	19	Koch-KR	15	28	1.90
6	Truesdale VW	2	9	4.50	20	Cortie-MB	14	25	1.79
7	Mace RL	8	35	4.40	21	Jacobs D	4	6	1.50
8	Smith VR	16	68	4.25	22	Darkwa	19	28	1.47
9	Bandoli-G	5	21	4.20	23	Laing M	15	15	1.00
10	McKenzie IF	27	99	3.70	24	Davidowitz B	3	3	1.00
11	Raubenheimer HG	34	118	3.50	25	Dominguez-CA	8	6	0.75
12	Rautenbach M	8	23	2.90	26	Engelbrecht-GD	5	2	0.40
13	Zunckel M	4	11	2.75	27	Lues JF	8	2	0.25
14	Burgess IJ	7	19	2.71					

The four most leading authors who have produced above 25 papers during the period of study, in order of ranking, were Raubenheimer HG (34) and Michael JP (33), Marques-HM (27), and McKenzie If (27). On the other hand, measuring authors' performance from citations received per paper, four of the most cited authors representing 40.80% of the total counted are; Bilic N (16.40), Michael JP (6.36), Sacht C (6.00), and Marques-HM (4.60). Followed by Gutzmer J, Truesdale VW and Mace RL, who received 4.50, 4.50 and 4.40 citations per paper respectively.

From the total number of citations (1076) received, 572 or 53.20% citations belong to Chemistry, 267or 24.80% belong to physics, 72 or 7.0% belong to Geology, and 68 or 6.30% belong to Plant science. All the other departments account below 5.00%. Farther analysis on authors-department indicated that out of the top 27 authors selected, the majority belongs to chemistry with 37.0% followed by Physics (26%), Medicine (7.40%) and Biology (7.40%). However, the number of top selected authors from the other departments' accounts 3.70% each.

Evaluating the performance of South African journals

Table 2 indicates the performance of South African journals. It is observed that the South African Medical Journal (SA MEDICAL J) ranks first with the total citations of 2061 from 62 articles. South African journal of science (S AFR J SCI) follows with 1397 citations from 89 papers.

Table 2. South African journals in JCR: 2003 indicators

Rank	Abbreviated Journal Title	Category	Total Articles	Total Cites	Impact Factor	Immediacy Index	Cited Half life
1	SA J OF GEOLOGY	Geology	6	438	1.021	0.333	7.7
2	SA MEDICAL J	Medicine	62	2061	0.989	0.532	>10.0
3	SA J OF SCIENCE	M.D sciences	89	1397	0.930	0.124	9.8
4	WATER SA	Water resource	69	490	0.600	0.174	7.2
5	AFRICAN ENTOMOL	Entomology	39	108	0.577	0.000	5.0
6	J OF VETERINARY RES.	Veterinary Sci	29	675	0.548	0.034	>10.0
7	SA J OF BOTANY	Plant sciences	49	445	0.462	0.469	10.0
8	AFRICAN ZOOLOGY	Zoology	37	39	0.393	0.027	9.6
9	SA J OF WILDLIFE	Zoology	19	232	0.341	0.000	>10.0
10	BOTHALIA	Plant sciences	15	286	0.281	0.067	>10.0
11	J VETERINARY ASSOC.	Veterinary Scie	16	380	0.265	0.000	>10.0
12	SA J OF CHEMISTRY	Chemistry	12	120	0.240	0.167	8.8
13	OSTRICH	Ornithology	-	321	0.187	-	>10.0
14	SA J OF ANIMAL SCI	Animal Sci.	17	163	0.143	0.059	9.6
15	SA J OF SURGERY	Surgery	17	128	0.119	0.000	9.9
16	J S AFR I MINING AND METALLOGY	Metallurgy	53	94	0.061	0.057	>10.0
17	SA J OF MARINE SCI	Marine Biol.	-	915	0	0.89	>10.0
18	AFRICAN J MARINE SC.	Marine Biol.	49	58	-	1.18	-
	TOTAL		578	8350			

Distribution of papers by journal impact shows that only one journal, SA J OF GEOLOGY, has an impact factor above one. Thirty three percent (33.30%) of the journals possess an impact factor ranging between 0.5 and 1.0 exclusively and the remaining 40% between 0.2 and 0.5. The rest, 16.70%, accounts for an impact factor below 0.2.

Based on the South Africa journals in JCR, Table 2, the following Pearson's correlation coefficient was used to investigate the association among productivity, citation frequency, impact factor and cited half-life of South Africa main journals. A one-tailed test was used and it was carried out at the 5% and 1% level of significance.

The test for the association between journal productivity and citation frequency yields Pearson's correlation coefficient of 0.610 with a P- value of 0.010; correlation coefficient of 0.768 with a P-value of 0.001 between citation frequency and impact factor; correlation coefficient of 0.596 with a P-value of 0.012 between citation frequency and immediate index and correlation coefficient 0.636 with a P-value of 0.007 between impact factor and immediate index. These results indicate that, for South Africa journals, with 95% confidence interval (P-value < 0.05), there is a significant correlation between journal productivity and citation frequency, and between citation frequency and immediate index.

Table 3. Pearson's correlation coefficient matrix (journal variables)

Correlations matrix	Total no. Articles	Total no. Cites	Impact Factor	Immediacy Index	Cited Half-life
Total Articles	1.000				
Total Cites	0.610*	1.000			
Impact Factor	0.435	0.768**	1.000		
Immediacy Index	0.319	0.596*	0.636**	1.000	
Cited Half-life	-0.012	0.114	-0.349	-0.205	1.000

* Correlation is significant at the p-value< 0.05 level (1-tailed)
** Correlation is significant at the p-value< 0.01 level (1-tailed)

Further analysis of the result demonstrated that there is no significant correlation at 95% confidence interval between citation frequency and cited half-life (p-value =0.349), between impact factor and cited half-life (p-value =0.111), between immediate index and cited half-life (p-value=0.241). The result also demonstrated that the correlation between journal productivity and cited half-life is not significant at 95 % confidence interval. This suggests that more productive journals usually publish papers with a higher quality in terms of citation frequency and impact factor. Besides these, more productive journals also tend to be aging slowly.

A relative comparison of the research institutions of South Africa

The trend analysis in Figure 1, depicted that the relative citation impact of both University of Pretoria (UP) and University of Witwatersrand (WITS) suffer from negative growth during the 9-year period. UP demonstrated further periods of decline. The UP's relative citations' share fell from 1.93 in 1994-1999 to less than 80% in 1999-2003(0.37) and the University of WITS' relative citation share decreased dramatically during the period by 49% from 1.42 in 1994-1998 to 0.73 in 1998-2002 and then started to increase by 16% in 1999-2003. However, there was not much fluctuation in the percentage share in relative citation impact of the University of Cape Town (UCT). University of Stellenbosch (STELL) marked the highest percentage increase during this period by 180% and this was followed by 22% increase in the University of Natal (UN). In addition, both universities showed a continuous increase in the relative citation impact from 1994 to 2003.

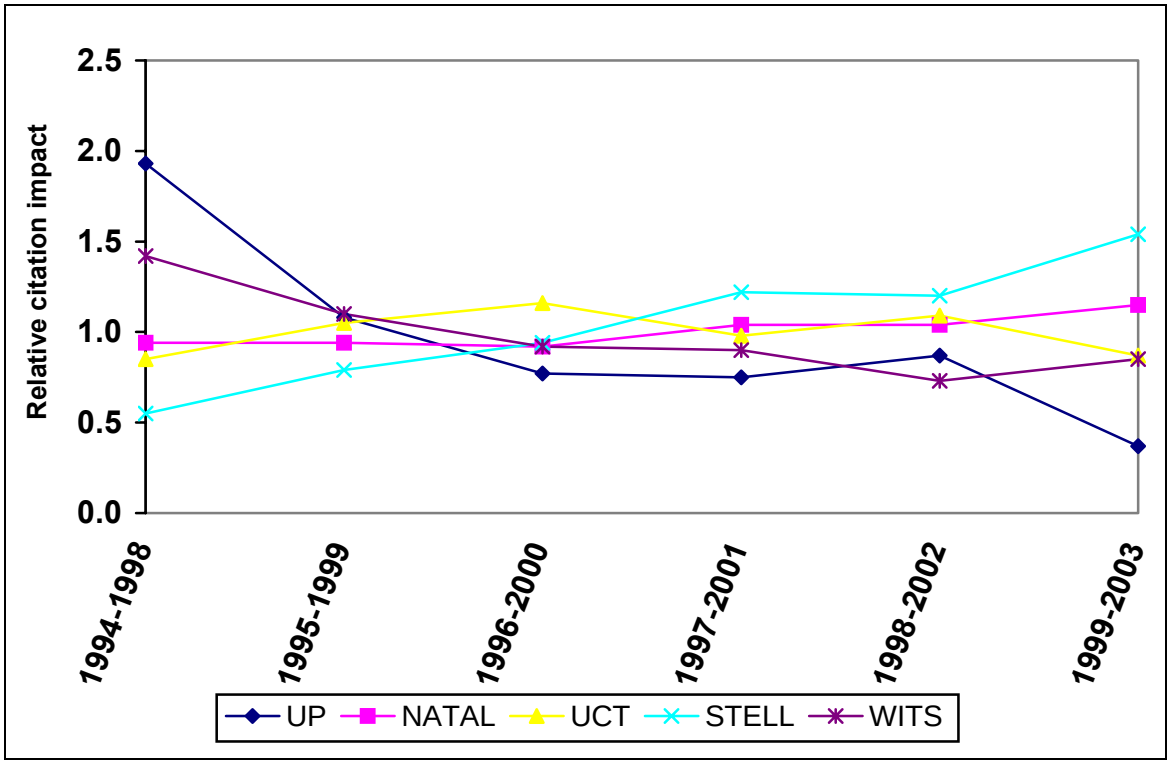

Figure1. Relative citations for most South Africa productive institution, 1994-2003

5. Conclusion

The Bibliometric analysis and the comparison of the productivity of the five research universities, in terms of their research output demonstrates the strengths and weaknesses of each university. University of Pretoria had the lead in publication for the last ten years followed by University of Cape Town. University of Pretoria is the largest university with student strength of 70,000 and the number of staff is more than double of that of other universities and hence its publications should also be much more than all other universities. But according to the ISI data this is not so. The main reason being most of the publications from UP are not in journals indexed by ISI. The universities need to inform their staff of the need for publishing in journals indexed by ISI.

This study also further revealed that out of the 18 journals indexed in JCR, only South African Journal of Geology (SA J OF GEOLOGY), had impact factor above one. Thirty percent of the journals acquire impact factor ranging between 0.5 and 1.0 exclusively and 40% between 0.2 and 0.5 These results are not satisfactory given that more than 40% of the journals in the JCR have an impact factor greater than one (Pouris, 2004). The association between productivity and citation frequency, and between citation frequency and immediacy index have been proved to be positive using the appropriate statistical Pearson's correlation coefficient at the p-value <0.05. In other words, journals with high productivity receive more citations and more cited journals attain high immediate index.

The activity of institutions against their relative citation impact for the time period 1994- 2003, point out that STELL and Natal marked the highest percentage increase by 180% and 22% respectively. Both the university of Pretoria (UP) and University of Witwatersrand (WITS) suffer from negative growth during the same 9-year period. However, the percentage increase or decrease of university of Cape Town (UCT) relative citation impact activity was not as conspicuous.

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