Web presence and impact of South African Universities: a Cybermetric study

O.B. Onyancha[1] and D.N. Ocholla[2]
Department of Library and Information Science
University of Zululand
KwaDlangezwa
South Africa
[1]b_onyancha@yahoo.com, [2]docholla@pan.uzulu.ac.za

Abstract

Use was made of Link Analysis to analyze South African universities according to several Web-based indicators, some of which include the number of pages, and the number of in and out-links. The study further examined external out-links so as to determine which institutions are targeted by South African universities. Also investigated were the links or connectivity between universities. Web Impact Factors (WIFs) were calculated and reported in order to compare the universities' web influence. Results indicate that South African universities have made remarkable progress in their web presence, which is at an advanced stage of development, and compares well with those found in developed countries. Noted that the World Wide Web (WWW) enables universities to: provide online library catalogues; announce the existence and promote the achievements of individuals, research groups, institutes and departments; disseminate findings, either by hosting online articles or by publishing summaries, data sets or tools; provide a platform for knowledge sharing of local content through the creation of institutional depositories; and provide scholars with a tool to evaluate universities. The authors observed that the evaluation of universities, which was previously limited to the use of bibliometric analyses (publications and citations analysis), expert review (peer-review), economic rate of return, case studies, surveys, analysis of competition for funds and retrospective analysis, can now also be conducted webometrically. The study concludes that South African Universities provide a sufficient platform for webometric evaluation. This study provides an agenda for further research involving web-related developments of African universities.

Keywords: Webometrics, link analysis, universities, South Africa

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[1] OB Onyancha is a PhD student at the University of Zululand and a Deputy Librarian at the University of Eastern Africa, Baraton, P.O. Box 2500 ELDORET – KENYA

[2] Dennis N. Ocholla is Professor and Head of the Department of Library and Information Science, University of Zululand

1. Introduction

The emergence of the Internet and the World Wide Web (WWW) has revolutionalized not only scholarly communication (although publishing on the WWW is yet to gain as much recognition as traditional scientific publishing) but also the manner in which institutions and individuals offer information concerning their services and products. Studies indicate that the Web is becoming a significant communication medium for science and scholarship (Cronin & McKim, 1996). Institutions of higher learning, and particularly universities, have embraced the WWW and its many features which enable the performance of activities such as: announcing the existence and promoting the achievements of individuals, research groups, institutes and departments; providing online library catalogues; disseminating findings, either by hosting online articles or by publishing summaries, data sets or tools (Noruzi, 2005). The aforementioned provides scholars with an additional tool with which they can and/or have used to evaluate universities. Thus, evaluation of universities, which was previously limited to the use of bibliometric analyses (publications and citations analysis), expert reviews (peer-reviews), the economic rate of return, case studies, surveys, the analysis of competition as regards funds and retrospective analysis, can also now be conducted webometrically.

Previous informetric studies that have made use of a wide range of indicators to rank institutions of higher learning (e.g. The Time's Higher Education Supplement [2005]; Institute of Higher Education, Shanghai Jiao Tong University [2004]; InternetLab, 2005) indicate that the visibility of African universities is insubstantial. African universities did not feature in the Times list's 200 top ranking universities and only the University of Cape Town, the University of Witwatersrand, the University of KwaZulu-Natal, and the University of Pretoria made an appearance in the top 500 of the Shanghai Jiao Tong University's list. This trend is repeated in a webometric ranking of world universities, conducted by InterLab, which lists the top African university (i.e. the University of Cape Town) at number 546. The absence or low ranking of African universities from/within world rankings has raised many concerns. Although many have queried the methods and criteria of evaluation, others' primary concern has been whether African Universities are ready for cybermetric studies, given the region's poor technological and economic conditions, which have led, to a large extent, to the ever increasing digital divide between African countries and the developed world.

2. Purpose of the study

This paper takes the form of an exploratory study that employs Link analysis to measure the performance of South African universities on the Web by examining their web presence and impact. The current study therefore seeks to examine the:
   • Number of universities in South Africa that have websites

- Number of web pages, in-links and out-links for each university's website
- External links that are targeted by South African Universities, thereby discovering the most popular external links/websites and the connectivity of the universities to the outside world
- Web influence of the universities' websites
- Web inter-connectivity between universities
- The Universities' coverage in key online indexing services (search engines) – i.e. Google and AltaVista

3. Conceptual framework

Cybermetrics (or cyber-metrics) and webometrics (or webmetrics or web-metrics) are fairly recent metric terms that have come to be commonly associated with several methodologies and tools meant to assist in understanding the dynamics of disciplines, developing policy, and justifying research funding (Noruzi, 2005). Although it has been argued that both cybermetrics and webometrics deal with the production, retrieval, and use of Internet information resources, there still exists confusion regarding their differences, or respective definitions. More often than not, the two terms are used interchangeably. Björneborn (in Björneborn & Ingwersen, 2004:1217) has defined Webometrics as "*the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the Web drawing on bibliometric and informetric approaches*". Webometrics is therefore, simply put, the application of bibliometric methods to the WWW. In essence, therefore, webometrics is restricted to the study of patterns of information production, storage, seeking, retrieval, dissemination and use in the WWW. The WWW, in this case, is the Internet component that utilizes text, images, sound, video and file transfers in order to provide information accessed through billions of web pages from around the world. The study of web information, using informetric approaches, is what is termed webometrics. Some aspects of the internet, such as the emails, listservs, forums, usenet news, infranet, intranet, etc, are not covered under webometrics, but incorporated in cybermetrics. Cybermetrics is defined by Björneborn (as cited in Björneborn & Ingwersen, 2004:1217) as "*the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the whole Internet drawing on bibliometric and informetric approaches*". Thus, Cybermetrics encompasses all webometric studies and includes the statistical studies of "*discussion groups, mailing lists, and other computer-mediated communication on the Internet*" (Björneborn & Ingwersen, 2004:1217).

Webometrics draws most of its approaches from bibliometrics, a generic term that was coined by Pritchard in 1969. Bibliometrics is defined as the "*application of mathematical and statistical methods to books and other media of communication*" (Pritchard in Hertzel, 1987:153; Ikpaahindi, 1985:163) and consists of several methods broadly classified into two categories, namely, publications count and citation analysis (see Onyancha & Ocholla, 2004). Publications count involves the study of the "*number of publications in a given*

field, or productivity of literature in the field for the purpose of comparing the amount of research in different countries, the amount produced during different periods, or the amount produced in different subdivisions of the field" (Stevens, as cited in Hertzel, 1987:156), accomplished through counting documents such as papers, books, and other writings. Citations analysis is used to study the "*literature used by research workers in a given field ... [by] counting the references cited by a large number of research workers in their papers*" (Stevens, as cited in Hertzel, 1987:156). It is this latter bibliometric/infometric approach that is analogous with one of the most commonly used webometric techniques, known as link analysis. Just as in citation analysis, link analysis is used to study the quality and relevance of a set of links pointing to a given site. The technique was developed in order to determine: which pages in a given collection are important to users; which pages enjoy the most popularity; what a page is all about; and whether a page deserves a ranking boost.

The application of bibliometric/informetric approaches by library and information scientists to web related studies is growing increasingly common. A number of studies have applied publications count and citation analysis techniques whilst studying patterns of web information production, organization, storage, retrieval and use, as well as the influence of websites on each other. These studies have led to the establishment of webometrics as a viable area of research in Library and Information Science (LIS). Examples of LIS-related webometric studies include Björneborn (2004), Björneborn & Ingwersen 2004), Candan & Li (2002), Ingwersen (1998), Jana & Chatterjee (2004), Thelwall (2002a, 2002b, 2003), and Vaughan & Hysen (2002), to name a few. University Websites have been largely evaluated using Link analysis in order to: measure their web impact factors (Thelwall, 2002a); find the most important web pages (Thelwall, 2003); identify link relationships between universities (Thelwall, 2002b; 2002c); classify link types in academic environments on the Web (Bar-Ilan, 2005); and to rank universities (InterLab, 2005).

One of the major parameters used to rank universities on the Web is the Web Impact Factor (WIF). The WIF is analogous to the Citation Impact Factor (CIF) proposed by Eugene Garfield of the Thomson Scientific (formerly the Institute for Scientific Information) in 1969. The CIF is defined as an average number of citations in a given year of articles published in a journal in the preceding two years. The ratio is obtained through dividing citations received in one year by papers published in the two previous years (Garfield, 1996:411). Ingwersen (1998) introduced and defined the WIF as the number of external pages (i.e. pages in other sites or Top Level Domains [TLDs]) with links to the given site (or TLD) divided by the number of web pages at the site (or TLD). The measurement of the WIF was initially problematic due to what Bjorneborn (2004:28) refers to as "*the fluctuating performance of AltaVista*" which "*yielded problematic variations in the calculated WIF measures*" in a study that was conducted by Ingwersen in 1998. Since then, many scholars (e.g. Thelwall, 2002a, 2002b, 2002c, 2003) have developed WIFs using different tools and approaches, thus making the

measure a popular evaluative and ranking tool of universities and other institutions on the Web.

4. Methodology

The study investigated South African institutions of higher learning according to website ownership. The recently completed merger of institutions of higher learning resulted in the creation of 21 universities, all of which were selected for this study. The list of the studied universities in each country is provided in Table 1. Sources of data include:

- Catalogue of world universities (http://www.webometrics.info/university_by_country_select.asp.htm)
- Canada's University and College Information Center (http://www.canadian-universities.net/index.html)
- International Network for Higher Education in Africa (2003). (http://www.bc.edu/bc_org/avp/soe/cihe/inhea/index.htm)
- Study in South Africa (http://www.studysa.co.za/index.php)

Using Link Analysis this study crawled through and analyzed South African universities' websites based on several Web-based indicators, some of which include the number of pages, number of out-links (page out-links, directory out-links, domain out-links, and site out-links) and the number of in-links (page in-links, directory in-links, domain in-links, and site in-links). Two approaches were used for data collection. SocSciBot software and SocSciBot tools were respectively used to crawl the university websites and analyze the collected data.. The crawled pages were limited to those without question marks, as in some cases these pages are repeated, and thus crawling them would have been an endless task. Data collection was conducted within the same month (April 2006) in order to limit errors associated with frequent website updates. As a way of triangulation, AltaVista and Google, two top ranked search engines, were used for comparison purposes, especially as regards the number of pages, in-links, and the WIF. The following uniform search strategy was used:

1.   The total number of pages linking to the website
     Example (AltaVista): *linkdomain:anu.ac.ke/* OR linkdomain:*www.anu.ac.ke/*
     Example (Google): *link:www.anu.ac.ke/*

2.   The total number of pages at the website
     Example (AltaVista): *domain:anu.ac.ke/* OR *domain:www.anu.ac.ke/*
     Example (Google): *site:anu.ac.ke/* OR *site:www.anu.ac.ke/*

We also examined external links to determine the most common types of institutions and Top Level Domains (TLD) targeted by South African universities. We employed the Citation Impact Factor analogy to calculate the universities' Web Impact Factors (WIFs) in order to compare the universities' web influences. The following formula was used to calculate the WIFs:

$$WIF = \frac{The\ total\ number\ of\ pages\ linking\ to\ the\ web\ site}{The\ number\ of\ pages\ at\ the\ web\ site}$$

Visualization networks illustrating the inter-connectivity of universities were provided using Pajek software.

Table 1: List of South African Universities with the corresponding website addresses

No.	University	Website address
1	Cape Peninsula Univ. Tech	www.cput.ac.za
2	Central Univ. Tech	www.cut.ac.za
3	Durban University of Tech	www.dit.ac.za
4	N. Mandela Metropolitan Univ	www.nmmu.ac.za
5	Rhodes Univ.	www.ru.ac.za
6	Stellenbosch Univ.	www.sun.ac.za
7	Tshwane Univ. of Technology	www.tut.ac.za
8	University. Of Cape Town	www.uct.ac.za
9	Univ. of Fort Hare	www.ufh.ac.za
10	Univ. of Johannesburg	www.uj.ac.za
11	Univ. of KwaZulu Natal	www.ukzn.ac.za
12	Univ. of South Africa	www.unisa.ac.za
13	Univ. of Venda	www.univen.ac.za
14	Univ. of the North	www.unorth.ac.za
15	Univ. of the Free State	www.uovs.ac.za
16	Univ. of Pretoria	www.up.ac.za
17	Univ. of Western Cape	www.uwc.ac.za
18	Univ. of Zululand	www.uzulu.ac.za
19	Vaal Univversity of Tech	www.vut.ac.za
20	Univ. of Witwatersrand	www.wits.ac.za
21	Walter Sisulu Univ. Tech&Sci	www.wsu.ac.za

5. Results and discussion

This section provides and discusses the results under five sub-headings, notably:
- Number of pages and out-links
- Web influence of South African universities
- University visualization networks
- Number of in- and out-links amongst universities in South Africa
- Targeted external websites or links

5.1 Number of pages and out-links

Table 1 provides the total number of pages and out-links (links from the Universities' pages) as crawled by SocSciBot. The University of Cape Town produced 119,454 pages and 1,118,132 out-links followed by the University of Pretoria (111,496; 1,551,541) and Rhodes University (61,418; 2,403,463).

Table 2: South African universities: ranked by number of pages

No.	Site	Pages	Out-links	No. of out-links per page
1	www.uct.ac.za	119454	1180132	9.8794
2	www.up.ac.za	111496	1551541	13.9157
3	www.ru.ac.za	61418	2403463	39.1329
4	www.wits.ac.za	41408	397374	9.5966
5	www.sun.ac.za	32491	169535	5.2179
6	www.ukzn.ac.za	5691	25619	4.5017
7	www.uwc.ac.za	5272	19242	3.6498
8	www.ufh.ac.za	836	12344	14.7656
9	www.cput.ac.za	628	11058	17.6083
10	www.uovs.ac.za	436	14841	34.0390
11	www.univen.ac.za	305	1725	5.6557
12	www.cut.ac.za	136	1842	13.5441
13	www.dit.ac.za	106	818	7.7170
14	www.wsu.ac.za	98	1286	13.1224
15	www.tut.ac.za	62	159	2.5645
16	www.unisa.ac.za	58	144	2.4828
17	**www.uzulu.ac.za**	**45**	**424**	**9.4222**
18	www.uj.ac.za	24	170	7.0833
19	www.vut.ac.za	15	115	7.6667
20	www.unorth.ac.za	15	44	2.9333
21	www.nmmu.ac.za	2	18	9.0000

5.2 Web Influence of South African universities

Table 2 ranks the universities according to the number of web pages, links to the websites and WIFs in both AltaVista and Google search engines. The top ranked universities are, in descending order, the University of Witwatersrand, the University of Cape Town, the University of South Africa and the University of Pretoria. None of the universities appeared to rank constantly throughout the variables, i.e. number of web pages, links to the websites and WIFs. For instance, the University of Witwatersrand ranked fifth in the number of web pages in both search engines as well as in Google's links to the website, and twenty in Google's WIF, whilst ranking second and twelfth in AltaVista's links to the website and WIF respectively. It is worth noting that the results yielded with

reference to the number of pages in Table 1 and Appendix A for most of the universities are different. Even within Appendix A, AltaVista yielded different results to those of Google. In the first instance, the approaches used to download data presented in Table 1 and Appendix A were different. Appendix A contains all web pages as indexed in AltaVista and Google, whilst Table 1 consists of web pages whose links did not contain question marks. The differences between AltaVista's and Google's coverage can be attributed to differences in indexing. Previous studies have demonstrated that search engine overlaps with regard to web coverage are small (Lawrence & Giles, 1999 and Bar-Ilan, in Thelwall, 2004) therefore meaning that whatever is indexed in one search engine may not necessarily be covered in another. Thelwall (n.d.) observes that Google only reports a fraction of links that Google is aware of (approx. 10%) which may explain why Google produced less links to African universities than AltaVista. Table 2 also shows that most of the universities recorded high impact factors:- a situation that may be attributed to the inclusion of self-links. High impact factors were particularly recorded by universities with fewer web pages and a high pattern of in-links.

Table 3: Rank distribution of South African Universities by number of web pages, links to websites and WIF in AltaVista and Google search engines

No.	Rank	University	AltaVista			Google		
			Web Pages	Links to Website (Total)	WIF	Web Pages	Links to Website (Total)	WIF
1	1	www.wits.ac.za	5	2	5	5	5	11
2	2	www.uct.ac.za	3	1	13	9	2	9
3	3	www.unisa.ac.za	7	7	11	2	1	11
4	4	www.up.ac.za	1	3	19	3	3	11
5	5	www.ru.ac.za	4	4	15	4	4	11
6	6	www.uovs.ac.za	9	9	6	1	8	12
7	7	www.sun.ac.za	2	5	20	7	6	11
8	8	www.ukzn.ac.za	8	8	8	10	9	10
9	9	www.uwc.ac.za	6	6	17	8	7	11
10	10	www.uj.ac.za	11	11	16	13	11	2
11	11	www.ufh.ac.za	17	14	4	12	12	6
12	12	www.nmmu.ac.za	14	12	7	6	17	12
13	13	www.unorth.ac.za	12	10	12	17	20	4
14	13	www.univen.ac.za	19	18	3	15	15	5
15	13	www.tut.ac.za	15	16	14	10	10	10
16	14	www.cut.ac.za	16	17	9	14	13	8
17	15	www.cput.ac.za	18	19	10	16	14	1
18	16	www.vut.ac.za	21	21	1	11	16	11
19	17	www.dit.ac.za	13	15	18	18	18	3
20	17	www.uzulu.ac.za	10	13	21	15	19	7
21	18	www.wsu.ac.za	20	20	2	19	21	8

5.3   Universities' networks

Figures 1, 2 and 3 are visual maps illustrating links between the universities in South Africa. Figure 1 provides site links, while Figures 2 and 3 show the directory and page inter-linkages, respectively. Figure 1 shows that all of the 21 South African universities appeared in the network map. In terms of results, the University of Western Cape (UWC) provided links to the highest number of universities (16 or 76.2%) followed by Stellenbosh University, Rhodes University and the University of Pretoria which posted 15 (71.4%). Others included the University of Cape Town (UCT) and University of Witwatersrand, each of which provided links to 14 (66.7%) universities. This pattern is well illustrated in Table 4. Generally, Universities in South Africa appear to have a fairly well developed network.
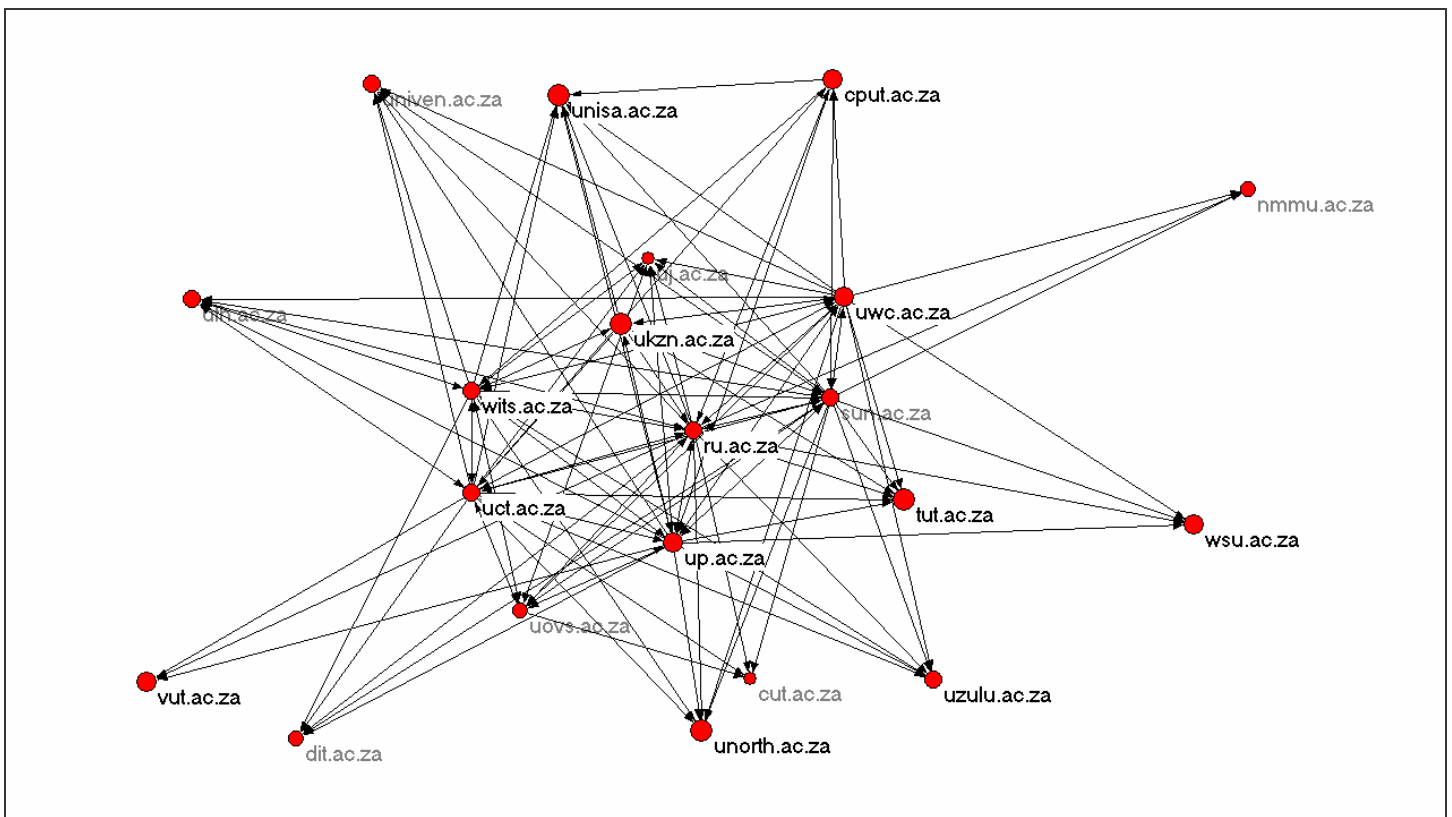
Figure 1: University inter-linkages: site links
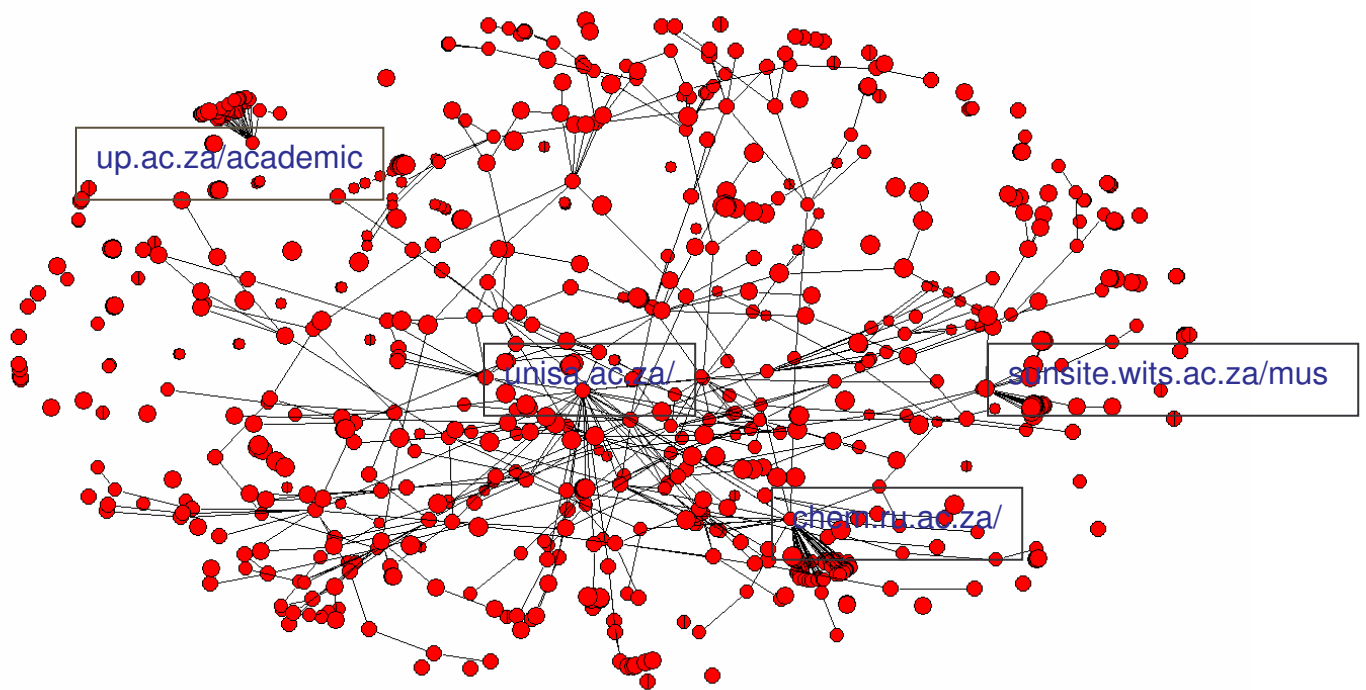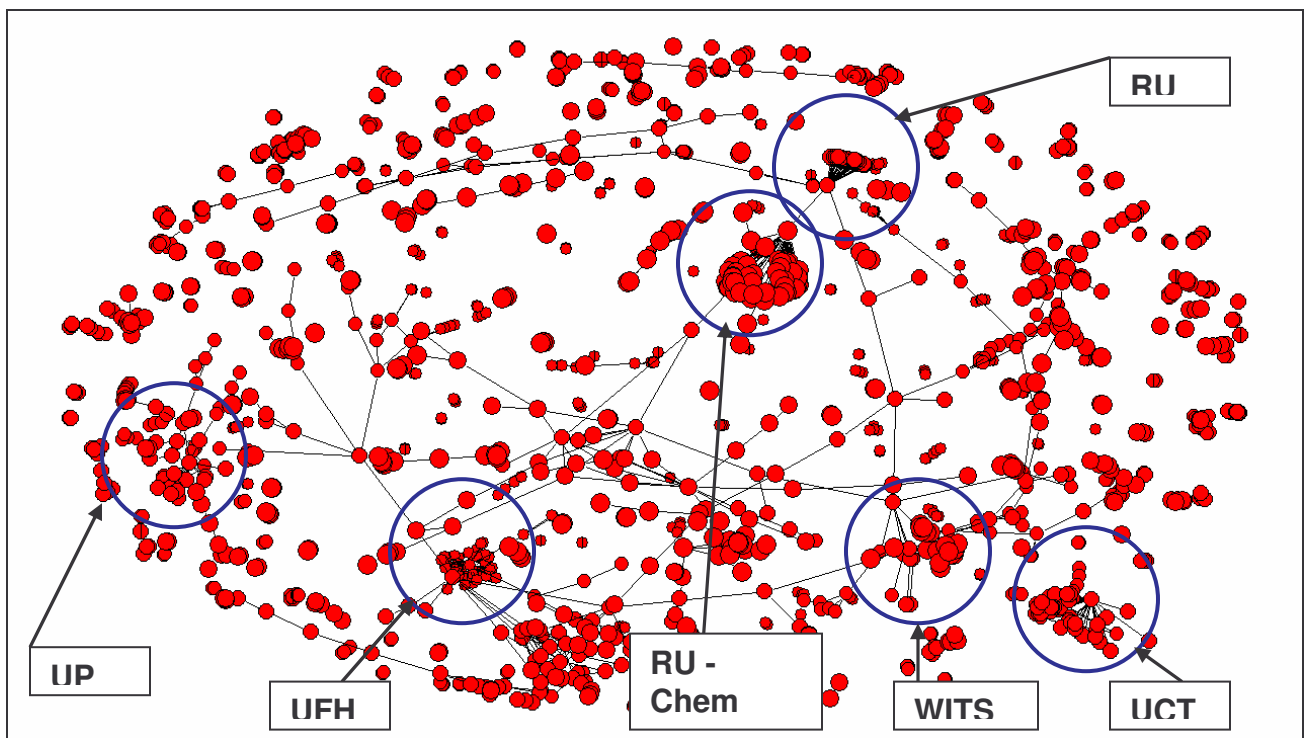
Figure 2: University networks: directory links

up.ac.za/academic

unisa.ac.za/

sunsite.wits.ac.za/mus

chem.ru.ac.za/

Figure 3: University networks: page links

RU

UP

UFH

RU - Chem

WITS

UCT

As regards the directory and page links, there were a total of 967 pages and 1588 directories that were mapped in Figures 2 and 3. Of these, the UCT was the most productive, having received 357 and 245 page in-links, respectively while it provided 218 and 193 page and directory out-links, respectively, to other universities. Further, Fig 3 reveals the key players in each large network. These universities include RU, UCT, WITS, UFH and UP. A description of the performance patterns of each university in terms of page, directory, domain and site in-links and out-links is given in Table 4.

Table 4: In- and out-links among South African Universities: ranked by number of page in-links

	Page Inlinks	Directory Inlinks	Domain Inlinks	Site inlinks	Page Outlinks	Directory Outlinks	Domain Outlinks	Site Outlinks
www.uct.ac.za	357	245	101	8	218	193	88	14
www.sun.ac.za	247	206	68	7	179	150	77	15
www.ru.ac.za	228	130	64	9	97	74	45	15
www.unisa.ac.za	147	107	35	8	0	0	0	0
www.uovs.ac.za	114	91	33	7	6	5	5	5
www.up.ac.za	109	53	17	2	273	232	68	15
www.ukzn.ac.za	43	30	15	7	16	14	12	5
www.unorth.ac.za	33	27	17	6	0	0	0	0
www.uzulu.ac.za	30	29	17	6	0	0	0	0
www.ufh.ac.za	25	24	14	6	49	13	12	2
www.uj.ac.za	19	14	14	7	2	2	2	2
www.cput.ac.za	18	12	7	4	48	4	4	3
www.tut.ac.za	17	11	7	6	0	0	0	0
www.uwc.ac.za	15	14	7	1	106	54	28	16
www.dit.ac.za	12	10	9	5	0	0	0	0
www.univen.ac.za	12	12	6	3	0	0	0	0
www.cut.ac.za	11	10	5	4	0	0	0	0
www.wsu.ac.za	11	5	4	4	0	0	0	0
www.nmmu.ac.za	9	4	4	3	0	0	0	0
www.vut.ac.za	6	4	3	3	0	0	0	0
www.wits.ac.za	0	0	0	0	469	297	106	14

5.4 In- and out-links among universities in South Africa

Table 4 provides the number of in- and out-links between universities in South Africa. The Table demonstrates that UCT received the highest number of page in-links (357), directory in-links (245), and domain in-links (101) whilst receiving 8 site in-links from other Southern African universities. Overall, South African universities have performed better in providing links to each other, as shown in Fig 1 and Tables 4. The second ranked university in terms of page in-links is Stellenbosch University, which posted 247 pages followed by Rhodes University (228), the University of South Africa (147), the University of the Free State (114), and the University of Pretoria (109). Other universities received less than 50 page in-links each. The highest page out-links were recorded by Wits University

which produced 469 page out-links followed by UP (273), UCT (218), SUN (179), and UWC (106).

5.5 Targeted external websites and/or links

Table 5 provides a list of the top 15 most targeted TLD links by South African universities. The highest ranking TLD domains include: informationweek.com (magazine published in the U.S. that offers news, features and events for technology professionals); java.sun.com (website that offers information on Java programing); boingboing.net (a blog whose main themes include technology, futurism, science fiction, gadgets, intellectual property, and political issues; and forbes.com (American business and financial magazine founded in 1917 by B.C. Forbes).

Table 5: Most commonly targeted TLD domains by South African Universities

No.	External TLD	No. of links	No. of links
1	informationweek.com/	38495	338
2	java.sun.com/cgi-bin/	21113	68
3	.boingboing.net/	17707	63
4	.forbes.com/bow	17707	62
5	.heavens-above.com/	17706	34
6	.hypermail.org/	11405	27
7	root.cern.ch/	7232	13
8	gallery.sourceforge.net	2111	10
9	.digitaldutch.com/	1491	9
10	validator.w3.org/	1330	9
11	jigsaw.w3.org/	1148	8
12	plone.org	842	8
13	.section508.gov	842	7
14	.w3.org/WAI/	841	7
15	plone.org/	840	7

6. Conclusions and recommendations

A significant observation that has previously been made is that Web-based tools are rarely used within South African universities (Blewett & Singh, 2002), perhaps because African universities, in general, have embraced the Internet and its features fairly recently. Consequently, their websites are still relatively new. This late launch into cyberspace could be attributable to the African governments' lack of active involvement in web development (Chisenga, 2004).

Nevertheless, it was noted in this study that all universities do have own websites.

The total number of pages produced by SocSciBot and the two search engines differed significantly as shown in Table 1 and Appendix A. Even within Appendix A, AltaVista yielded different results to those of Google. In the first instance, the approach that was used to download data presented in Table 1 was different from the one used for extracting data presented in Appendix A. Appendix A contains all web pages as indexed in AltaVista and Google, while Table 1 consists of only the web pages whose links did not contain question marks. The differences between AltaVista's and Google's coverage may be attributed to differences in indexing. Previous studies have shown that search engine overlaps of web coverage are small (Lawrence & Giles, 1999 and Bar-Ilan, in Thelwall, 2004), therefore meaning that whatever is indexed in one search engine may not necessarily be covered in another. In addition, Thelwall (n.d.) observes that Google only reports a fraction of links that Google is aware of (approx. 10%) which may explain why Google produced less links to African universities than AltaVista.

There were a total of 379996 university webpages and 5791894 outlinks, producing an average score of 15.2 links per page. An analysis of each university's mean number of pages, using AltaVista and Google, showed that there were a total of 55,090 pages per university. As a result South African universities seem to have made remarkable progress in developing their websites which are at an advanced stage and can be compared to those of their counterparts in the developed countries, e.g. Spain, Australia, the UK, Taiwan and New Zealand which recorded 33187, 71749, 49000, 46754 and 39393 pages respectively per university between 2001 and 2002 (Thelwall, 2004).

Impact-wise, the universities recorded an impact factor of 0.61. When compared to universities in other African countries such as Kenya (see Onyancha & Ocholla, 2006), South African universities' web influence is low, a situation that may have been caused by the few pages and several inlinks (including selflinks) that Kenyan universities yielded. This perhaps explains why using the impact factor as a means of ranking, evaluating or assessing individuals, institutions and countries is problematic. WIF usage with other measures such as the number of pages, number of links, website size, etc may yield better rank results as illustrated in this study.

It was observed that the most commonly targeted external links were largely news sites (especially magazines and newspapers on computers/computing and technology), freeware downloadable, and electronic databases. The first two's high ranking could be attributable to the persons responsible for creating links on the universities' websites. Usually, these people are computer scientists or information technologists. Links to electronic databases such as EBSCO and EMERALD may have originated from the university libraries' websites.

A 'content divide' was noted between South African universities' websites. It was noted that historically advantaged universities' (HAUs) web performance in terms of the number of web pages, content, out-links and in-links, was better than historically disadvantaged universities (HDUs), perhaps due to privileges the former category enjoyed during the apartheid era (Jacobs, 2000) and their subsequent growth following the 'Matthew's' principle. Nevertheless, links between South African universities were manifest. The universities exhibited fairly strong linkages/patterns. Seemingly, the broad social gap between the HAUs and the HDUs that existed in the apartheid era is slowly being narrowed.

In conclusion, given that Webometric studies are usually based on Web-based indicators, which in turn largely depend on how well a Web site of an institution is developed and visible, it is our view that some universities in Africa may not qualify for comparative webometric studies, especially for ranking purposes, due to underdeveloped websites. Similarly, universities operate under different economic, political and social conditions and unless these aspects are taken into consideration, comparative webometric studies meant to rank universities on the basis of quality may be subjected to unprecedented criticism. Worth noting as well is that the size of an institution may also influence the quantity of web pages. Nevertheless, African institutions of higher learning have developed web sites which, in our view, should be periodically evaluated. Although weblinks have been used for ranking universities, studies have emphasized that given the constraints of web-link methods, caution should be taken when applying these indicators to rankings. Emphasis on the benefits of weblink studies such as enabling visibility should be viewed as stronger reasons demonstrating why such webometric studies are vital. It should be appreciated however that there is no method that is perfect and reasonably objective.

For African universities to compete favorably with the rest of the world and do better than they are currently performing on the Web there is an urgent need to invest in information technology and to popularize the Web within institutions, whilst engaging the services of qualified webmasters in the design and construction of their websites. Other specific measures to be taken include: to formulate minimum web development standards, revisit their link development and codification policies so as to increase links for visibility, and placing/locating institutions' products on the web through such tools as Open Access and institutional repositories. Similarly, ICT policies with adequate web development guidelines are critical. We believe that these factors would, among others, assist in improving web development, bridging both the digital and content divide between African universities' websites and those of universities elsewhere and give the universities better visibility.

There are unresolved issues that could make an agenda for future research. Among them are:
1. To find out the types and nature of the links

2. To use other online indexing services so as to compare coverage and visibility of African universities
3. To compare findings from webometric studies with those generated from other performance indicators (e.g. publication count and citation analysis)
4. To broaden the area of study to include all African universities/countries
5. To employ other web performance measurements (e.g. relevance, link relationships, rankings, visibility, etc.)
6. To establish reasons for sitations (links)
7. To explore both institutional and national ICT policies in the region with a view to finding out their formulation/creation and implementation and the bearing they may be having on web development.

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Appendix A

No.	Rank	University	AltaVista			Google		
			Web Pages	Links to Website (Total)	WIF	Web Pages	Links to Website (Total)	WIF
1	1	www.wits.ac.za	93200	134000	1.44	75500	701	0.01
2	2	www.uct.ac.za	209000	148000	0.71	29400	1640	0.06
3	3	www.unisa.ac.za	30800	24000	0.78	180000	2130	0.01
4	4	www.up.ac.za	288000	122000	0.42	120000	830	0.01
5	5	www.ru.ac.za	157000	104000	0.66	77200	811	0.01
6	6	www.uovs.ac.za	11400	14000	1.23	195000	334	0.00
7	7	www.sun.ac.za	242000	89000	0.37	35200	483	0.01
8	8	www.ukzn.ac.za	14600	14300	0.98	13500	302	0.02
9	9	www.uwc.ac.za	90800	46400	0.51	34300	343	0.01
10	10	www.uj.ac.za	3720	2310	0.62	688	239	0.35
11	11	www.ufh.ac.za	641	1200	1.87	800	132	0.17
12	12	www.nmmu.ac.za	1570	1910	1.22	47700	61	0.00
13	13	www.univen.ac.za	283	552	1.95	334	72	0.22
14	13	www.unorth.ac.za	3140	2400	0.76	176	46	0.26
15	13	www.tut.ac.za	1270	857	0.67	13500	284	0.02
16	14	www.cut.ac.za	783	735	0.94	553	85	0.15
17	15	www.cput.ac.za	640	531	0.83	202	80	0.40
18	16	www.vut.ac.za	97	267	2.75	9530	66	0.01
19	17	www.dit.ac.za	2130	1070	0.50	163	56	0.34
20	17	www.uzulu.ac.za	5700	1300	0.23	334	53	0.16
21	18	www.wsu.ac.za	112	305	2.72	126	19	0.15