Web link analysis of interrelationship between top ten African universities and world universities

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Data for the exploratory study on web link analysis were extracted using the AltaVista search engine. A sample of 2395 links was selected using proportional-to-size sampling technique while individual link was selected using systematic sampling. The data were analysed using the frequency and percentage distributions. The results of the analyses showed that 73.7% of the links were from the Top Ten African Universities to the Top Ten World Universities; whereas these Ten African Universities received only 26.3% inlinks from the Top Ten World Universities. It was also found that most of the outlinks from the Top Ten African Universities were to Massachusetts Institute of Technology (27.3%) while the highest number of inlinks were from Stanford University (21.8%). The study concludes that African universities showed more interest in linking to the world class universities; a trend that was not reciprocated by the world universities. The low level of links received by the African universities was probably due to the fact that African universities in general have only recently embraced the many features of the World Wide Web. It is recommended that African universities should improve their presence on the web and incorporate ranking in their web relationship with other universities which should significantly be tailored to benefits that could be received from academic activities.

Introduction

The World Wide Web (WWW) was born primarily to ease knowledge dissemination among academic institutions. Expectedly, it constitutes one of the available avenues for universities to source and provide information for purposes ranging from advertisement of their academic activities, admission processing, information dissemination to staff and students, teaching and research. Previous studies have however shown that African universities are poorly represented on the WWW. For example, Onyancha and Ocholla reported that 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 was repeated in a webometric ranking of world universities, conducted by InterLab, which listed the top African university (i.e. the University of Cape Town) at number 546.

Ranking has become unavoidable, and they will remain part of the academic life. General ideas about the international reputation and position of universities will continue to be influenced considerably by ranking. Largely, webometric indicators address issues such as web links, web visibility and impact in terms of the number of external links received by a host level domain. These indicators have been applied to several university web studies in the developed countries, and developing countries like India where they have been used to assess the productivity of researchers and their institutions and establish relationship among various universities.

Noteworthy is the observation that a few web link studies in Africa, for instance Nwagwu and Agarin and Onyancha and Ocholla have also investigated inter-university web connectivity among African universities. The former reported that web sites of Nigerian universities do not interlink and the latter showed that while few inter-university connectivity was observed in the web sites of universities in Kenya, universities in South Africa have fairly developed networks among themselves. Findings from the study also revealed that all the links between Kenyan and South African universities emanated
from the latter. In view of the literature available on web links, this study established the need to investigate inter-university web connectivity among African Universities and the top World universities ranked webometrically.

Hence, the chief aspect of this study is to assess whether there is any web relationship among African universities and the top world universities and evaluate the relationship vis-à-vis the ranking of these universities. This evaluation is imperative in view of the fact that counting web links between institutions has been described as a useful exercise in identifying patterns of international recognition of one institution by another and determining information flow. In addition to this is the notion that rankings of universities serve as a means of comparing academic institutions, thus creating a positive competition between them. Evidence from research showed that there is a relationship between link count to universities and their rankings. Universities with higher average peer-review ratings attracted more links per faculty member to their web sites in the UK and New Zealand. A similar relationship was found for Australian universities, using a government calculation for research funding.

**Literature review**

Web links have been studied by information scientists for over a decade now. Web link research in information science started with Larson, Rousseau, and Almind and Ingwersen, all using an analogy between citations and hyperlinks to trigger explorations into web link research. This was followed by further investigations by Ingwersen and Leydesdorff and Curran amongst others. Several studies on web links have subsequently been carried out with many of them focusing on sites with academic content.

A few reported hyperlink studies have focused on international academic web interconnectivity. Smith used a hyperlink-based metric to compare university web sites in Australasia and Latin America. The study reported that Australasia web sites received higher visibility whereas for linguistic reasons, Latin American sites did not receive the attention that they deserve from the World Wide Web except for the few that were in English. In a similar study, Thelwall et al. surveyed the linguistic dimensions of web site hosting and interlinking of the universities of 16 European countries. Smith and Thelwall studied UK, Australian and New Zealand University interlinking, discovering that links between different institutions in the same country dwarfed international links and that New Zealand was relatively isolated on the web. A larger follow-up study by Thelwall and Smith mapped the interlinking between universities in the Asia-Pacific region showing that Australia and Japan were central web players in the region, as they were the major sources and targets for academic links.

A case study of inter-regional and intra-regional web connectivity was investigated by Park and Thelwall. In this study, Park and Thelwall examined the connectivity structure of links between university websites in 25 Asian and European countries. The five most linked-to universities in each nation-state were selected and the results suggested that the UK apparently had a significant influence on other websites, attracting over one-quarter of all links. The study further showed that Universities’ websites in Asia are more heavily connected to European universities than linked to each other. European countries’ universities dominated the overall networks, in terms of being the largest sources and targets of links. The highest ranked Asian countries were Japan and Singapore. Small countries in both regions were the least linked, a pattern which seems to be for larger, richer countries to be better linked, with wealth being more important than size. Aguillo used five major search engines to carry out a cybermetrics analysis of Indian universities, observing that English is the predominant language of the Indian academic web space and that ten academic institutions are among the first hundred most visible Indian web sites.

In Africa, only one study by Onyancha and Ocholla has investigated inter-university web connectivity at a regional level. Onyancha and Ocholla used link analysis to compare the performance of Kenyan and South African universities’ websites. The study found that whereas universities in South Africa have fairly well developed network, inter-connections between Kenyan universities’ web are few. Furthermore, it was observed that all the links between Kenyan and South African universities emanated from the latter.

At the national level, Bar-Ilan carried out a link
analysis of the 8 universities in Israel and reported that all the universities were interlinked; however, links between these universities were inserted as web conventions or indicated reputation more than research appreciation or research collaboration. Onyancha and Ocholla\textsuperscript{59} used link analysis to analyze the websites of 21 South African universities and the study revealed that universities in South Africa have a fairly well developed network with University of Western Cape (UWC) providing links to the highest number of universities, followed by Stellenbosch University, Rhodes University and the University of Pretoria. Nwagwu and Agarin\textsuperscript{60} carried out an exploratory analysis of links to Nigerian universities’ websites using a sample of 1000 pages selected from 30 of Nigeria’s 65 universities. The study revealed that Nigerian universities’ websites do not interlink, neither do they link educational websites outside their country. Self-linking among the individual websites was found to be a dominant feature.

**Objectives of the study**

- To examine the web interrelationship between the top ten African and top ten world universities;
- To compare the distribution of outlinks and inlinks among the universities; and
- To establish whether the linkage pattern of the African universities follows their ranking position as given by Webometrics Ranking of World Universities in Spain.

**Methodology**

The study covers the Top Ten African Universities (TTAU) and Top Ten world Universities (TTWU). The 20 universities were selected based on January 2008 Webometric Ranking of world universities by Cybermetrics Lab (Table 1). It should however be mentioned that the Nelson Mandela Metropolitan University is actually the eleventh in the ranking of African universities, while University De La Reunion is the tenth. The choice of the former as the tenth African university is borne out of the fact that University De La Reunion although classified under Africa is actually located in France. Also, South African universities dominate the Top Ten African Universities and universities in United States of America dominate the Top Ten World Universities. The study examined inlinks to and outlinks from these African universities to the Top Ten World Universities.

Data used for this study were extracted from WWW archives, using the AltaVista commercial search engine to retrieve records of web link interconnectivity between the selected universities. The search engine was selected based on its suitability compared to other search engines\textsuperscript{61}. Previous results indicate that AltaVista has become more reliable as a data source at least for the academic web as it has been shown to have a good coverage of university web sites\textsuperscript{62-64}. Thelwall\textsuperscript{65} discovered that despite the partial search engine coverage of the web, AltaVista did appear to cover UK academic sites, on average, better than a purpose built crawler.

In extracting outlinks from the Top Ten African Universities to the Top Ten World Universities, the Boolean search statement (linkdomain:xxx.yyy/ AND domain:bbb.cc.dd/) was used. The syntax; xxx

<table>
<thead>
<tr>
<th>Rank</th>
<th>Top Ten World Universities (TTWU)</th>
<th>University</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Massachusetts Institute of Technology</td>
<td>University of Cape Town</td>
<td><a href="http://www.mit.edu">www.mit.edu</a></td>
</tr>
<tr>
<td>2</td>
<td>Stanford University</td>
<td>Rhodes University</td>
<td><a href="http://www.stanford.edu">www.stanford.edu</a></td>
</tr>
<tr>
<td>3</td>
<td>Harvard University</td>
<td>Stellenbosch University</td>
<td><a href="http://www.harvard.edu">www.harvard.edu</a></td>
</tr>
<tr>
<td>4</td>
<td>Pennsylvania State Univ.</td>
<td>University of Pretoria</td>
<td><a href="http://www.psu.edu">www.psu.edu</a></td>
</tr>
<tr>
<td>5</td>
<td>Univ. Of California Berkeley</td>
<td>Univ. of the Witwatersrand</td>
<td><a href="http://www.berkeley.edu">www.berkeley.edu</a></td>
</tr>
<tr>
<td>6</td>
<td>University of Michigan</td>
<td>Univ. of the Western Cape</td>
<td><a href="http://www.umich.edu">www.umich.edu</a></td>
</tr>
<tr>
<td>7</td>
<td>Univ. Of Wisconsin Madison</td>
<td>University of South Africa</td>
<td><a href="http://www.wisc.edu">www.wisc.edu</a></td>
</tr>
<tr>
<td>8</td>
<td>University of Minnesota</td>
<td>Univ. of KwaZulu Natal</td>
<td><a href="http://www.umn.edu">www.umn.edu</a></td>
</tr>
<tr>
<td>9</td>
<td>Univ. Of Illinois Urbana Champaign</td>
<td>American Univ. in Cairo</td>
<td><a href="http://www.uiuc.edu">www.uiuc.edu</a></td>
</tr>
<tr>
<td>10</td>
<td>Cornell University</td>
<td>Nelson Mandela Metropolitan University</td>
<td><a href="http://www.cornell.edu">www.cornell.edu</a></td>
</tr>
</tbody>
</table>

Source: Cybermetrics Lab http://www.webometrics.info
represents the domain name of the university receiving the link (e.g. harvard for Harvard University), yyy represents the sub-top level domain (e.g. edu), bbb represents the domain name of the university sending the link, (e.g. uct for University of Cape Town), cc represents the sub-top level domain for bbb (e.g. .ac) while dd represents the top level domain (e.g. .za for South Africa). Hence, the Boolean search statement used to retrieve links received by Harvard University from the University of Cape Town in South Africa was (linkdomain:harvard.edu/ AND domain:uct.ac.za/).

Conversely, the Boolean search statement (linkdomain:bbb.cc.dd / AND domain: xxx.yyy/) was used in extracting inlinks to the Top Ten African Universities from the Top Ten World Universities.

All the data used were downloaded on the same day on 21st April 2008. The study did not restrict the period of linking and search was restricted to HTML pages. The queries used returned a total hit of 7,645 links out of which, only 4,789 were accessible; 3,531 outlinks and 1,258 inlinks. Reason for inaccessibility was basically denial of permission to access such links. Subsequently, the proportional to size sampling technique was used to determine the number of links that were selected for the study. A sample size of 50 percent was used resulting to 2,395 links; 1,766 outlinks and 629 inlinks. Using systematic sampling, individual links were selected based on every third link.

Using the Statistical Package for Social Sciences (SPSS) software, descriptive statistical tools, specifically, the frequency distribution and percentages were used to determine the proportion of outlinks and inlinks between the TTAU and the TTWU.

**Results**

**Distribution of links**

Findings showed that while the TTWU received considerably high number of links from the TTAU, this was not reciprocated by the TTWU as the African universities generated very low number of links from them (Tables 2 and 3).

<table>
<thead>
<tr>
<th></th>
<th>MIT</th>
<th>SU</th>
<th>HU</th>
<th>PSU</th>
<th>UCB</th>
<th>UM</th>
<th>UWM</th>
<th>UMN</th>
<th>UIUC</th>
<th>CU</th>
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</thead>
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<td>15</td>
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<td>23</td>
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<td>12</td>
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<tr>
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<td>10</td>
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<td>5</td>
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<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
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</tr>
</tbody>
</table>

UCT: University of Cape Town; RU: Rhodes University; SUN: Stellenbosch University; UP: University of Pretoria; WITS: University of Witwatersrand; UWC: University of Western Cape; UNISA: University of South Africa; UKZN: University of Kwazulu Natal; AMUC: American University in Cairo; NMMU: Nelson Mandela Metropolitan University; MIT: Massachusetts Institute of Technology; SU: Stanford University; HU: Harvard University; PSU: Pennsylvania State University; UCB: University of California Berkeley; UM: University of Michigan; UWM: University of Wisconsin Madison; UMN: University of Minnesota; UIUC: University of Illinois Urbana Champaign; CU: Cornell University
came from Stanford University, followed by University of Michigan (Table 3).

Data characteristics by university

The study examined link relationship of each of the TTAU with each of the TTWU.

University of Cape Town (UCT)

This South Africa’s oldest university, had the highest number of outlinks and inlinks. Figure 1 shows that outlinks from UCT to Harvard University (19.6%) and University of Wisconsin Madison (17.1%) were highest.

A corresponding number of inlinks was not received by University of Cape Town from both Harvard University and University of Wisconsin Madison. Rather, University of Cape Town received the highest number of inlinks from Stanford University (21.3%) and University of Michigan (15.5%).

Rhodes University

Rhodes University had almost equal number of links to Massachusetts Institute of Technology (16.8%), Stanford University (15.2%) and University of California Berkeley (15.2%). Inlinks from Stanford University (25.3%) was the highest, followed by University of California Berkeley (14.7%). Overall, both Stanford University and University of California Berkeley featured among the top 3 universities in both outlinks and inlinks (Figure 2).

Table 3—Distribution of inlinks to the Top Ten African Universities from the Top Ten World Universities

<table>
<thead>
<tr>
<th></th>
<th>MIT</th>
<th>SU</th>
<th>HU</th>
<th>PSU</th>
<th>UCB</th>
<th>UM</th>
<th>UWM</th>
<th>UMN</th>
<th>UIUC</th>
<th>CU</th>
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</thead>
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</table>

UCT: University of Cape Town; RU: Rhodes University; SUN: Stellenbosch University; UP: University of Pretoria; WITS: University of Witwatersrand; UWC: University of Western Cape; UNISA: University of South Africa; UKZN: University of Kwazulu Natal; AMUC: American University in Cairo; NMMU: Nelson Mandela Metropolitan University; MIT: Massachusetts Institute of Technology; SU: Stanford University; HU: Harvard University; PSU: Pennsylvania State University; UCB: University of California Berkeley; UM: University of Michigan; UWM: University of Wisconsin Madison; UMN: University of Minnesota; UIUC: University of Illinois Urbana Champaign; CU: Cornell University
Stellenbosch University

Stellenbosch University had about 60 percent of its outlinks to Massachusetts Institute of Technology (Figure 3). The closest was University of Michigan with only 11.0 percent. Such a wide margin was however not observed with the inlinks to Stellenbosch as the 3 most frequently linked world universities were Stanford University (22.5%), Massachusetts Institute of Technology (17.5%) and University of California Berkeley (15.0%).

University of Pretoria

Cornell University (17.1%) had the highest number of links from University of Pretoria closely followed by University of California Berkeley (16.5%). However, University of Pretoria received only 5.6 percent of links from Cornell University with University of Minnesota (18.1%), Massachusetts Institute of Technology (15.3%) and Stanford University (15.3%) taking the lead with the highest number of inlinks to University of Pretoria (Figure 4).
University of Witwatersrand

The University of Minnesota (42.1%) received the highest number of links from University of Witwatersrand with the closest institution being Harvard University with only 9.1 percent (Figure 5).

Ordinarily, it would have been expected that a corresponding level of links would be received from University of Minnesota but only 10.9 percent of links originated from University of Minnesota to University of Witwatersrand. Stanford University (21.8%) had the highest number of links to University of Witwatersrand.

University of the Western Cape

The highest number of links to University of the Western Cape were received by University of California Berkeley (22.2%), University of Michigan (17.8%) and Harvard University (15.6%). Inlinks from the top ten world universities were remarkably highest for Stanford University (29.4%) with the closest to it being University of Illinois Urbana Champaign with 14.7 percent (Figure 6).

University of South Africa

The University of Wisconsin Madison (26.3%) received the highest number of links from University of South Africa, followed by Stanford University (15.8%). Stanford University (37.0%) however had the highest number of links to University of South Africa the closest to it being University of Wisconsin Madison with 14.8 percent (Figure 7). One would have expected that the University of South Africa, a distance learning institution would have generated more links than the other nine, but the university
generated only 5.4 percent and 4.3 percent of outlinks and inlinks respectively.

University of Kwazulu Natal

Fifty-five percent of the outlinks from University of Kwazulu Natal were received by University of California Berkeley while 43.8 percent of the inlinks to University of Kwazulu Natal were received from Stanford University (Figure 8).

American University in Cairo

American University in Cairo, the only non-South African university and the only private university among the TTAU consistently maintained the 5th position in both outlinks and inlinks. Figure 9 shows that over 65 percent of links were received by Massachusetts Institute of Technology from American University in Cairo. Very scanty representations were observed in the remaining top 9 world universities. American University in Cairo received 26.7 percent links from University of Michigan and 13.3 percent each from University of Wisconsin Madison and University of Minnesota.

Nelson Mandela Metropolitan University

Nelson Mandela Metropolitan University, the tenth on Webometrics Ranking had only 6 links in all; 3 outlinks and 3 inlinks. The 3 outlinks were to Stanford University, Harvard University and University of California Berkeley. The 3 inlinks were from Harvard University, University of California Berkeley and University of Illinois Urbana Champaign.
Discussion

The study evidently showed the presence of web interconnectivity between African universities and the top world universities. Similar studies have reported international academic web interconnectivity among universities. However, analysis of frequency showed 73.7 percent of outlinks from the TTAU and 26.3 percent of inlinks from the TTWU. According to Thelwall and Smith, web links between institutions can identify patterns of international recognition of one institution by another and determine information flow. This can be extrapolated to probably conclude that African universities show more interest in linking to the world universities; a relationship that is not reciprocated by these world universities to African universities. The low level of links received by the African universities may probably be partially due to the fact that African universities in general have embraced the many features of the WWW only recently as the study revealed that the relationship began slowly from 1995 and progressively been increasing since 2003. The study noted that Stanford University’s consistency in the frequency of outlinks and inlinks between the institution and the TTAU. Specifically, Stanford University, the youngest among the TTWU, remarkably featured as one of the top four universities with the highest number of links from Rhodes University, Stellenbosch University, University of Witwatersrand, University of South Africa and University of KwaZulu Natal. More striking is the position of Stanford University with the highest number of inlinks to each of the TTAU with the exception of University of Pretoria and American University in Cairo.

The positions of the universities in terms of frequency of links did not follow their ranking positions. While the position of University of Cape Town as the 1st in Webometrics ranking was also maintained in its outlinks and inlinks, the trend was not the same for others. Generally and in both outlinks and inlinks, University of Cape Town was not followed by Rhodes University. The average number of links generated and received by each of the TTAU did not follow the ranking as observed in the Webometrics ranking of these universities. It was however interesting to observe that University of Cape Town, Rhodes University, University of Stellenbosch, University of Pretoria, University of Witwatersrand and American University in Cairo maintained the 1st – 6th positions generally and in both outlinks and inlinks, but not in that order. This observation can partially be said to agree with studies in the UK and New Zealand where Universities with higher average peer-review ratings attracted more links per faculty member to their web sites.

Conclusion

Although this study was an exploratory work on link analysis of websites of the TTAU and the TTWU, its findings have again proved that ranking of universities has come to stay and will definitely continue to shape institutions, educational institutions inclusive. There is, therefore, the need for African
universities to improve their web presence and incorporate ranking in their web relationship with other universities which should significantly be tailored to benefits that could be received from academic activities including scholarly communication, collaboration, and taking part in cutting edge research among others.

Future studies might focus on understanding the basis for the link relationships among these universities investigated.

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