A Co-Link Analysis Of Institutions Of Higher Learning In Eastern And Southern Africa: Preliminary Findings

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Abstract

This paper presents the preliminary findings of a co-link analysis of 95 (out of a total of 142) institutions of higher education in eastern and southern Africa. Data was collected using a uniform search strategy, i.e. two search queries were used to extract relevant data from the Yahoo! search engine. Data was captured and stored in Microsoft Excel spreadsheets as 2-dimensional matrices. UCINET version 6 (comprising of several analytic technologies) was primarily used to analyse the data in order to: find out the number of external inlinks for each institution; determine the most colinked institutions; map the colinkages; measure the strengths of colink ties; examine colink relationships; and establish the motivations for colinking. For the purposes of presenting the findings, 40 institutions which recorded a normalised colink count of 1.5 and more were selected. Results indicate that most South African institutions have the highest number of inlink and colink counts. Insitutions belonging to the same geographic region established closer relationships amongst themselves than institutions located in different geographic regions. The institutions which yielded fewer inlinks and higher colink counts produced stronger colink ties. Other findings, conclusions and recommendations are provided.

Keywords

Webometrics, colink analysis, Institutions of Higher Education, Eastern Africa, Southern Africa

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1 Introduction

In her article "What do we know about links and linking? A framework for studying links in academic environments", Bar-Ilan (2005:975) defines the World Wide Web (WWW; web) as an "enormous set of documents connected through hypertext links created by authors of web pages". The author maintains that web links are not only a means by which documents are linked, but are also tools that have been used to improve the performance of information retrieval systems (IRS). Hypertext links, according to Bar-Ilan, are created for various reasons, some of which include: (a) a sign of appreciation; (b) technical reasons, e.g. for downloading documents; and (c) links to advertisements, i.e. in exchange for free space on a web server, a page may be required to carry some advertisement (Bar-Ilan, 2005:975). Thus, web links are increasingly becoming important sources of information and essential tools by which the web can be measured or evaluated. Institutions of higher learning, particularly universities, have become subject to such evaluations in recent years (see Thelwall, 2002a, 2002b, 2002c, 2003; Onyancha & Ocholla, 2007; Cybermetrics Lab, 2005).

Just like all institutions and organisations across the world, higher education institutions (HEIs) see the web as a tool that enhances their academic programs. As a result, virtually all universities have developed their own websites, through which they provide important information regarding their contact details (e.g. telephone numbers, addresses, emails), management and academic structures and programs, research/scientific activities and outputs, community outreach engagements, events and activities, students composition and activities, document repositories, networks, information services and much more. Universities in Africa have not been left behind (see Onyancha & Ocholla, 2007) in web development. In the process of developing and constructing websites, web page authors increasingly provide links to various websites and/or web pages, including those belonging to individuals, other universities, the government and the industry at large. Similarly, non-academic institutions provide links to a number of educational institutions for reasons such as cited above, thus providing a fundamental basis for studying the structure, nature, type and motivations of web linking.

Thelwall (2006:61) considers the following to be among the types of links that may be investigated within a research context:

- counts of links to each of a set of websites (e.g. websites belonging to universities, academic departments, journals, non-governmental organisations)
- counts of links from each of a set of websites
- counts of links between each pair of sites in a set of websites
- counts of links from each of a set of websites to a given site or domain
- counts of links to each of a set of websites from a given site or domain

This last type of link forms the basis of this study. The term commonly used to describe an analytic study or measurement of this type of links is "co-link analysis".

2 Co-Link Analysis: A Brief Introduction

Co-link analysis is analogous with co-citation analysis. The concept of co-citation analysis was discovered independently by Marshakova and Small in 1973 (Ikpaahindi, 1985). Co-citation analysis differs from bibliographic or bibliometric coupling, in that whereas the latter measures the relationship between source documents, the former measures the relationship between cited documents. Figures 1 and 2 show the analogous relationship between co-cited documents and co-linked web documents/pages/sites.

The two illustrations demonstrate how similar the two concepts are. In Figure 1, documents D, E and F are co-cited by A and F, A and D, and B and E respectively, while Figure 2 shows that the same nodes (i.e. D, E and F) which represent web documents/pages/sites, are co-linked by web documents/pages/sites A and F, A and D, and B and E. In the views of Zuccala (2006:1487), Web Co-link Analysis (WCA) and Author Co-citation Analysis (ACA) are sister techniques. It is worth noting that there are two types of colinks, namely in-colinks and out-colinks. In-colinks occur when two external web documents/pages/sites provide links to one given web document/page/site. All the above cited examples fall in this category. Out-colinks are provided when one web document/page/site provides links to two external web documents/pages/sites. Using Figure 2, B and E have colinked A and F, and B and F, respectively. The latter concept is analogous to bibliographic or bibliometric coupling. This study is limited to in-colinks, i.e. two external links coming in to a given web document/page/site. In-colink analysis is the most commonly used technique (e.g. Thelwall, 2004; Vaughan & You, 2006; Larson in Zuccala, 2006). All these authors use "colink" synonymously with "in-colink". For instance, Thelwall (2004:5) defines "colink" as an instance "when two web pages have in-links from a third page".

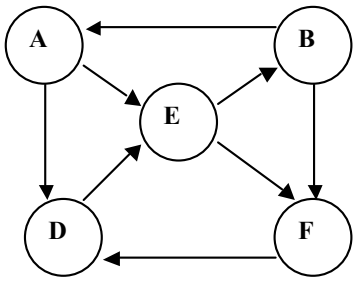

Figure 1: Co-citing

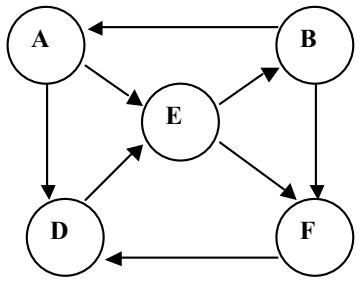

Figure 2: Colinking

Another similarity between the two concepts is founded on the assumptions largely associated with co-citation analysis. Co-citation analysis is based on the assumption that if two references are cited together, in any later literature, the two references are themselves related in some way. The more the documents are cited together, the greater their co-citation strength. Co-citation analysis can be applied to fields of study other than individual articles, journals, and authors. Industrial organisations, academic departments, publishing houses, cities, nations, etc; can be used as units of study in co-citation analysis (Ungern-Sternberg, 1995; Ikpaahindi, 1985; Wallace, 1989). Likewise, in colink analysis, it is assumed that two or more links of websites or pages that appear together in another website or page are related in some way. In the words of Vaughan & You (2006:612), "the number of colinks to websites of a pair of companies is a measure of the similarity between two companies. The more colinks the two companies have, the more closely related they are in the views of the sites that link to them".

Studies employing the colink analysis method to demonstrate relationships between institutions on the web are generally few in the world, and rare (if any) in Africa, possibly because the technique is relatively new (Zuccala, 2006:1487). Zuccala (2006) cites only four colink-specific studies (i.e. Larson, 1999; Polanco, Boudourides, Besagni & Roche, 2001; Thelwall & Wilkinson, 2004; and Vaughan & You, 2005). We can add Vaughan and You (2006) and Zuccala (2006). Technically, Vaughan and You's two papers are the same. The paper was first published in conference proceedings in 2005 and as a journal article in 2006. In their article entitled "Finding similar academic websites with links, bibliometric coupling and colinks", Thelwall and Wilkinson (2004) randomly sampled 500 pairs of UK academic web domains and assessed the sites for similarity using links, colinks and couplings. The study concluded that "using a combination of all three (i.e. links, colinks and couplings) gives the highest probability of identifying similar sites" and "high values for either colink counts or couplings were associated with only a small increased likelihood of similarity" (Thelwall & Wilkinson, 2004:515). Vaughan and You (2006) conducted a colink analysis of 32 telecommunications companies' websites in order to compare the companies' business competitive intelligence. The authors collected the web colink data using the Yahoo! search engine and found that the "number of colinks to a pair of business websites is a measure of the similarity between the two companies" (Vaughan & You, 2006:611). Zaccula (2006) set out to compare Author Co-citation Analysis (ACA) and Web Colink Analysis (WCA) in terms of the concepts' data retrieval, mapping, and interpretation procedures. The study found that the two analytic techniques are similar in all respects except at the interpretive stage, where "ACA maps become more meaningful in light of citation theory, and WCA maps require interpretation based on hyperlink theory" (Zuccala, 2006:1487).

3 Purpose Of Study

This study presents the preliminary results of a colink analysis of institutions of higher learning within eastern and southern Africa, in order to map the relationships between these institutions. At this stage, only 95 out of 142 HEIs are analysed and the results reported in order to:

- determine the motivations for colinking
- determine the most colinked institutions
- map the colinkages of the institutions
- measure the strengths of colink ties
- examine colink relationships amongst the institutions

4 Methodology

For the purposes of conducting this particular study, web pages (as units of measurement) were used to examine the link co-occurrences of HEIs in external websites in order to determine the relationship between the institutions in eastern and southern Africa. A total of 142 URLs belonging to HEIs from 22 eastern and southern African countries (i.e. Angola, Botswana, Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Rwanda, Seychelles, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe) were identified (see Appendix A) using various web-based sources, which included:

- the *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)
- Ahibo: Ecoles & Universités en Afrique / African colleges & universities http://ahibo.com/uaf.htm
- Universidades Africanas: datos sobre todas las Universidades de Africa www.ikuska.com/Africa/universidad.htm

Initially, the SocSciBot personal crawler was selected to crawl the web for links to and from the institutions' websites, the intent having been to analyse the data via LexiURL. LexiURL is free software designed to analyse lists of web page URLs and lists of hyperlinks in order to produce - among other file outputs - summaries of colink

counts (http://lexiurl.wlv.ac.uk/). However, the process of crawling the web was found to be especially slow with regard to large institutional websites, such as those belonging to the University of Cape Town (UCT), University of KwaZulu-Natal (UKZN), and Rhodes University (RU). Sometimes, the crawler forced the computer to 'hang', a situation that prompted the restarting of the computer on several occasions. Consequently, we banned all URLs which contained question marks because, according to Prof. Mike Thelwall, the software developer (Onyancha & Ocholla, 2007), URLs that contain question marks are sometimes repeated and therefore crawling them would be an endless task. Although crawling the URLs thereafter stabilised, it was still extremely slow and problematic. It is hoped that a solution will be found, enabling us to generate findings using this method that may be compared to the results reported in this study for validation.

In view of the above limitations, we opted to use the Yahoo! search engine for data collection. Unlike the personal crawler, which requires the URL to be active, using Yahoo! to search for links to particular institutional websites is not limited in this respect. However, it was essential to confirm that the URL being used in the search query actually belongs to the institution in question. For instance, while confirming the URLs of eastern and southern African HEIs, we noted that the University of Western Cape's website had been infiltrated. The information that was on the website was not the university's web content. Fortunately, the situation was rectified before we concluded the data collection process and the university was ultimately included in the analysis.

The following two search queries were employed in order to collect relevant data. We provide two URLs belonging to two institutions that were investigated in this study as examples (i.e. www.fmuan.ao - FACULDADE DE MEDICINA UNIVERSIDADE AGOSTINHO NETO and www.anu.ac.ke – AFRICA NAZARENE UNIVERSITY):

1. link:http://www.fmuan.ao –site:fmuan.ao
2. (link:http://www.fmuan.ao –site:fmuan.ao) AND (link:http://www.anu.ac.kesite:anu.ac.ke)
   where: link:http://www.fmuan.ao was meant to produce links that point to the URL: http://www/fmuan; and
   -site:fmuan.ao was meant to exclude self-inlinks

Search one yielded the number of external links to a particular institution; and search two yielded the number of colinks to a set of institutions investigated in this study.

As already mentioned, only 95 out of 142 HEIs belonging to 16 out of the 22 eastern and southern African countries have been analysed thus far, and the findings reported in this paper. The complete list of the institutions and their URLs is provided in Appendix A. It is worth noting that the first search query involved 95 searches, while the second involved a total of 8930 search combinations. By the end of the data collection

exercise, the total number of searches is estimated to be 142 (in the case of the first search) and 20022 (using the second search query).

Data that was extracted from the search engine using the first search query was captured and stored in a two-column and 96-row matrix using Microsoft Excel spreadsheet. Data that was yielded using the second search was captured and stored in the same way, but presented as a 2-dimensional matrix that contained 96x96 rows and columns. In order to measure the strength of the colink ties between the colinked institutions, a symmetrical matrix consisting of normalised colink counts was generated using the following formula, as outlined in Vaughan & You (2006:616):

$$\text{NormalisedColinkCount: } n(X, Y) = n(A \cap B) / n(AUB)$$

where:

n (X, Y) is the normalised colink count for URL X and URL Y
A is the set of the web pages which links to URL X
B is the set of the web pages which links to URL Y

n (A∩B) is the raw colink count (i.e. number of pages which link to both URL X and URL Y) and *n (AUB)* is the number of pages which link either to URL X or URL Y.

Using these imaginary URLs and assuming that the number of pages which link to both URL X and URL Y is 50; the number of pages pointing to only URL X is 150; and the number of pages which point to URL Y is 200; then,

$$n(X, Y) = 50/(150+200-50) = 0.17$$

In order to present the findings, and given that the matrices that were generated were too large to be respectively processed by UCINET version 6 and presented in Microsoft Word, we decided to select a small but representative number of institutions. To do this, we selected only those institutions that registered a total normalised colink count of 1.5 or more. There were a total of 40 institutions that met the selection criterion.

The normalised colink count matrix was then used to generate a social map in order to examine the relationships between the institutions (see Figure 3). This was achieved using Pajek social network software. Additionally, a factor analysis was conducted on the normalised colink count matrix. Factor analysis decomposes a matrix into factors using either principal components or minimum residual methods, and was thus used to identify the principal colinked institutions. According to Borgatti, Everett & Freeman (2002), the technique is used to conduct an analysis in which the matrix is factored into a product of the most dominant eigenvectors. One of the output files that were generated using factor analysis comprised the factor scores, which were in turn used

to produce the scatter graph in Figure 6. The analysis also produced the eigenvectors file which contained the Eigen values that corresponded to each institution.

Furthermore, we employed the use of the non-metric multi-dimensional scaling analysis (MDS) to examine colink relationships and map similarities amongst the investigated university websites. Commenting on the usefulness of MDS analysis, Borgatti, Everett & Freeman (2002) note that wherever there is a matrix of proximities (similarities or dissimilarities) among a set of items, the program finds a set of points in k-dimensional space in such a way that the Euclidean distances among these points corresponds as closely as possible to a rank preserving transformation of the input proximities. In the analysis of the similarities between the items analysed, the program draws a set of the items close together on the MDS map, while the opposite is true when the option of dissimilarities is selected. Figures 4 and 5 were generated using the non-metric MDS analysis.

We note that one of the limitations of this type of study is the dynamism with which the links are added to an indexing service such as Google and Yahoo! For instance, a search for link:http://www.fmuan.ao -site:fmuan.ao at the preliminary stage of investigation (i.e. before the commencement of data collection) yielded 70 links. A revisit of the search after two weeks produced 72 links and on the fourth week, the number of links had increased to 73.

5 Results And Discussion

This section provides the findings under the following subheadings: number of external inlinks; number of institutions with which each institution is colinked; the social network of colinked institutions; raw colink counts for each pair of institutions; normalised colink counts for each pair of institutions; and cluster mapping of the institutions.

5.1 Number Of External Inlinks To Each Institution

The number of external inlinks (i.e. links pointing to one particular institution investigated in this study) is highlighted in Appendix B for each institution. The University of Cape Town (UCT) led with 8200 inlinks, followed by the University of Limpopo [UL] (4050), University of Western Cape [UWC] (4040), University of Witwatersrand [WITS] (3460), University of KwaZulu-Natal [UKZN] (3100), University of South Africa [UNISA] (2980), Rhodes University [RU] (2900), Stellenbosch University [SUN] (2520), and University of the Free State [UOVS] (1280). The rest of the institutions received less than 1000 inlinks each.

5.2 Number Of Institutions With Which Each Institution Is Colinked

Table 1 provides a summary of the number of institutions with which each institution was colinked. Out of the top 40 institutions, 39 (100%) were colinked with the University of Western Cape (UWC), while the Addis Ababa University (AAU) came second together with 9 other universities (i.e. Kenyatta University [KU], Moi University [MU], United States International University [UISU], Rhodes University [RU], Stellenbosch University [SU], University of Cape Town [UCT], University of Pretoria [UP], University of the Free State [UOVS] and University of Witwatersrand [WITS]). Each of these universities was colinked with 38 (97.44%) others. With the exception of the Debub University (DEBUB], which ranked last with 6 colinked institutions, all the institutions were colinked with more than 50% of the top 40 institutions.

Table 1: Number of universities with which each university was colinked (N = 39)

No.	Rank	University	No. of colinked universities	Percentage
1	1	uwc.ac.za	39	100.00
2	2	aau.edu.et	38	97.44
3	2	ku.ac.ke	38	97.44
4	2	mu.ac.ke	38	97.44
5	2	usiu.ac.ke	38	97.44
6	2	ru.ac.za	38	97.44
7	2	sun.ac.za	38	97.44
8	2	uct.ac.za	38	97.44
9	2	up.ac.za	38	97.44
10	2	uovs.ac.za	38	97.44
11	2	wits.ac.za	38	97.44
12	3	jkuat.ac.ke	37	94.87
13	4	strathmore.edu	36	92.31
14	4	nmmu.ac.za	36	92.31
15	4	unisa.ac.za	36	92.31
16	4	wsu.ac.za	36	92.31
17	5	ufh.ac.za	35	89.74
18	5	univen.ac.za	35	89.74
19	5	uzulu.ac.za	35	89.74
20	6	cuea.edu	34	87.18
21	6	ukzn.ac.za	34	87.18
22	7	mantec.ac.za	33	84.62
23	8	ugondar.edu.et	32	82.05
24	8	kwust.ac.ke	32	82.05

25	8	uj.ac.za	32	82.05
26	9	ksps.ac.ke	31	79.49
27	9	nwu.ac.za	31	79.49
28	10	anu.ac.ke	29	74.36
29	10	ueab.ac.ke	29	74.36
30	11	cput.ac.za	28	71.79
31	11	cut.ac.za	28	71.79
32	11	tut.ac.za	28	71.79
33	12	vut.ac.za	27	69.23
34	13	mu.edu.et	25	64.10
35	14	mombasapoly.ac.ke	24	61.54
36	14	ul.ac.za	24	61.54
37	15	kabarak.ac.ke	23	58.97
38	15	kemu.ac.ke	23	58.97
39	16	alemayau.edu.et	21	53.85
40	17	d-univ.edu.et	6	15.38

5.3 Social Network Of Colinked Institutions

The above table is further illustrated in Figure 3 which provides the institutional colinkages. The figure reveals the number of institutions as well as the institutions with which each institution is colinked. The thickness/density of the lines that join one institution to another indicates the strength of the link or tie between two institutions. For instance, Figure 3 shows that there are strong ties between the Alemaya University (ALEMAYA) and DEBUB [Ethiopia]; AAU and Mekelle University (MEKELLE) [Ethiopia]; the Tswane University of Technology (TUT) and Vaal University of Technology (VAAL) [South Africa]; and the University of Venda (UNIVEN) and Walter Sisulu University (WSU) [South Africa]. The illustration also reveals three densities involving universities in Kenya (top left corner), South Africa (top right corner) and Ethiopia (bottom of the illustration).

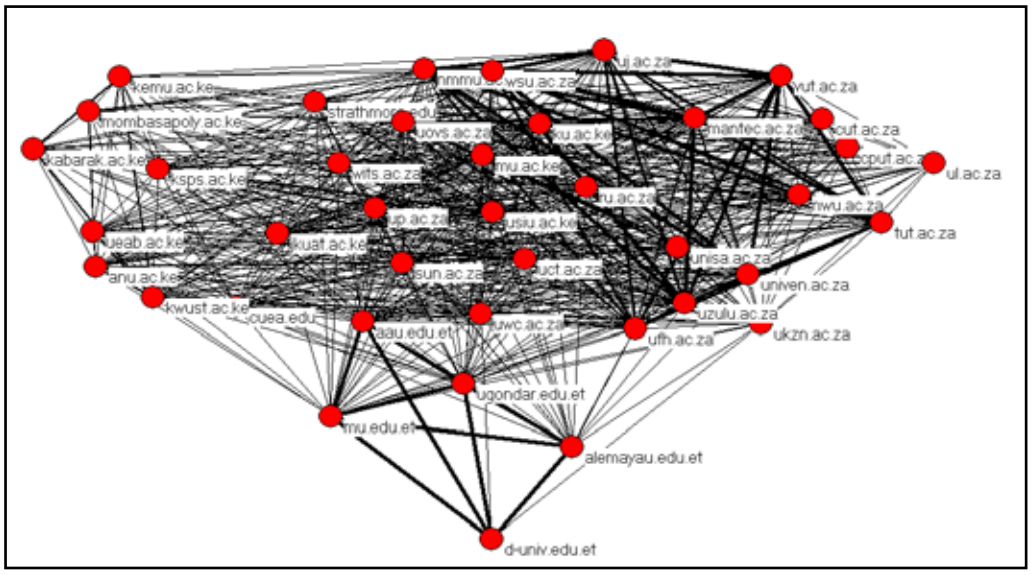

Figure 3: Social network of colinked institutions

5.4 Raw Colink Counts For Each Pair Of Institutions

The raw colink data is provided in Appendix B. The table reveals the number of pages that link to a pair of the institutions investigated in this study. The largest number of colinking pages (1030) pointed to two South African universities, namely Stellenbosch University (SUN) and the University of Cape Town (UCT). The UCT and the University of Pretoria (UP) were jointly colinked to by a total of 948 pages, while 937 web pages contained links to both UCT and UOVS. Other institutions which were highly colinked, in descending order of the number of pages that pointed to a pair of institutions, include: UCT and UWC (905); UP and UNISA (886); SUN and UP (882); UCT and WITS (872); SUN and UNISA (805); and RU and UCT (802). Others are UP and WITS (774); SUN and WITS (758); UNISA and WITS (735); SUN and UWC (732); SUN and UWC (725); and UP and UOVS (707).

5.4 Normalised Colink Counts For Each Pair Of Institutions

The normalised colink count was computed in order to measure the strength of ties amongst the institutions. Appendix C reveals that the highest count (i.e. 0.42) was between UCT and WSU. Other pairs of institutions that recorded a high normalised colink count are: University of Zululand (UZULU) and WSU (0.41); ALEMAYA and

DEBUB (0.41); DEBUB and Gondar College of Medical Sciences (GONDAR) (0.41); NWU and WSU (0.40); NWU and UZULU (0.39); Nelson Mandela Metropolitan University (NMMU) and VUT (0.39); NMMU and WSU (0.39); DEBUB and MEKELLE (0.39); and NWU and UCT (0.38). High normalised colink counts were also recorded by NMMU and NWU (0.37); NMMU and UCT (0.37); UGONDAR and MEKELLE (0.37); VUT and WSU (0.36); University of KwaZulu-Natal (UKZN) and WSU (0.36); and ALEMAYA and UGONDAR (0.36).

5.5 Cluster Maps Of The Institutions

Figures 4, 5 and 6 are scatter graphs showing clusters of inter-related institutions within the eastern and southern African regions. Figure 4 was generated using raw colink data after the data was subjected to a non-metric multidimensional scaling (non-metric MDS) analysis of the colink matrix. The non-metric MDS option was chosen primarily because of its popularity in mapping proximity matrices for similar and/or dissimilar relationships between actors (Vaughan & You, 2006).

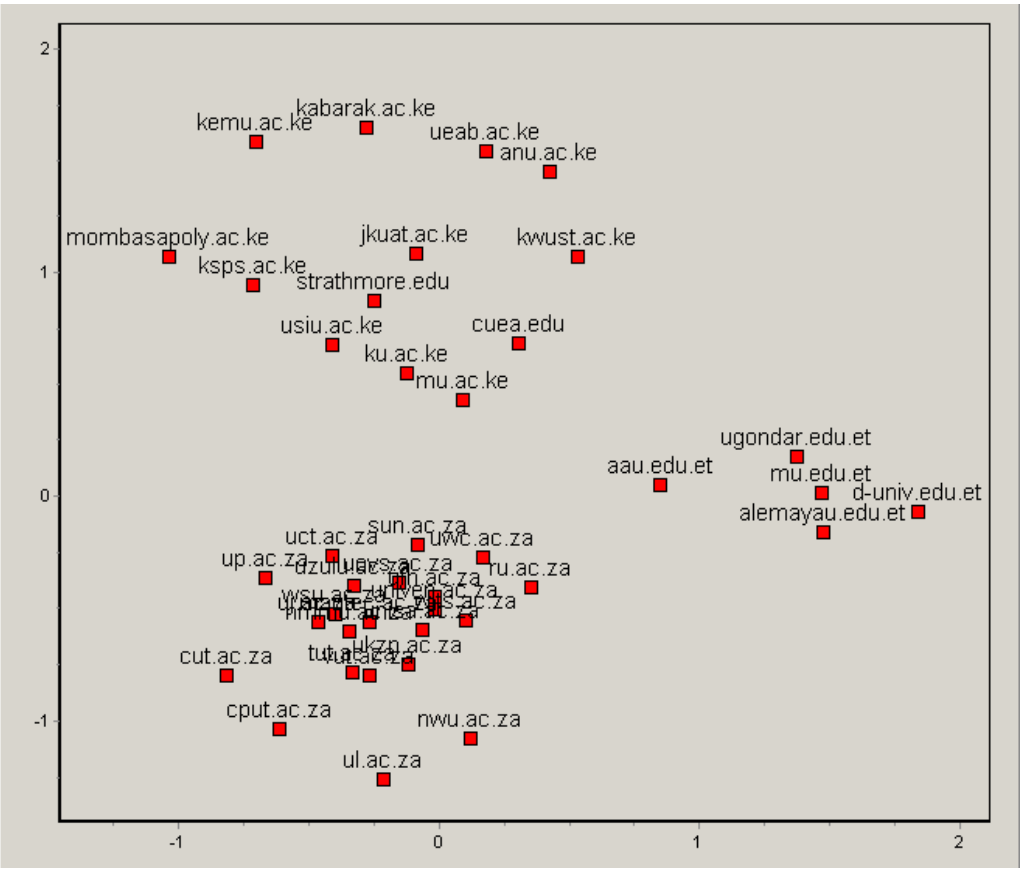

Figure 4: Non-metric MDS mapping of the colink raw data

This study considered only the similarities between the coordinates (i.e. the institutions), thus ignoring the differences. The non-metric MDS coordinates stress for Figure 4 was 0.145, which indicates a slightly higher value than the one computed in Vaughan & You's (2006) study. Commenting on a suitable stress value, Meulman & Heiser in Vaughan & You (2006:617) note that a normalised stress value of less than 0.05 "indicates very good fit between the input data and the out maps". Commenting on the same, Borgatti, Everett & Freeman (2002) opine that any stress values below 0.1 are excellent and above 0.2 unacceptable.

Figure 4 indicates that there were three clusters, each containing the institutions that were close together. Generally, the illustration reveals three large clusters. In the top left corner are institutions located in Kenya. These institutions can be said to be closely linked, judging from their proximity to each other in the illustration. Similar patterns are depicted in the clusters which consist of Ethiopian (mid-right of the scatter plot) and South African institutions (bottom left corner of the scatter plot), respectively.

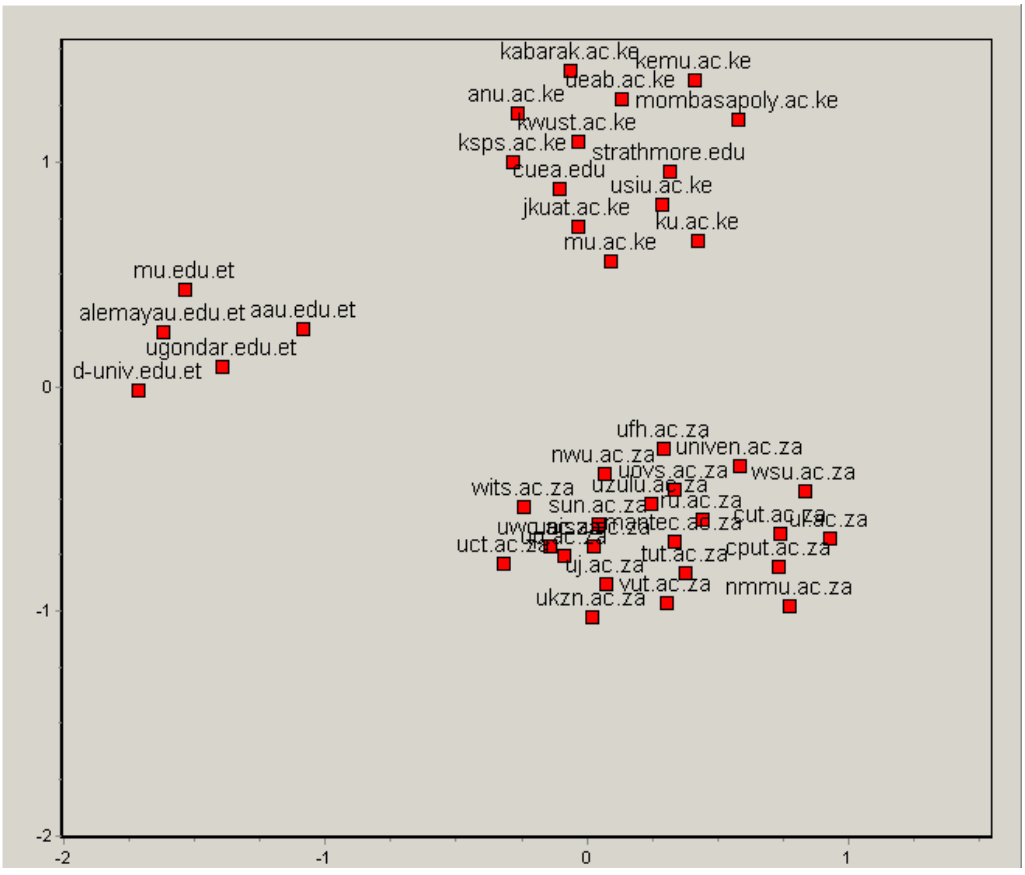

Figure 5: Non-metric MDS mapping of the normalised colink count data

Figure 5 was generated using the normalised colink counts with the stress value of 0.104 in 18 iterations. Again, the program generated three clusters, one each for the three countries whose institutions produced a normalised colink count of 1.5 and more. Unlike Figure 4, the elements in Figure 5 are closer to each other, implying stronger relationships between the participating institutions. The institutions which had closer colink ties are closer to each other in the scatter graph.

We also plotted the colink relationships of the institutions on a scatter graph using the Eigen scores. Figure 6 shows similar patterns as those depicted in Figures 4 and 5. However, the institutions, even those that can be said to be in the same cluster, were not as adjacent to each other as in Figure 5. For instance, in the case of Kenya, the distance between Kiriri Women's University of Science and Technology (KWUST) and the Catholic University of Eastern Africa (CUEA) in Figure 5 is much shorter than it is in Figure 6. There are several similar instances implying differences in approaches of measurements of data and not the resultant pattern of inter-relationships. All illustrations reveal similar patterns of colink relationships amongst the institutions.

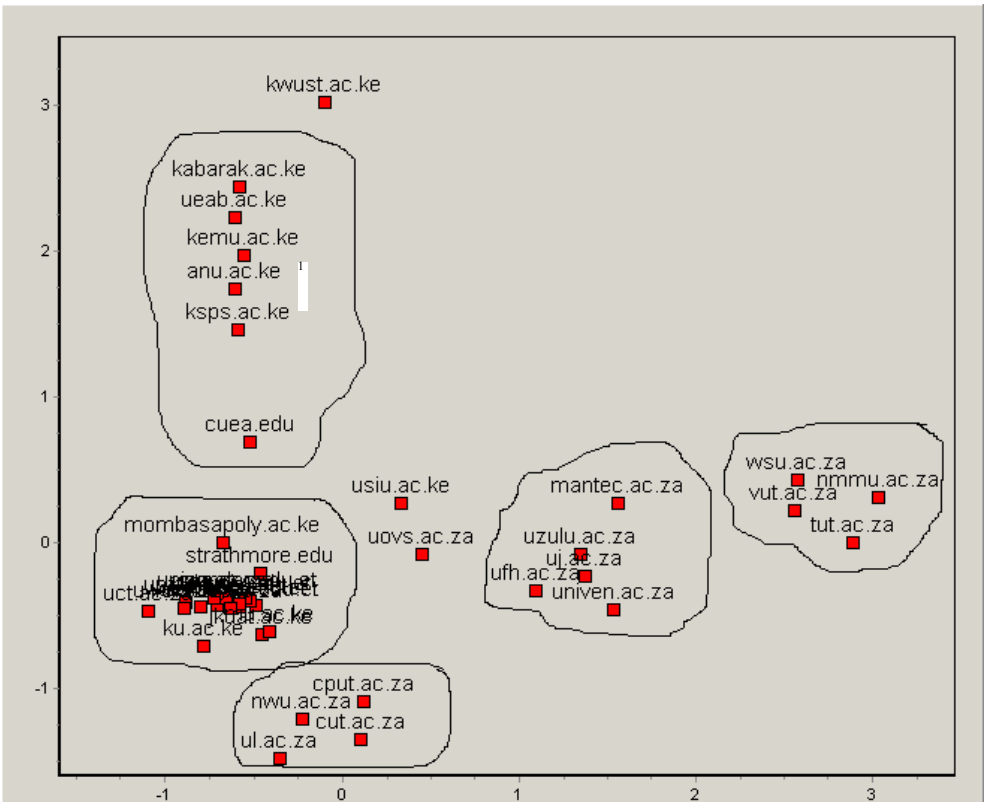

Figure 6: Scatter graph showing inter-relationships generated using Eigen Scores

6 Conclusions And Recommendations

An analysis of the number of links to the eastern and southern African HEIs' websites shows that all the institutions received links from external sources. These linking web pages belong to governments, non-governmental organisations, companies, and other institutions that are within the same country as the HEIs and/or in foreign countries Although we could not immediately determine the location of the institutions (i.e. whether local or international) which colink to the HEIs, the inlinks may generally reflect the visibility status of the websites, in which case visibility refers to local and/or international visibility. It was also observed that older institutions received the lion's share of inlinks. For instance, in Kenya, Kenyatta University (KU), the University of Nairobi (UONBI), and Jomo Kenyatta University of Agriculture and Technology (JKUAT) were linked to by 630, 1170 and 371, respectively. The UONBI did not feature in the top 40 universities which recorded a normalised colink count of 1.5 and more. In the case of South Africa, more established universities recorded higher inlinks than less established institutions. The UCT recorded the highest number of inlinks (i.e. 8200) followed by UP (4050), UWC (4040) and WITS (3460). It is worth noting, however, that there could be other reasons explaining the linking patterns illustrated in Appendix B.

The number of institutions with which each university is colinked was computed, and results reveal that most institutions (39 out of 40) were colinked with more than 50% of the top 40 institutions. The implication of such a colinking pattern is that most of the websites of HEIs in eastern and southern African countries can be accessed through single websites that have colinked the institutions. It makes access easier when most of the institutions' URLs are found in one website or page. It is however prudent that the links are clearly visible to the user of a particular website to ensure access.

The institutions' colink relationships in Table 1 are supported by the illustration in Figure 3, which reveals ties between the nodes representing the institutions. The figure shows that there are strong colink relationships amongst most South African institutions, as illustrated by the thickness/density of the lines that join a set of institutions. Similarly, Ethiopian institutions have strong colink ties, in contrast to their Kenyan counterparts. Worth noting is the absence of dense lines joining two institutions from different countries. This relationship is further supported by Appendix B and C. Appendix B provides raw colink data, while Appendix C provides the normalised colink count (i.e. strength of colink ties). Respectively, the appendices show high and strong colink occurrences and ties of the institutions' URLs that are located in the same country. For instance, UCT and SUN were colinked to 1030 web pages; UCT and UP yielded 948 colinking pages; and 937 web pages colinked UCT and UOVS. Others include UCT and UWC (905); UP and UNISA (886); SUN and UP (882); UCT and WITS (872); SUN and UNISA (805); and RU and UCT (802). All these institutions are located in South Africa.

In Ethiopia's case, higher raw colink counts were witnessed between ALEMAYA and DEBUB (558); Addis Ababa University (AAU) and ALEMAYA (556); and AAU and MEKELLE (556). In Kenya, the KU is colinked together with Moi University (MU) and the United States International University (USIU) by 129 and 108 web pages respectively, while JKUAT and USIU are colinked by 121 web pages. The same pattern is repeated in Appendix C. The lack of high colink counts between institutions in different countries may imply weak colink relationships between the institutions. The pattern may also imply that most colinking web sites or pages were country-specific, i.e. either located within the same country as the institutions or in different countries but concerned with institutions located in a particular country or set of countries. It was not possible to determine from the links and linking patterns whether fewer colink counts reflect weaker relationships (or similarity) amongst the HEIs themselves.

Furthermore, it has been observed that researchers lack knowledge about the motives for linking. We concur with Thelwall, as cited in Zeinolabedinio, Maktabifard & Osareh (n.d.), who argues that "there are some theoretical reasons for colink in different situations but we have little knowledge about models and motivations of linking". The same view is held by Zeinolabedinio, Maktabifard & Osareh (n.d.), i.e. that no one reason could be given to explain the motives behind colinking institutions. However, some motives or reasons for linking and colinking have been suggested by several authors (e.g. Zeinolabedinio, Maktabifard & Osareh, n.d.; Ortega, Aguillo, Cothey & Scharhorst, n.d.; Vaughan, Kipp & Gao, 2006; and Vaughan, Gao & Kipp, 2006). For example, in their study of the world national library websites, Zeinolabedinio, Maktabifard & Osareh (n.d.) observed that the libraries are co-linked based on the following: guiding lists provided in websites, online national bibliographies, important information resources, news, working programs and electronic full-text resources. Motivations for the provision of links to business websites, according to Vaughan, Gao and Kipp (2006), include online directories, lists of companies, news articles, acknowledging sponsors, links to business partners, links from customers, links of products, links from job advertisements, and lists of clients. These two papers provide motivations for linking in non-academic environments. Vaughan, Kipp & Gao's (2006) and Ortega, Aguillo, Cothey & Scharnborst's (n.d.) articles provide academic-specific motives for colinking. The former found that two universities were colinked because they were related academically. In this case, the authors suggest, the relationship was either general (i.e. university libraries or student organisations) or with specific reference to teaching or research. The latter suggests geographic proximity as a factor that influences colinks, as illustrated by several national networks within the European network. Similar results were observed in our study (see Figures 4, 5 & 6). The institutions that are located in the same country were placed adjacent to each other in the scatter graphs, implying closer colink ties. This in turn implies closer relationships, which can be explained by

the fact that the institutions are located in the same geographic region. An examination of the web pages that provided links to a pair or set of URLs belonging to HEIs in eastern and southern Africa revealed more reasons for co-linking, which include the following:

They are of the same type, i.e. they are institutions of higher learning. Colinking web pages provided only a list of the institutions and their URLs (e.g. Ahibo : African colleges & universities – http://ahibo.com/uaf.htm; Links Southern African Universities - www.library.unp.ac.za/LinksSAUniversities.htm; African Universities on the internet – www-sul.stanford.edu/depts/ssrg/africa/.../african-universities.html)

They offer common or African related academic programs (e.g. African Studies Programs - www.columbia.edu/cu/lweb/indiv/africa/cuvl/afstprog.html; Afrikanska språk vid GU - www.african.gu.se/linkorg-afr.html; Sociosite: Social Science Departments in Africa - www.sociosite.net/socdeps/africa.php)

They are subjects of evaluative studies (e.g. World Universities' ranking on the web: Top Africa - www.webometrics.info/top100_continent.asp?cont=africa)

This study has drawn us closer to the nature of colinks but left us speculating on the reasons behind/governing the links. Whether this missing thread can be found through a qualitative follow up study of the websites' contents, is worth exploring.

- We propose further research in order to:
- comprehensively establish reasons for linking
- compare applicable methodologies for comparative purposes (e.g. co-word analysis)
- compare the results with those of other search engines (e.g. Google)
- study other African institutions of higher learning
- compare with other analytic measurements, such as measures of centrality (e.g. closeness and betweenness)
- establish the social aspects of linking and links

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APPENDIX A: Institutions and URLs investigated

ANGOLA	FACULDADE DE MEDICINA UNIVERSIDADE AGOSTINHO NETO	**http://www.fmuan.ao**
	INSTITUTO SUPERIOR DE ENFERMAGEM	**http://www.iseuan.ed.ao**
	UNIVERSIDADE CATOLICA DE ANGOLA	**http://www.ucan.edu**
	UNIVERSITY AGOSTINHO NETO	**http://www.uan.ao**
BOTSWANA	BOTSWANA COLLEGE OF AGRICULTURE	**http://www.bca.bw**
	UNIVERSITY OF BOTSWANA	**http://www.ub.bw**
BURUNDI	CENTRE AFRICAIN DES HAUTES ETUDES	**http://www.cahe.bj.refer.org**
	UNIVERSITE DU BURUNDI	**http://www.ub.edu.bi**
DJIBOUTI	UNIVERSITE DE DJIBOUTI	**http://www.univ.edu.dj**
ERITREA	UNIVERSITY OF ASMARA	**http://www.uoa.edu.er**
ETHIOPIA	ADDIS ABABA UNIVERSITY	**http://www.aau.edu.et**
	ALEMAYA UNIVERSITY	**http://www.alemayau.edu.et**
	DEBUB UNIVERSITY	**http://www.d-univ.edu.et**
	GONDAR COLLEGE OF MEDICAL SCIENCES	**http://www.ugondar.edu.et**
	MEKELLE UNIVERSITY	**http://www.mu.edu.et**
	UNITY UNIVERSITY COLLEGE	**http://www.unityuniversity.net**
KENYA	AFRICA NAZARENE UNIVERSITY	**http://www.anu.ac.ke**
	AFRICAN VIRTUAL UNIVERSITY	**http://www.avu.org**
	CATHOLIC UNIVERSITY OF EASTERN AFRICA	**http://www.cuea.edu**
	DAYSTAR UNIVERSITY	**http://www.daystar.ac.ke/**
	EGERTON UNIVERSITY	**http://www.egerton.ac.ke**
	INTERNATIONAL SCHOOL OF KENYA	**http://www.isk.ac.ke**
	JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY	**http://www.jkuat.ac.ke**
	KABARAK UNIVERSITY	**http://www.kabarak.ac.ke**
	KENYA CHRISTIAN INDUSTRIAL TRAINING INSTITUTE	**http://www.kciti.edu**
	KENYA METHODIST UNIVERSITY	**http://www.kemu.ac.ke**
	KENYA SCHOOL OF PROFESSIONAL STUDIES	**http://www.ksps.ac.ke**
	KENYATTA UNIVERSITY	**http://www.ku.ac.ke**
	KIRIRI WOMEN'S UNIVERSITY OF SCIENCE & TECHNOLOGY	**http://www.kwust.ac.ke**

	MARYKNOLL INSTITUTE OF AFRICAN STUDIES NAIROBI	**http://www.mias.edu**
	MASENO UNIVERSITY	**http://www.maseno.ac.ke**
	MOI UNIVERSITY	**http://www.mu.ac.ke**
	MOMBASA POLYTECHNIC	**http://www.mombasapoly.ac.ke**
	STRATHMORE UNIVERSITY NAIROBI	**http://www.strathmore.edu**
	SWISS MANAGEMENT ACADEMY	**http://www.sma.ac.ke**
	TANGAZA COLLEGE	**http://www.tangaza.org**
	UNITED STATES INTERNATIONAL UNIVERSITY	**http://www.usiu.ac.ke**
	UNIVERSITY OF EASTERN AFRICA BARATON	**http://www.ueab.ac.ke**
	UNIVERSITY OF NAIROBI	**http://www.uonbi.ac.ke**
LESOTHO	NATIONAL UNIVERSITY OF LESOTHO	**http://www.nul.ls**
MADAGASCAR	UNIVERSITE D'ANTANANARIVO	**http://www.univ-antananarivo.mg**
	UNIVERSITE D'ANTSIRANANA	**http://www.univ-antsiranana.mg**
	UNIVERSITE DE FIANARANTSOA	**http://www.univ-fianar.mg**
	UNIVERSITE DE MAHAJANGA	**http://www.univ-mahajanga.mg**
	UNIVERSITE DE TOAMASINA	**http://www.univ-toamasina.mg**
MALAWI	UNIVERSITE DE TULEAR	**http://www.univ-toliara.mg**
	COLLEGE OF MEDICINE UNIVERSITY OF MALAWI	**http://www.medcol.mw**
	MALAWI POLYTECHNIC	**http://www.poly.ac.mw**
	MZUZU UNIVERSITY	**http://www.mzuni.ac.mw**
	UNIVERSITY OF LIVINGSTONIA	**http://www.ulivingstonia.org**
	UNIVERSITY OF MALAWI	**http://www.unima.mw**
MOZAMBIQUE	INSTITUTO SUPERIOR DE CIÊNCIAS E TECNOLOGIA DE MOCAMBIQUE	**http://www.isctem.com**
	INSTITUTO SUPERIOR DE RELACÕES INTERNACIONAIS	**http://www.isri.ac.mz**
	INSTITUTO SUPERIOR POLITECNICO E UNIVERSITARIO	**http://www.ispu.ac.mz**
	UNIVERSIDADE CATOLICA DE MOCAMBIQUE	**http://www.ucm.ac.mz**
	UNIVERSIDADE EDUARDO MONDLANE	**http://www.uem.mz**
NAMIBIA	POLYTECHNIC OF NAMIBIA	**http://www.polytechnic.edu.na**
	UNIVERSITY CENTRE FOR STUDIES IN NAMIBIA	**http://www.tucsin.org**
	UNIVERSITY OF NAMIBIA	**http://www.unam.na**

RWANDA	KIGALI INDEPENDENT UNIVERSITY	**http://www.ulk.ac.rw**
	KIGALI INSTITUTE OF SCIENCE & TECHNOLOGY	**http://www.kist.ac.rw**
	NATIONAL UNIVERSITY OF RWANDA	**http://www.nur.ac.rw**
SOMALIA	AMOUD UNIVERSITY	**http://www.amouduniversity.net**
	BENADIR UNIVERSITY	**http://www.benadiruniversity.com**
	EAST AFRICA UNIVERSITY BOSASO	**http://www.bosaso-university.net**
	MOGADISHU UNIVERSITY	**http://www.mogadishuuniversity.com**
	NUGAAL UNIVERSITY	**http://www.nugaaluniversity.com**
	PUNTLAND STATE UNIVERSITY	**http://www.puntlandstateuniversity.com**
	UNIVERSITY OF BURAO	**http://www.buraouniversity.com**
	UNIVERSITY OF HARGEISA	**http://www.universityofhargeisa.net**
SOUTH AFRICA	CAPE PENINSULA UNIVERSITY OF TECHNOLOGY	**http://www.cput.ac.za**
	CENTRAL UNIVERSITY OF TECHNOLOGY	**http://www.cut.ac.za**
	DURBAN UNIVERSITY OF TECHNOLOGY	**http://www.dut.ac.za**
	MANGOSUTHU TECHNIKON	**http://www.mantec.ac.za**
	MIDRAND GRADUATE INSTITUTE	**http://www.mgiweb.co.za**
	MONASH UNIVERSITY SOUTH AFRICA	**http://www.monash.ac.za**
	NELSON MANDELA METROPOLITAN UNIVERSITY	**http://www.nmmu.ac.za**
	NORTH WEST UNIVERSITY	**http://www.nwu.ac.za**
	RHODES UNIVERSITY	**http://www.ru.ac.za**
	STELLENBOSCH UNIVERSITY	**http://www.sun.ac.za**
	TSHWANE UNIVERSITY OF TECHNOLOGY	**http://www.tut.ac.za**
	UNIVERSITY OF CAPE TOWN	**http://www.uct.ac.za**
	UNIVERSITY OF FORT HARE	**http://www.ufh.ac.za**
	UNIVERSITY OF JOHANNESBURG	**http://www.uj.ac.za**
	UNIVERSITY OF KWAZULU NATAL	**http://www.ukzn.ac.za**
	UNIVERSITY OF LIMPOPO	**http://www.ul.ac.za**
	UNIVERSITY OF PRETORIA	**http://www.up.ac.za**
	UNIVERSITY OF SOUTH AFRICA	**http://www.unisa.ac.za**
	UNIVERSITY OF THE FREE STATE	**http://www.uovs.ac.za**

	UNIVERSITY OF THE WESTERN CAPE	**http://www.uwc.ac.za**
	UNIVERSITY OF THE WITWATERSRAND	**http://www.wits.ac.za**
	UNIVERSITY OF VENDA	**http://www.univen.ac.za**
	UNIVERSITY OF ZULULAND	**http://www.uzulu.ac.za**
	VAAL UNIVERSITY OF TECHNOLOGY	**http://www.vut.ac.za**
	WALTER SISULU UNIVERSITY	**http://www.wsu.ac.za**
	ACADEMY OF MEDICAL SCIENCES AND TECHNOLOGY	**http://www.amst-edu.com**

APPENDIX B: Raw colink data (Number of pages pointing to a pair of institutions)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	855	556	512	526	556	5	19	22	2	2	6	24	7	27	2	10	16	3	2	3
2	556	776	558	527	532	0	6	4	0	0	0	4	0	7	0	0	3	0	0	0
3	512	558	590	518	518	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	526	527	518	687	518	3	3	5	0	0	4	2	4	5	0	2	5	2	0	1
5	556	532	518	518	724	1	4	3	0	0	0	4	4	4	0	4	4	1	0	0
6	5	0	0	3	1	71	19	17	12	11	12	15	17	19	8	17	17	15	0	0
7	19	6	0	3	4	19	150	46	11	11	17	43	22	53	9	38	51	15	1	0
8	22	4	0	5	3	17	46	371	9	8	22	118	19	121	47	84	99	14	3	4
9	2	0	0	0	0	12	11	9	38	13	7	10	11	11	8	12	14	13	0	0
10	2	0	0	0	0	11	11	8	13	34	8	11	10	10	8	12	13	11	0	0
11	6	0	0	4	0	12	17	22	7	8	53	18	12	22	12	14	58	9	0	0
12	24	4	0	2	4	15	43	118	10	11	18	630	17	129	46	75	108	12	3	2
13	7	0	0	4	4	17	22	19	11	10	12	17	32	20	7	19	22	15	0	0
14	27	7	0	5	4	19	53	121	11	10	22	129	20	407	47	82	104	13	3	4
15	2	0	0	0	0	8	9	47	8	8	12	46	7	47	102	46	48	6	0	0
16	10	0	0	2	4	17	38	84	12	12	14	75	19	82	46	250	83	12	2	3
17	16	3	0	5	4	17	51	99	14	13	58	108	22	104	48	83	254	16	2	3
18	3	0	0	2	1	15	15	14	13	11	9	12	15	13	6	12	16	51	0	0
19	2	0	0	0	0	0	1	3	0	0	0	3	0	3	0	2	2	0	300	88
20	3	0	0	1	0	0	0	4	0	0	0	2	0	4	0	3	3	0	88	182
21	8	0	0	4	0	2	5	8	0	0	5	5	3	11	0	5	8	2	44	45
22	7	0	0	2	0	2	3	5	1	1	2	8	2	9	1	3	9	2	78	66
23	4	0	0	1	0	0	1	4	0	0	1	5	1	5	0	3	5	0	42	41
24	21	4	0	4	3	2	19	33	2	2	6	40	6	41	2	10	25	2	78	70
25	40	9	0	4	4	2	19	37	2	2	6	36	6	48	3	10	22	2	89	79
26	3	0	0	1	0	0	0	4	0	0	0	3	0	3	0	3	4	0	80	82
27	38	5	0	4	4	2	20	42	2	2	6	45	6	47	3	12	27	2	104	81
28	21	5	0	4	3	2	18	21	0	0	5	27	6	41	0	8	21	3	88	77
29	6	0	0	0	0	0	3	3	2	2	2	11	0	10	2	4	9	0	76	59
30	15	4	1	1	1	0	5	8	0	0	2	3	1	4	0	3	4	0	84	61
31	0	0	0	0	0	0	0	0	0	0	0	4	0	3	0	0	4	0	41	37

32	28	5	0	4	3	2	20	38	6	2	5	43	6	4	2	10	27	2	73	81
33	29	2	0	4	13	2	15	32	0	0	6	34	6	37	3	8	24	2	80	72
34	25	5	0	4	2	2	19	25	2	1	5	27	6	39	2	10	25	2	84	84
35	26	4	2	4	5	2	19	21	2	2	6	28	6	44	2	10	24	2	92	83
36	38	5	0	4	3	3	23	36	2	2	5	45	6	41	2	10	24	2	75	83
37	16	3	0	4	3	2	15	19	0	0	5	21	6	26	0	8	17	2	76	73
38	12	1	0	4	2	2	10	13	0	0	5	12	6	22	0	8	15	2	68	63
39	2	0	0	0	0	0	0	2	0	0	0	2	0	2	0	2	2	0	78	68
40	5	0	0	2	0	2	4	3	2	2	2	7	2	10	2	2	8	2	65	53

Note: The highlighted figures indicate the number of external pages pointing to URL X or URL Y

APPENDIX B - Continued

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	8	7	4	21	40	3	38	21	6	15	0	28	29	25	26	38	16	12	2	5
2	0	0	0	4	9	0	5	5	0	4	0	5	2	5	4	5	3	1	0	0
3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0
4	4	2	1	4	4	1	4	4	0	1	0	4	4	4	4	4	4	4	0	2
5	0	0	0	3	4	0	4	3	0	1	0	3	13	2	5	3	3	2	0	0
6	2	2	0	2	2	0	2	2	0	0	0	2	2	2	2	3	2	2	0	2
7	5	3	1	19	19	0	20	18	3	5	0	20	15	19	19	23	15	10	0	4
8	8	5	4	33	37	4	42	21	3	8	0	38	32	25	21	36	19	13	2	3
9	0	1	0	2	2	0	2	0	2	0	0	6	0	2	2	2	0	0	0	2
10	0	1	0	2	2	0	2	0	2	0	0	2	0	1	2	2	0	0	0	2
11	5	2	1	6	6	0	6	5	2	2	0	5	6	5	6	5	5	5	0	2
12	5	8	5	40	36	3	45	27	11	3	4	43	34	27	28	45	21	12	2	7
13	3	2	1	6	6	0	6	6	0	1	0	6	6	6	6	6	6	6	0	2
14	11	9	5	41	48	3	47	41	10	4	3	4	37	39	44	41	26	22	2	10
15	0	1	0	2	3	0	3	0	2	0	0	2	3	2	2	2	0	0	0	2
16	5	3	3	10	10	3	12	8	4	3	0	10	8	10	10	10	8	8	2	2
17	8	9	5	25	22	4	27	21	9	4	4	27	24	25	24	24	17	15	2	8
18	2	2	0	2	2	0	2	3	0	0	0	2	2	2	2	2	2	2	0	2
19	44	78	42	78	89	80	104	88	76	84	41	73	80	84	92	75	76	68	78	65
20	45	66	41	70	79	82	81	77	59	61	37	81	72	84	83	83	73	63	68	53
21	510	395	34	440	450	399	456	251	387	399	18	457	456	455	457	439	243	458	393	388
22	395	560	53	215	225	431	222	444	431	437	50	223	221	214	213	217	435	427	423	422
23	34	53	167	76	78	51	74	68	58	53	40	83	81	70	73	79	66	57	44	39
24	440	215	76	2900	665	431	802	372	244	220	52	681	674	607	589	586	297	396	413	426
25	450	225	78	665	2520	219	1030	362	283	248	47	882	805	692	732	758	323	441	423	431
26	399	431	51	431	219	568	215	432	432	441	49	241	231	442	204	218	203	420	444	417
27	456	222	74	802	1030	215	8200	389	288	297	55	948	937	725	905	872	331	465	424	438
28	251	444	68	372	362	432	389	825	439	214	53	378	390	371	405	379	358	309	419	433
29	387	431	58	244	283	432	288	439	674	211	46	284	287	264	248	282	203	423	416	423
30	399	437	53	220	248	441	297	214	211	3100	42	274	253	246	248	275	436	214	425	424
31	18	50	40	52	47	49	55	53	46	42	81	62	62	57	56	61	59	38	42	41
32	457	223	83	681	882	241	948	378	284	274	62	4050	886	707	650	774	328	444	441	431
33	456	221	81	674	805	231	937	390	287	253	62	886	2980	692	686	735	331	456	444	214
34	455	214	70	607	692	442	725	371	264	246	57	707	692	1280	612	613	318	442	427	429
35	457	213	73	589	732	204	905	405	248	248	56	650	686	612	4040	637	327	469	424	425
36	439	217	79	586	758	218	872	379	282	275	61	774	735	613	637	3460	312	440	438	427
37	243	435	66	297	323	203	331	358	203	436	59	328	331	318	327	312	543	281	429	426
38	458	427	57	396	441	420	465	309	423	214	38	444	456	442	469	440	281	656	411	413
39	393	423	44	413	423	444	424	419	416	425	42	441	444	427	424	438	429	411	496	408
40	388	422	39	426	431	417	438	433	423	424	41	431	214	429	425	427	426	413	408	487

Note: The highlighted figures indicate the number of external pages

pointing to URL X or URL Y

Appendix C: Normalised colink count

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		0.34	0.35	0.34	0.35	0.01	0.02	0.02	0.00	0.00	0.01	0.02	0.01	0.02	0.00	0.01	0.01	0.00	0.00	
2	0.34		0.41	0.36	0.35	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.34
3	0.35	0.41		0.41	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35
4	0.34	0.36	0.41		0.37	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.34
5	0.35	0.35	0.39	0.37		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.35
6	0.01	0.00	0.00	0.00	0.00		0.09	0.04	0.11	0.10	0.10	0.02	0.17	0.04	0.05	0.05	0.05	0.12	0.00	0.01
7	0.02	0.01	0.00	0.00	0.00	0.09		0.09	0.06	0.06	0.08	0.06	0.12	0.10	0.04	0.10	0.13	0.07	0.00	0.02
8	0.02	0.00	0.00	0.00	0.00	0.04	0.09		0.02	0.02	0.05	0.12	0.05	0.16	0.10	0.14	0.16	0.03	0.00	0.02
9	0.00	0.00	0.00	0.00	0.00	0.11	0.06	0.02		0.18	0.08	0.01	0.16	0.02	0.06	0.04	0.05	0.15	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.10	0.06	0.02	0.18		0.09	0.02	0.15	0.02	0.06	0.04	0.05	0.13	0.00	0.00
11	0.01	0.00	0.00	0.01	0.00	0.10	0.08	0.05	0.08	0.09		0.03	0.14	0.05	0.08	0.05	0.19	0.09	0.00	0.01
12	0.02	0.00	0.00	0.00	0.00	0.02	0.06	0.12	0.01	0.02	0.03		0.03	0.12	0.06	0.09	0.12	0.02	0.00	0.02
13	0.01	0.00	0.00	0.01	0.01	0.17	0.12	0.05	0.16	0.15	0.14	0.03		0.05	0.05	0.07	0.08	0.18	0.00	0.01
14	0.02	0.01	0.00	0.00	0.00	0.04	0.10	0.16	0.02	0.02	0.05	0.12	0.05		0.09	0.12	0.16	0.03	0.00	0.02
15	0.00	0.00	0.00	0.00	0.00	0.05	0.04	0.10	0.06	0.06	0.08	0.06	0.05	0.09		0.13	0.13	0.04	0.00	0.00
16	0.01	0.00	0.00	0.00	0.00	0.05	0.10	0.14	0.04	0.04	0.05	0.09	0.07	0.12	0.13		0.16	0.04	0.00	0.01
17	0.01	0.00	0.00	0.01	0.00	0.05	0.13	0.16	0.05	0.05	0.19	0.12	0.08	0.16	0.13	0.16		0.05	0.00	0.01
18	0.00	0.00	0.00	0.00	0.00	0.12	0.07	0.03	0.15	0.13	0.09	0.02	0.18	0.03	0.04	0.04	0.05		0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
20	0.00	0.34	0.35	0.34	0.35	0.01	0.02	0.02	0.00	0.00	0.01	0.02	0.01	0.02	0.00	0.01	0.01	0.00	0.00	
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.18	0.00
22	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.05	0.01
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.09	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.09	0.00
25	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01
26	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.01	0.00	0.03	0.01
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00
29	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.02	0.01	0.03	0.00	0.01	0.02	0.00	0.08	0.01
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.08	0.00
31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.11	0.00
33	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01
34	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01
35	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.01	0.02	0.00	0.05	0.01
36	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01
37	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01
38	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.01	0.02	0.01	0.03	0.00	0.01	0.02	0.00	0.09	0.01
39	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.00	0.07	0.01
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00

Note: Higher normalised colink counts are highlighted

Appendix C – Continued

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.01	0.00

8	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.02	0.01	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
12	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.00
13	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
14	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.01	0.03	0.01	0.00	0.01	0.00	0.01	0.02	0.01	0.01	0.03	0.02	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00
17	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.02	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.18	0.05	0.09	0.09	0.02	0.03	0.09	0.01	0.08	0.08	0.02	0.11	0.02	0.02	0.05	0.02	0.02	0.09	0.07	0.10
20	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
21		0.07	0.09	0.12	0.02	0.03	0.11	0.01	0.08	0.07	0.02	0.14	0.02	0.02	0.06	0.02	0.02	0.10	0.08	0.10
22	0.07		0.37	0.05	0.13	0.15	0.37	0.05	0.19	0.33	0.11	0.03	0.10	0.13	0.25	0.10	0.11	0.23	0.39	0.39
23	0.09	0.37		0.07	0.06	0.07	0.38	0.03	0.32	0.35	0.12	0.08	0.05	0.06	0.12	0.05	0.05	0.39	0.35	0.40
24	0.12	0.05	0.07		0.02	0.03	0.07	0.01	0.07	0.07	0.02	0.16	0.02	0.03	0.05	0.02	0.02	0.09	0.07	0.07
25	0.02	0.13	0.06	0.02		0.12	0.12	0.07	0.10	0.07	0.04	0.02	0.10	0.11	0.15	0.08	0.09	0.09	0.11	0.12
26	0.03	0.15	0.07	0.03	0.12		0.07	0.10	0.11	0.09	0.04	0.02	0.13	0.15	0.18	0.11	0.13	0.11	0.14	0.14
27	0.11	0.37	0.38	0.07	0.12	0.07		0.02	0.31	0.35	0.12	0.08	0.05	0.07	0.24	0.04	0.05	0.18	0.34	0.42
28	0.01	0.05	0.03	0.01	0.07	0.10	0.02		0.04	0.03	0.03	0.01	0.08	0.08	0.08	0.07	0.07	0.04	0.05	0.05
29	0.08	0.19	0.32	0.07	0.10	0.11	0.31	0.04		0.29	0.05	0.06	0.08	0.10	0.18	0.08	0.09	0.26	0.21	0.32
30	0.07	0.33	0.35	0.07	0.07	0.09	0.35	0.03	0.29		0.06	0.06	0.06	0.08	0.14	0.05	0.07	0.17	0.32	0.36
31	0.02	0.11	0.12	0.02	0.04	0.04	0.12	0.03	0.05	0.06		0.01	0.04	0.04	0.06	0.03	0.04	0.12	0.06	0.12
32	0.14	0.03	0.08	0.16	0.02	0.02	0.08	0.01	0.06	0.06	0.01		0.02	0.02	0.04	0.01	0.02	0.09	0.05	0.07
33	0.02	0.10	0.05	0.02	0.10	0.13	0.05	0.08	0.08	0.06	0.04	0.02		0.13	0.13	0.08	0.10	0.07	0.09	0.10
34	0.02	0.13	0.06	0.03	0.11	0.15	0.07	0.08	0.10	0.08	0.04	0.02	0.13		0.16	0.10	0.11	0.09	0.13	0.13
35	0.06	0.25	0.12	0.05	0.15	0.18	0.24	0.08	0.18	0.14	0.06	0.04	0.13	0.16		0.12	0.13	0.17	0.23	0.24
36	0.02	0.10	0.05	0.02	0.08	0.11	0.04	0.07	0.08	0.05	0.03	0.01	0.08	0.10	0.12		0.08	0.07	0.10	0.09
37	0.02	0.11	0.05	0.02	0.09	0.13	0.05	0.07	0.09	0.07	0.04	0.02	0.10	0.11	0.13	0.08		0.08	0.11	0.11
38	0.10	0.23	0.39	0.09	0.09	0.11	0.18	0.04	0.26	0.17	0.12	0.09	0.07	0.09	0.17	0.07	0.08		0.23	0.41
39	0.08	0.39	0.35	0.07	0.11	0.14	0.34	0.05	0.21	0.32	0.06	0.05	0.09	0.13	0.23	0.10	0.11	0.23		0.36
40	0.10	0.39	0.40	0.07	0.12	0.14	0.42	0.05	0.32	0.36	0.12	0.07	0.10	0.13	0.24	0.09	0.11	0.41	0.36	

Note: Higher normalised colink counts are highlighted

APPENDIX D: Key to Appendices B and C

1	**aau.edu.et**	**11**	**ksps.ac.ke**	**21**	**mantec.ac.za**	**31**	**ul.ac.za**
2	**alemayau.edu.et**	**12**	**ku.ac.ke**	**22**	**nmmu.ac.za**	**32**	**up.ac.za**
3	**d-univ.edu.et**	**13**	**kwust.ac.ke**	**23**	**nwu.ac.za**	**33**	**unisa.ac.za**
4	**ugondar.edu.et**	**14**	**mu.ac.ke**	**24**	**ru.ac.za**	**34**	**uovs.ac.za**
5	**mu.edu.et**	**15**	**mombasapoly.ac.ke**	**25**	**sun.ac.za**	**35**	**uwc.ac.za**
6	**anu.ac.ke**	**16**	**strathmore.edu**	**26**	**tut.ac.za**	**36**	**wits.ac.za**
7	**cuea.edu**	**17**	**usiu.ac.ke**	**27**	**uct.ac.za**	**37**	**uneven.ac.za**
8	**jkuat.ac.ke**	**18**	**ueab.ac.ke**	**28**	**ufh.ac.za**	**38**	**uzulu.ac.za**
9	**kabarak.ac.ke**	**19**	**cput.ac.za**	**29**	**uj.ac.za**	**39**	**vut.ac.za**
10	**kemu.ac.ke**	**20**	**cut.ac.za**	**30**	**ukzn.ac.za**	**40**	**wsu.ac.za**