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NIGERIAN UNIVERSITY WEBSITES: WEBOMETRIC MAPPING OF HYPERLINK CONNECTIVITY IN AN EMERGING ACADEMIC WEB SPACE

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ABSTRACT

This paper examines the hyperlink architecture of Nigerian university websites by constructing and analyzing a web space, based on the official online presence of the universities in the most populous country in Africa. Using data collected in 2024 through web crawling, the findings reveal a disorganized and weakly connected web structure. The official sites of universities were often tiny in their size and generated a minimum of outbound links. Connectivity improved when web neighborhoods, owned by respective universities, were treated as single units of analysis. The most significant change in connectivity was observed with the inclusion of a central web communicator—the National Universities Commission (NUC)—which plays a pivotal role in linking the Nigerian academic web. The paper uses graph-theoretical webgraph analysis to map the structural characteristics of the Nigerian academic web, and gives specific recommendations for university web administrators and policy makers to enhance digital integration and visibility. The study highlights key methodological limitations of hyperlink analysis when reliant on search engines, particularly in contexts where comprehensive national-level web crawling is both feasible and necessary. Furthermore, it identifies the structural centrality of a single web communicator, the NUC, in shaping national academic web connectivity. Collectively, these insights offer meaningful implications for both future research and practical approaches to analyzing and managing academic web ecosystems.

Keywords: University Website, Nigeria, Hyperlinks, Webometrics, Academic Web

INTRODUCTION

The topic of hyperlink structures has traditionally been at the focus of webometric studies. Ever since the first search engines defined the theoretical and commercial worth of the link-based ranking model (Brin and Page, 1998; Segalovich et al., 2006), researchers have been the ones who empirically examine the web as a medium of academic relationships, institutional prestige, and pattern of scholarly communication (Thelwall et al., 2012; Paruschke & Philipps, 2022). University websites, especially, are a highly fruitful and analytically amenable field: they are endowed with an institutional presence, fulfil communicative roles between academicians and non-academicians, and their evolution history is sufficiently long to show significant structural patterns. The available literature on academic web structure has been more inclined towards institutions within Europe, North America and to some extent Latin America and Russia. Thelwall (2016) found that hyperlinks among some university websites follow discrete power law distribution, meaning a few highly linked "hub" sites have many links, while most sites have very few. Investigations of universities also reported a geographic aspect to the hyperlinking behavior where higher geographic proximity of the institutions to each other increased the chance of the institutions linking (Ponds et al., 2007; White & Lee, 2020). Durnev et al. (2025) analyzed websites of Russian universities and the results showed that the websites constitute slightly more than a half of a strongly connected element in the resulting webgraph. Filippetti & Savona (2017) studied the larger academic web and found that interlinking patterns differed substantially on the basis of the institutional affiliation of the linking and linked-to page. In a webgraph of 2,000 Spanish university departments and research groups built by Ortega and Aguillo (2007), it was found that only 699 of those websites of less than 35 per cent involvement were involved in a strongly connected component. African universities, and Nigerian ones in particular, also continue to be studied conspicuously in this literature. In the case of Nigerian universities, the situation is quite interesting: they are comparatively new educational organizations, whose online presence is actively developing, and the framework of higher education and the rise of internet penetration is expanding. The study of the organization of their web presence is not only useful as a contribution to the theory of web metrics, but also as a form of diagnostics with real-world implications on an institutional level of web strategy and national education policy. There are two main research questions that are discussed in this paper, and the data used in this paper was collected in 2024. The 2024 data represents one of the times when Nigeria has 288 universities a significant number that has since increased dramatically and when most institutions were first developing their first meaningful online presence. The investigative questions are the following: What is the structural composition of the Nigerian academic web? What are the connectivity properties of the Nigerian academic web space?

Literature Review

Webometrics, as a discipline, draws on both bibliometrics and information science to study the quantitative properties of the World Wide Web (Pathak & Verma, 2021; Rafiq et al., 2026). Within this field, the hyperlink functions as the primary unit of analysis, analogous, though not equivalent, to the citation in traditional bibliometrics.

Initial studies on webometrics confirmed that hyperlink networks could be used as indicators of scholarly communication, institutional presence and knowledge sharing (Yi and Jin, 2008; Höppner et al., 2009; Fragoso, 2011). Nevertheless, later research has also pointed at the shortcomings of using hyperlink data only since link-based networks do not necessarily capture the actual usage patterns or academic impact (Jiang et al., 2024; Borgonovi and Andrieu, 2025).

Weak and underdeveloped academic web presence has been reported all along by prior studies. To illustrate this, a previous webmetric study of websites of Nigerian universities found a low interconnectivity with institutional websites having little hyperlink exchange and structural cohesion (Nwagwu & Agarin, 2008). Likewise, a study of academic library websites found that more than half of the sites did not have a web presence of their own, and of those that did, web impact factor and inbound links were very low, indicating low visibility and online activity (Asubiaro, 2017). These results indicate systemic issues in the online presence of higher education institutions in Nigeria.

The university websites have been analyzed in complementary studies through the perspectives of usability, accessibility and performance. For instance, analysis based on such tools as Alexa Internet has demonstrated that there are differences in the traffic, user participation, and worldwide presence between the Nigerian universities, and only some of the institutions have a large online presence (Adetayo & Adeniran; 2020). Other studies focusing on web portal usability and accessibility standards, it has been shown that most university websites do not meet international standards, and thus limiting their effectiveness for students and other stakeholders (Oliha, 2014). Such usability and accessibility constraints add to the structural weaknesses of hyperlink-based analyses.

Recent studies have started to investigate the functional implications of web presence, since it has been associated with institutional performance in the form of student enrollment and academic reputation. The prospects of a high-quality digital footprint in higher education are strengthened by the fact that prospective students can be swayed by the quality of the websites they visit and the experience they get on their site (Anozie and Ogba, 2023). Meanwhile, the webmetric ranking research conducted worldwide has highlighted the increasing rivalry between universities in an attempt to increase their online presence as a way of securing prestige and resources (Ojokoh & Akinola, 2017).

It is against this background that the focal article makes its contribution by taking a graph-theoretical approach to chart the connectivity of the hyperlinks of the websites of the Nigerian universities as a new academic web space. It extends previous research on weak connectivity and adds to the literature by showing that structural cohesion can be influenced significantly by centralized actors within the network, especially regulatory bodies. In doing so, the study not only deepens understanding of the Nigerian academic web but also aligns with broader webometric debates on the validity and interpretation of hyperlink-based indicators in assessing academic systems.

MATERIALS AND METHODS

Data Collection

The inquiry demanded the domain names of official web sites to each of the 288 universities in total in the National Universities Commission (NUC) as of 2024 consisting of 72 federal, 67 state, and 149 private universities (NUC, 2024). The NUC directory of institutional web addresses was considered as an initial basis since it was found that the list contains a lot of inaccuracy and omissions, which had to be iteratively checked and supplemented during the data collection process. The last target list was composed of 97 domain names with verified, available websites belonging to universities. According to Thelwall and Zuccala (2008), there are two major ways in which hyperlink data can be collected and they are search engines of a commercial nature and web crawlers. Nwohiri & Pechnikov (2024) found that the largest search engines do not index educational websites in Nigeria well, hence search-engine-generated link information cannot be used in this context. Based on this, we developed a web crawler that was used in this study to gather outbound hyperlinks of each of the target sites in a systematic manner. Crawling was done up to a depth of five levels which was perceived to be adequate in capturing the huge majority of the outlinks on most Nigerian university sites.

Analytical Procedure

The analysis process was based on a formulated methodology used in examining the Russian academic web spaces (Pechnikov et al., 2021) but tailored to the Nigerian situation. Starting with the target set, one created a full database of external hyperlinks with the help of the crawler. Based on this database, the corresponding set was obtained and further divided into the web neighborhoods, web communicators and a cover set (sites that had very little or no reciprocal linking activity). All the target sites were then grouped with their web neighborhood to become a unit of analysis. At three levels of aggregation (a) the target set; (b) the set of units of analysis; and (c) the set of units of analysis with identified web communicators added, the webgraphs were built. The node of a webgraph is the representatives of sites or units of analysis and the directed edges are the existence of at least one hyperlink between the related entities. The isolated vertices (those that have no incoming or outgoing edges) are mentioned but not considered in connectivity analysis. Graph-theoretical measures such as the degree of a vertex, connected components and strong and weak connectivity were then calculated and compared amongst the three webgraph configurations.

RESULTS AND DISCUSSION

Target Set: Nigerian University Websites

The 97 higher education institutions in the target population are spread in the five geopolitical regions of Nigeria: North (15 universities), the South-South (17 universities), Southeast (16 universities), Middle Belt (20 universities) and the Southwest (29 universities). The imbalance of higher learning institutions in the Southwest is historical as the region is rated as housing majority of higher education institutions with Lagos and Ibadan being the most prominent. As far as domain naming is concerned, 83 of the 97 websites are under the normal top-level domain namely .edu.ng; the other 14 websites have a top-level domain of .net, .org, .com, or .gov, which is an aspect of inconsistency that carries implication to indexing and recognition of the institutions. Sites used were usually small. The number of sites with less than 200 HTML pages was 55, the number of sites with 201-1,000 pages was 23, the number of sites with 1,001-10,000 pages was 16, the number of sites with 10,001 pages was 3 only. The number of outlinks was also rather small: 56 outlinks generated less than 10 outlinks, with 5 sites generating no outlinks at all. Twenty-eight sites had 1100100 outlinks, 100 outlinks had 101100 outlinks, and only 3 outlinks had more than 1000 outlinks. Together, the process of scanning the target set provided a database of about 9,500 outlinks based on 102,000 pages.

Web Neighborhoods and Units of Analysis

The outlink database was analyzed to determine the web neighborhood set identified 138 websites in the web neighborhood. Eleven of these have later been established to be non-functional leaving the active neighborhood at 127 sites 74 direct and 53 hidden neighborhoods. In half of the 97 target universities, the web neighborhood was not identified whatsoever, and the unit of analysis was the official site of the

university. In the case of the other 47 universities, web neighborhoods added extra pages and outlinks that were very helpful in boosting the analytical footprint of individual institutions. Table 1 indicates that aggregation into units of analysis increased the average number of HTML pages of all the university types. The impact was greatest with state universities, where the average outlink went up by 24 (official site only) to 294 (unit of analysis) over a hundred and twenty-four times. This jump is partly attributed to the relatively low baseline: the sites of state universities officials had on average only 369 pages and 24 outlinks as compared to the overall averages of 1,054 pages and 98 outlinks. Even the introduction of the more modest scale neighborhood sites so disproportionately impacted.

Table 1: Average Count of HTML Pages and Outlinks by University Type

University Group	Site count	HTML Page count (Official sites)	Outlink count (Official sites)	HTML Page count (Units of Analysis)	Outlink count (Units of Analysis)
Federal	30	1,607	131	2,313	209
State	27	369	24	697	294
Private	40	1,102	128	1,242	165
Total	97	1,054	98	1,422	215

The regional difference is also significant (see Table 2). The universities in the Southwest dominated all regions in every measure: the official websites of the universities had an average of 1,342 pages and 189 outlinks and 2,360 pages and 544 outlinks at the unit of analysis level. This increasing rate of about 2 to 1 in pages and triple in outlinks indicates the agglomeration of well-endowed and long-established federal universities in the area which have grown to larger sub-site ecosystems.

Table 2. Average Count of HTML Pages and Outlinks by Regions

Region	Site count	HTML Page Count (Official)	Outlink count (Official)	HTML Page count (Unit of Analysis)	Outlink count (Unit of Analysis)
North	15	1,583	67	1,625	75
Middle Belt	20	639	52	692	63
SouthEast	16	591	16	630	18
South-South	17	1,019	101	1,245	140
SouthWest	29	1,342	189	2,360	544

The University of Ibadan (www.ui.edu.ng) is an example of the best practice in the target set. Its official site also had around 1,350 pages and 615 outlinks. In addition to this, 21 direct web neighborhood sites, which include faculties, colleges, university library, student and applicant portal, administrative offices and research centers also added over 3,000 additional pages and over 1,100 other outlinks. These sub-sites had a high degree of internal hyperlink connectivity and more than 750 inter-site links were recorded. The adjacency matrix of the web constellation of the University of Ibadan (see Table 3) shows the density of this internal web structure. Such an organizational structure where a central institutional portal connects a dense network of sub-sites is a model of organizational structure that other institutions in Nigeria can deploy successfully. Overall, the 74 direct web neighborhood sites provided 24,148 HTML pages and 4913 outlinks to the analysis whereas the 53 hidden neighborhood sites contributed 6778 pages and 6224 outlinks. More to the point, it would be impossible to locate the hidden neighborhoods on a search-engine-driven analysis, which is why crawler-based data collection is a must when conducting such a study.

Table 3: Webgraph Adjacency Matrix for the Sites of the University of Ibadan

#	Name	Domain name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	University of Ibadan	www.ui.edu.ng		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
2	Admission Application Portal	admissions.ui.edu.ng	1																					
3	University Advancement Centre	advance.ui.edu.ng	1																					
4	Faculty of Agriculture	agric.ui.edu.ng	1					1				1					1			1	1		1	1
5	Africa Regional Centre	arcis.ui.edu.ng	1												1	1								

#	Name	Domain name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	for Information Science																							
6	Faculty of Arts	arts.ui.edu.ng																						
7	Centre for Peace and Conflict Studies	cepacs.ui.edu.ng	1																					
8	Centre for Sustainable Development	cesdev.ui.edu.ng	1																					
9	College of Medicine	comui.ui.edu.ng																						
10	Faculty of Education	educ.ui.edu.ng	1			1		1					1				1			1	1		1	
11	Faculty of Law	law.ui.edu.ng																						
12	Kenneth Dike Library	library.ui.edu.ng	1																					
13	International Programmes	oip.ui.edu.ng																						
14	Postgraduate School	pgs.ui.edu.ng																						
15	Faculty of Pharmacy	pharm.ui.edu.ng	1			1	1					1	1							1	1		1	1
16	Portal University of Ibadan	portal.ui.edu.ng																						
17	Research Management Office	rmo.ui.edu.ng																						
18	Faculty of Science	sci.ui.edu.ng	1			1	1					1	1				1				1		1	1
19	Faculty of Social Sciences	socsc.ui.edu.ng	1			1	1					1	1				1			1			1	1
20	STEP B Project	stepb.ui.edu.ng																						
21	Faculty of Technology	tech.ui.edu.ng	1			1		1				1	1				1			1	1			1
22	Faculty of Veterinary Medicine	vet.ui.edu.ng	1			1		1				1	1							1	1		1	

Accompanying Set and Web Communicators

The web neighborhood sites scanning performed on the target set, as well as the web neighborhood, provided an extended outlink database of around 21,600 links. The set external sites that were used with the help of these links included approximately 6,800 websites, to which approximately 20,670 hyperlinks were directed. This is through subtraction to mean that Nigerian university locations (target set and neighborhoods combined) connected each other via some 930 hyperlinks an amount that gives out the scantiness cross-institutional connection of the Nigerian academic web. The set of the distribution thereof was extremely skewed to the right: about 5,500 sites were given only one inbound link, and 700 received two. A total of 14 sites in the registry of the set all with a rather scientific or academic focus such as African Journals Online (www.ajol.info), the National Virtual Library Project (www.nigerianvirtuallibrary.com) had over three different target or neighborhood sites that linked to them. Upon crawling these 14 sites however, only a small number were discovered to have outbound links back to the Nigerian university sites, which would eliminate them as communicator candidates. Only one of the websites was defined as a web communicator; the NUC website (www.nuc.edu.ng) contained outbound links to 15 sites of Nigerian universities and 16 inbound links with 14 sites. Being the only accrediting body of Nigerian higher education, the NUC is structurally centrally positioned, which, as the analysis below shows, has a disproportionate impact on the connectivity of the academic webgraph.

Webgraph Analysis

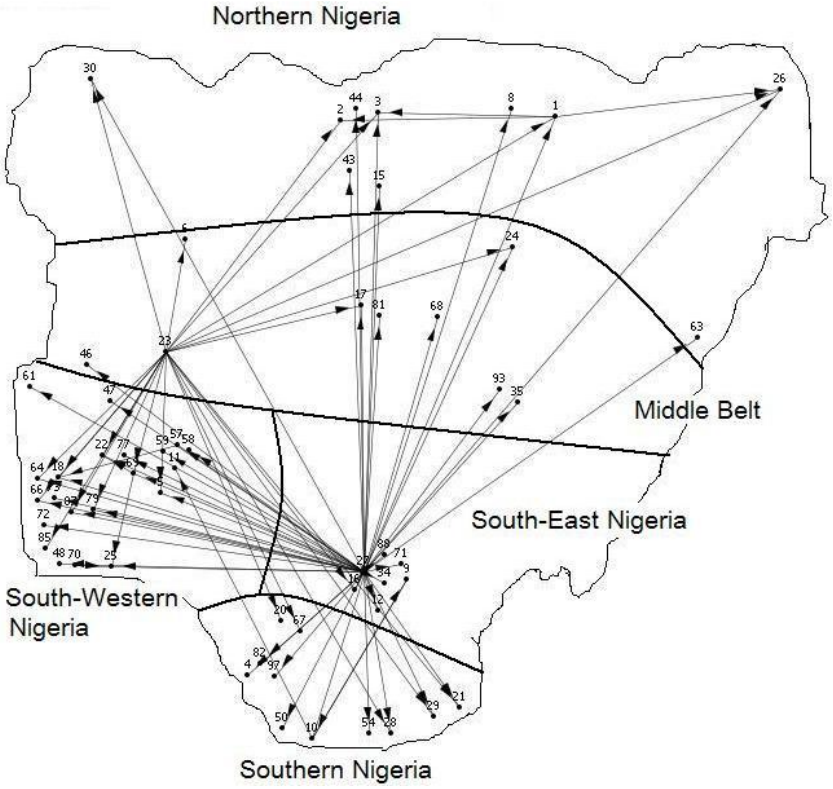

Figure 1: Target Set Webgraph

Figure 1 presents the webgraph constructed from the 97 target set sites. Of these, 18 were completely isolated no incoming or outgoing edges at all. The remaining 79 sites form the visible graph, but the structure is misleading at first glance: 72 of the 79 visible vertices are pendant nodes, meaning they possess only incoming edges and contribute no outbound links. The graph's apparent connectivity is sustained almost entirely by two vertices: site 23 (University of Ilorin, www.unilorin.edu.ng), which generated 23 outgoing edges, and site 27 (University of Nigeria, Nsukka, www.unn.edu.ng), which generated 46. Removing these two vertices as illustrated in Figure 2 of the original publication produces an almost entirely disconnected graph of 65 additional isolated vertices.

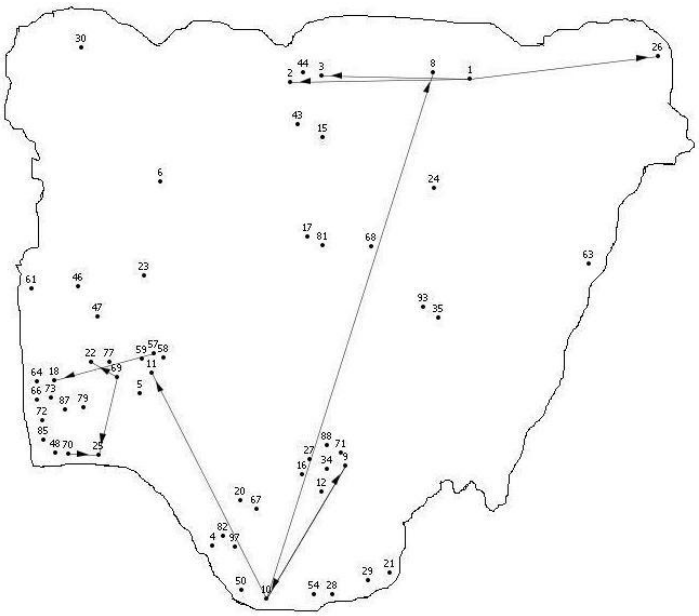

Figure 2: Target Set Webgraph without Vertices 23 and 27

Connectivity improved substantially when target set sites were replaced by their units of analysis and the NUC communicator site was added (Figure 3). The resulting webgraph exhibited the following graph-theoretical properties: number of vertices 98; number of edges 114; isolated vertices 30; pendant vertices 39; vertices in the maximal weakly connected component 68; vertices in the maximal strongly connected component: 5

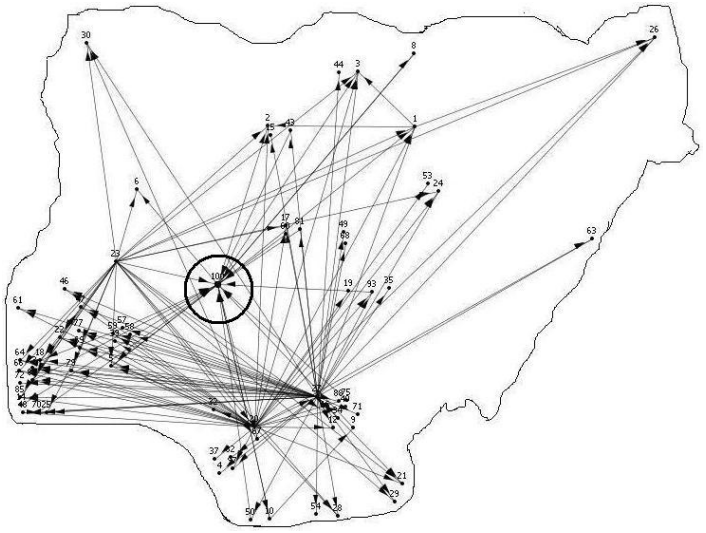

Figure 3: Webgraph on a Set of Units of Analysis, with the NUC Website Added

The five-vertex strongly connected component comprised the NUC website and four universities: Federal University of Technology (Akure), Federal University Dutse (Jigawa State), Federal University Ndufu-Alike (Ebonyi State), and Federal University Otuoke (Bayelsa). All four are federal institutions, a finding consistent with the broader pattern of federal universities demonstrating stronger web engagement relative to their state-owned and private counterparts.

Discussion

The results paint a pretty coherent picture: Nigerian university websites, as of 2024, were a sparse, loosely interconnected, and mostly self-referential web space. The average organization had a small, outlink-poor site that did not have much engagement with the digital world. Such a description, however, has to be understood in the context of the fast-growing higher education industry in Nigeria. The reduced web activity in few major sites reflects the trends recorded in other national scholarly web researches.

Thelwall (2016) observed analogous power law distributions in UK, Australian and New Zealand academic webs; analogous structural asymmetries were identified in a study of Spanish academic webs by Ortega and Aguillo (2007). The Nigerian case is unique in that the network is extremely thin in general, such that even minor disturbances like shutting down two of the most frequent nodes as it is shown in the analysis of the webgraph is disastrous to apparent connectivity. Of particular importance is the almost complete lack of web communicators. Conference sites, joint research portals and regional academic councils were the important communicators in the analysis of Russian university websites by Znamenskaya et al. (2024) which served to bring the

different facets of the academic web together. A similar infrastructure was not found in the Nigerian data: no conference websites, no collaborative project portals, no regional vice-chancellor council websites were found in the provided set and had useful two-way connections to the Nigerian universities. The communicator status of the NUC, which carries a structural importance, indicates regulatory authority and not academic collaborative achievement which is a significant difference. One can admit that there is a limitation to the use of hyperlink data as a proxy of academic relationships. It was demonstrated by Filippetti & Savona (2017) that patterns of hyperlinks among the universities are not only making connections between institutions about collaboration but also represent organization hierarchies, commercial relations, and web design standards. Given the indications in the Nigerian environment, where most outlinks seem to be based on template navigation patterns, the number of hyperlinks should be regarded with some degree of skepticism as an indicator of intellectual or collaborative activity. The structural results presented in this report are to be taken as an indicator of the quality of web infrastructure, rather than as a true measure of academic interaction.

CONCLUSION

This paper conducted a webometric analysis of web sites of Nigerian universities based on the data collected as of 2024. It is found that there is a national scholarly web space with a sparse connectivity, small site sizes, low outlink generation, and little collaborative web architecture. These institutional inefficiencies are better historically contextualized: the higher education sector in Nigeria was at the stage of a quantitative growth at the time of the data collection, and the lack of digital maturity on the part of the digital infrastructure was due to the lack of maturity of the institutional environment as a whole. The research has a number of contributions to the literature on webometrics. It applies the comparative analysis of national academic webs to sub-Saharan Africa where the area is still underrepresented. It shows methodological weaknesses of hyperlink analysis using search engines in situations where crawling at national level is possible and required, and reports the structural importance of one web communicator the NUC to national academic web connectivity. This conclusion carries apparent implications for both research and practice.

RECOMMENDATION

Based on the findings, some recommendations based on action are provided to university web administrators and national education policy bodies. First, the use of domain name standardization is a policy priority area. Existence of the domains *.edu.ng*, *.net*, *.org*, and *.com*, as well as, *.gov.ng* on the websites of Nigerian universities, lower the visibility of the institutions in web indices and introduce confusion to both users and search engines. Universities should add a standardized conversion to *.edu.ng* as the new top-level domain as it would enhance consistency in services and institutional legibility. Similar domains that refer to the same resource, e.g. parallel *.org* and *.edu.ng* addresses of the same institution should be combined.

Secondly, sub-sites should be actively integrated. It was discovered that the hidden web neighborhoods of the university-based sites with domain names which are structurally independent of the parent institution are simply invisible to search engine-based analyses and diminish the visible web presence of the parent institutions that run them. It would be more desirable (and enable easier discoverability and measured connectivity) that all university sub-sites be sub-domains of the official site (and explicitly linked between them in both directions).

Thirdly, development of web communicators has to be regarded as institutional goal. All conference sites, collaborative research portals and inter-university partnership pages can become communicators nodes that both accept and dispense links on the academic web. The universities that organize conferences or join in collaborative projects must make sure that there are links to all the official websites of the participating institutions on the related websites and must demand mutual links.

Lastly, the role of a "web communicator", which in this research is the NUC, should be more actualized. The NUC web site being the only web communicator in the 2024 data only connected to 15 out of the 97 universities being investigated. An expansion of the NUC institutional web directory to systematically connect with all accredited universities and an appeal to universities to in turn connect with the NUC would be a low cost, high impact intervention to improve the overall state of web connectivity in the academic sector in the country.

Future research should re-examine the state of Nigerian university web infrastructure using more recent and comprehensive datasets to capture the rapidly evolving digital footprint of the sector. This is particularly important as the number of universities in Nigeria has increased to a great extent in the past years.

Comparative studies that integrate webometric indicators with institutional performance metrics, such as research output, student admissions, and accreditation status, would provide deeper insights into the relationship between online presence and academic capacity in higher education in Africa. These multidimensional analyses could help clarify whether digital visibility aligns with institutional quality and productivity, thereby contributing to a more nuanced understanding of higher education development in Africa.

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