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# Why Is This Link Here? Identifying Academic Web Interlinking Motivations in Nigerian Universities

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## ABSTRACT

*This paper investigates the university websites of Nigeria, Africa's most populous nation. Its aim is to identify motivations why authors embed outbound hyperlinks on these websites. A classification scheme for academic web interlinking motivations was applied to over 5,000 hyperlinks pointing from the websites of 107 Nigerian universities. Classifying the motivations based on studying the source and target pages is a big challenge, especially due to the following three reasons: there could be many possible reasons available; guessing the true intentions of link creators could be a difficult task; multiple link creation motivations could exist. The pioneer application of Pearson's chi-square test of independence offers a better picture of motivations. The chi-square test identifies the significant differences in interlinking motivations, which are peculiar to Nigerian universities of a particular category (federal, state and private universities). The study is a stepping stone toward further research on feasibility of findings in other developing countries. Results obtained from this research will be of great use for academic webpage developers and web authors, and will modify their work towards improving the use of hyperlinks as one of the major communication tools on the Web.*

## TYPE OF PAPER AND KEYWORDS

Short Communication: *hyperlink, citation, university website, Nigerian university, interlinking motive, Pearson's chi-square test, data mining*

## 1 INTRODUCTION

Hyperlink analysis has been having a great deal of popularity among web researchers. This curiosity owes its origin to the emergence of the first search engines [3][9]. Sustained level of interests on hyperlink analysis is understandable – as stated in Thelwall & Harries [24], “... *hyperlinks had the potential to reveal new types of information about both scholarly communication and the value of the web pages themselves. In support of this, there is now a*

*considerable body of research to show that patterns of web linking between universities can be strongly associated with research productivity*”.

Today, web search monsters such as Google [8] and Yandex [28] use the complex mathematical models, which improve the performance of search significantly. However, these mathematical models are not known to the public because they are business secrets. This is why the analysis of hyperlinks leads to intriguing theoretical and practical results.

One major issue in hyperlink analysis is to gain a better understanding why links are created [23][27].

One of the main obstacles in the emerging scientific field of Webometrics is poor understanding of the true reasons why people create web links. This needs to be addressed despite the apparent complexity [27]. In reality, it is very difficult, or perhaps impossible to assess and categorize Web communication in general, due to the heterogeneous nature of publications on the web and problems inherent in obtaining the appropriate information, even without taking into account the size of the web.

The paper attempts to further develop and improve the approach proposed in [27] for website interlinking investigation. The approach developed in this paper is then applied to analysis of the motivations of hyperlinks in websites of Nigerian universities.

According to the National Universities Commission of Nigeria [12], Nigeria has 147 universities (46 federal universities, 40 state-owned universities and 61 private universities). The Commission is the sole accreditation and regulatory body that grants approval for all academic programs run in Nigerian universities. It approves the establishment of all higher educational institutions, which offer degree programs in Nigerian universities. It enforces uniform the academic standards and sets the capacity of admissions for each university in Nigeria.

Nigeria is made up of 36 states and Abuja, and Abuja is the capital of Nigeria. Thanks to the oil boom in 1970s, the tertiary education in Nigeria expanded to every sub-region of Nigeria. The federal government of Nigeria and the state governments were previously the only bodies licensed to operate universities. But later, the licenses were granted to individuals, corporates and religious bodies to establish private universities in the country [13]. Federal universities in Nigeria are universities owned by the central (federal) government. State-owned universities are owned and administered by the governments of the 36 states. Individuals, corporates and religious bodies run private universities.

The university domain names listed by National Universities Commission of Nigeria in [12] was incomplete and outdated. This paper adopted it as a basis. The list was then corrected, supplemented and elaborated upon in the course of research. These actions included: non-opening websites were excluded from the study; some newly created universities that do not have their own official websites yet were also excluded; websites that contained no outgoing hyperlinks or were under repair as of the time of this study were also removed. After these exclusions, we obtained a target set of 107 domain names (down from 147 mentioned above).

Out of the 107 websites finally investigated in this paper, 38 are federal universities, 41 are state-owned universities and 28 are private universities (Table 1).

**Table 1: Universities investigated**

University categories	Number
Federal universities	38
State-owned universities	41
Private universities	28
<b>Total number of universities investigated</b>	<b>107</b>

Federal universities are regarded as more prestigious than their state-owned and private counterparts. They normally attract more students and better government funding. Moreover, the admission requirements are more stringent in federal universities. Private universities are the most expensive in the country.

Over 5,620 outbound hyperlinks pointing from 107 official websites of Nigerian universities are analysed. The aim is to identify possible reasons behind such academic web interlinking behaviour. The paper reveals a significant difference among motivations, which depended on university categories (federal, state-owned or private). Armed with this, the author is able to formulate recommendations for academic website/page developers. The recommendations are aimed at improving the use of outbound hyperlinks as one of the major communication tools on the Web. The recommendations can also enhance the web presence of Nigeria's higher institutions.

## 2 RELATED RESEARCH

Hyperlink analysis in the web is a fairly new area of research. Perhaps, it could be weakly compared to citation analysis [16] [26]. "...*Web links are a radically new phenomenon, although partial parallels can be drawn with pre-existing similar entities including ... journal citation*" [27].

The approaches offered in [27] were used as a starting point for our study. The work used a web crawler to scan the university websites in United Kingdom, and collect the hyperlinks embedded in their webpages. Hyperlinks were then selected randomly from this hyperlink collection but under specific restrictions and conditions. For example, broken links and links pointing to own hosting sites were all excluded from their study. Besides, only the external hyperlinks pointing to the sites with the *ac.uk* domain were considered. The *ac.uk* domain is the major domain for the websites of United Kingdom's higher education institutions, colleges, research institutions and scientific communities – the so-called "*domain of academia*". Hyperlinks pointing to e-journals, whose

websites are from the *ac.uk* domain, were also excluded. The purpose of this action was to maintain a focus only on academic targets.

In [27], a hyperlink set comprising of 170 academic sites and 414 links were finally selected. Their authors, – independently of each other – analysed, evaluated and categorized the interlinking motivations. This was done by studying the source and target pages of the respective hyperlinks. An initial classification scheme was developed jointly by the authors, and this scheme identified 10 possible interlinking creation motivations from the 414 selected hyperlinks. Eventually, these 10 categories were merged into three broad categories.

Wilkinson et al. [27] came to three main conclusions:

- It is difficult to categorize link motivation based on only studying the source and target pages because (i) there could be various possible motivations, (ii) in certain cases, it is difficult to correctly guess the true intentions of authors of such links, and (iii) there are potentially multiple motivations. The researchers hence concluded that a better categorization would have led to more consistent results.
- Motivations for creating web links between United Kingdom's university websites are different from journal citation motivations;
- Direct student educational materials of one university are poorly used in other universities, despite "*extensive funding into collaborative inter-institutional teaching*" [27], and this is probably an indication that such funding is ineffective.

J. Bar-Ilan [2] applied a pre-defined classification scheme, including research oriented, educational, professional (work-related), general/informative, administrative, personal, social, navigational, superficial, technical, other and unknown/unspecified, for classifying Israeli inter-university links. The author found out that 31% of the links were created for professional reasons, while 20% were for research purposes. These two categories would have mainly been classified as scholarly reasons in the Wilkinson et al. study [27].

Smith [22] argued that the motives behind academic hyperlinking could be for general informational purposes (such as teaching and learning, research funding, administrative, dissemination of research, employment), for formal research citation (such as e-journals and online conference papers), for self-links and more information about their authors, and for acknowledgement of support. According to [22], the interlinking motives could also include relationship links (such as related persons, organizations and pages). Others include advertising

and commercial reasons, software download and reciprocal links.

Motivations for creating links from websites within the *.edu* domain to Iranian university websites were classified by Kousha & Horri [10] into three broad categories: student/staff support, gratuitous/navigational links, and non-academic. It was found that about 36% of the links were from Iranian students' or lecturers' homepages in American universities pointing to their previous universities in Iran. Most notably, the authors found no citation reasons for targeting Iranian universities.

Ortega and Aguillo [17] investigated interdisciplinary research relationships among several Spanish university departments and research groups located in the Spanish web space. A major result showed that the web presence of Experimental and Technological Sciences was higher than Social Sciences and Humanities.

In [18], it is noted that not all the links from sites of United Kingdom's universities lead to landing pages with scientific contents. Classification of outlinks investigated has revealed that banners, advertising links, links to statistics counters and site developers, as well as guest links represent only about 20% of all unique links. Of the links to pages with scientific content, 20% were links to publications, journals and databases, while 11% were links to conferences and meetings that have already been held or are upcoming.

Adekambi [1] analysed a sample of 2913 links, which showed: while a significant amount of outlinks from African universities was created for scholarly activities, a large percentage of links received by them was for administrative purposes. Disciplinary distribution of links showed that sciences were more prominent than all other disciplines. Links related to Agriculture, Education and Engineering were poorly represented.

Thelwall [23] postulated four new motivation types based on a sample of 100 random inter-site links to United Kingdom's university home pages. They are social, ownership, general navigational and gratuitous links. 'Social' links are links with a primarily social reinforcement role. The term 'ownership' is coined for links acknowledging authorship or co-authorship of a resource. 'General navigational' links are for links with a general information navigation function. 'Gratuitous' links are ones that serve no identifiable communication function at all.

Nwohiri and Pechnikov [15] analysed the university web space of Nigeria. A weak connectivity between the official websites of Nigerian universities was revealed. However, the connectivity was found to be stronger when all the university websites were included in the analysis. The connectivity increases

significantly with the addition of the so-called web communicator – National Universities Commission of Nigeria [12].

### 3 OBJECTIVES AND METHODOLOGY

The aim of examining the reasons why people embed external hyperlinks on Nigerian university websites is to identify the following:

- The possible motivations for placing hyperlinks on the websites of Nigerian universities.
- Which hyperlink motivations are most peculiar to federal, state and private universities in Nigeria.

As already mentioned, the approach proposed in [27] was used as a starting point in our work. However, our work has essential differences from the work in [27]:

- The hyperlink set used consisted not only of hyperlinks that were interlinking Nigerian university sites, but also all outgoing hyperlinks pointing from these sites;
- An essentially different hyperlink classification scheme was proposed.

BeeBot [19] was used to scan the Nigerian university web for external hyperlinks. BeeBot is an adaptive, focused crawler that traverses the web, collects, processes and visualizes external hyperlinks, which are relevant to pre-defined properties.

A unique outbound hyperlink (also referred to as outgoing or external hyperlink) is a hyperlink from a set of hyperlinks that have the same address and context, which is located on the highest-level page. The homepage level of a site is considered the highest [21]. Henceforth, we will consider only unique outbound links. So the words ‘unique’, ‘outbound’, ‘outgoing’ or ‘external’ will be mostly omitted.

We use the BeeBot crawler to traverse 137 university sites in Nigeria: over 5620 outbound hyperlinks were collected. Out of the 137 sites initially scanned and examined, a target set containing 107 sites was chosen. The set was reduced from 137 to 107 sites because some sites were excluded from further analysis for the following reasons: they either contained no outgoing hyperlinks, or were not opening or were under repair as of the time this study was carried out.

The University of Ibadan (unaab.edu.ng), a federal university in Nigeria, had the highest number of outbound hyperlinks – 841. The average number of outbound hyperlinks placed on the websites of the 107 universities was 52. Each site had at least 2 outbound

links. A total of six sites had only 2 outbound links, namely:

- Modibbo Adama University of Technology, Yola (mautech.edu.ng), federal university
- Taraba State University, Jalingo (tsuniversity.edu.ng), state university
- Godfrey Okoye University, Ugwuomu-Nike, Enugu State (gouni.edu.ng), private university
- Mountain Top University (mountaintopuniversity.org), private university
- Renaissance University, Enugu (rnu.edu.ng), private university
- Wesley University of Science & Technology, Ondo (wesleyuni.edu.ng), private university

### 4 CLASSIFICATION SCHEME

Originally, Pechnikov et al. [20] identified 24 main types of hyperlinks. However, after thorough examination of these hyperlink types, the list was reduced to 20 after merging some very similar hyperlink types: hyperlinks pointing to libraries and hyperlinks pointing to e-journals were merged, while hyperlinks pointing to commercial organisations and hyperlinks pointing to professional organisations were also merged. The new 20-item list was then adopted as the basis for interlinking motivation table (Table 2). To save space, only 6 university sites (out of the 107 investigated) are shown in Table 2. The 6 university sites were randomly selected.

The 11<sup>th</sup> motive (*Higher body*) refers to hyperlinks pointing to the sites of higher authorities that have direct influences on that university. Some examples of higher authorities are Nigerian Federal Ministry of Education, Federal Ministry of Finance, and the National Universities Commission of Nigeria mentioned above. The 13<sup>th</sup> motive (*Government*) refers to government authorities that have an indirect influence on that university. Examples include: the Joint Admissions and Matriculations Board (JAMB), West African Examinations Council (WAEC) and National Examination Council (NECO). The 20<sup>th</sup> motive (*Broken link*) is regarded as “pseudo-motivation”: this group comprises a fixed number of broken links.

Examination, study or investigation of a hyperlink means examining the source and target pages of that hyperlink, and analysing the context of that hyperlink in order to be able to identify and categorize it under one of the 20 motives listed in Table 2. Two researchers – the author of this paper and a professor from the Institute of Applied Mathematical Research,

Russian Academy of Sciences, Russia – examined and analysed these hyperlinks, and categorized the interlinking motivations independently of each other.

Of the 5,620 links examined, there was no clear decision on categorization of 369 hyperlinks. This was chiefly due to partial overlap between certain motives. Below are some few examples:

- A hyperlink pointing to online tutorials. Students can make use of such tutorials to prepare for their exams. Thus, such links can be categorized under the 1<sup>st</sup> motive (*Students' learning material*). However, graduate students can equally use these online tutorials for their research work. Hence, the links can also be categorized under the 3<sup>rd</sup> motive (*Research support*).
- A hyperlink pointing from the site of the library of one university to a book hosted on the site of another university's library can be interpreted as a link pointing to a similar organization – 6<sup>th</sup> motive (*Similar education-related organization*). But this link pointing to educational materials meant for students can be classified under the 1<sup>st</sup> motive (*Students' learning material*) or under the 3<sup>rd</sup> motive (*Research support*);
- A link pointing from the website of one university to the website of another university, which is sponsoring a conference being held in the first university, may be judged to be a link to the web resources of event sponsors – 14<sup>th</sup> motive (*Event sponsor*) – or interpreted as a link to similar organization – 6<sup>th</sup> motive (*Similar education-related organization*);
- A hyperlink pointing from the website of a university to the official website of the National Universities Commission of Nigeria can be interpreted as a link pointing to the site of a higher body, hence the 11<sup>th</sup> motive (*Higher body*). But this link can also be seen as pointing to the site of a government authority – 13<sup>th</sup> motive (*Government*)
- A banner hyperlink pointing to the goods or services sold by a company can be considered as a link pointing to information on products and services – 17<sup>th</sup> motive (*Ad links & banners*) – or as a link to information on leisure & tourism – 18<sup>th</sup> motive (*Leisure & tourism*). The link can equally be seen as pointing to the web-based resource of business organization – 15<sup>th</sup> motive (*Commercial/professional organization*);
- A hyperlink pointing from the website of a research team at a university to a group of researchers in another university with similar research interests can be interpreted as a link pointing to scientific research

support – 3<sup>rd</sup> motive (*Research support*). Such links can safely be interpreted as links pointing to a similar organization, hence the 6<sup>th</sup> motive (*Similar education-related organization*);

Due to these possible different interpretations of a single case, which could lead to more than one possible hyperlink motive categorization, the classification scheme was further modified. First, the classification scheme was simplified and made more convenient for analysis so as to be able to easily secure unambiguous motive interpretations.

The columns in Table 2 were merged based on specific conditions: all the universities were grouped into 3 (federal, state and private universities). This action summed up the number of their hyperlinks accordingly. So, instead of 107 universities in Table 2, there were only 3 university categories (federal, state and private universities). The purpose of the above action was to reduce the number of zeros in Table 2 and make the data more compact for further analysis.

Now coming to the main action of ensuring unambiguous interpretation of hyperlink creation motives, some rows in Table 2 were merged to form a new row in Table 3 as follows:

- In Table 2, motives “*Research support*”, “*Staff publications*” and “*Libraries & e-journals*” from Table 2 were all combined to form a new motive called “*Research support*” in Table 3.
- Motive “*Higher body*” in Table 3 was obtained by merging motives “*Higher body*” and “*Government*” from Table 2.
- Motive “*Educational institution & subordinate body*” in Table 3 came from combining the following motives from Table 2: “*Similar education-related organization*” and “*Subordinate body*”.
- From Table 2, four motives, namely “*Service site*”, “*Personal profile*”, “*News feed*”, and “*Academic event*”, were merged and called “*Social media*” in Table 3.
- Motive “*Business organisation*” in Table 3 combines motives “*Software*”, “*Event sponsor*”, “*Commercial organization*”, “*Ad links & banners*” and “*Leisure & tourism*” from Table 2.

It should be noted that in Table 3, motives “*Students' learning material*”, “*Information*”, “*Non-categorized*”, and “*Broken link*” remained the same as in Table 2. So, instead of the 20 motivations and 107 university sites in Table 2, we now have a much more simplified Table 3 with only 9 motivations and 3 university categories.

**Table 2: Hyperlink creation motives**

	Motive	Description of motive	Federal		State		Private	
			U1	U2	U3	U4	U5	U6
			<b>Outbound hyperlinks</b>					
1	Students' learning material	Link to educational materials, such as textbooks, lectures, curriculum	2	0	0	0	0	2
2	Information	Link to important information for students, applicants, and staff (work opportunities, application dates, call for papers, information on student loans, scholarship, etc.)	42	12	3	5	1	5
3	Research support	Link to resources on information and financial support for research; links to information on funds, grants.	31	6	0	6	6	14
4	Libraries & e-journals	Link to the web resources of libraries and e-journals	15	15	3	1	7	38
5	Staff publications	Link to online publications by persons working at the university, persons affiliated to the university, and students	6	5	15	0	50	1
6	Similar education-related organization	Link to the web resources of other universities, colleges, institutes, libraries and other education-related organizations.	239	2	12	0	0	0
7	Academic event	Link to web resources containing information about academic events, such as conferences, seminars, convocations, matriculations	5	0	0	0	0	3
8	Personal profile	Link to the personal pages and profiles of staff and students, hosted on other web resources, such as <i>Facebook</i> , <i>Twitter</i> and <i>LinkedIn</i> , university blogs and forums	1	5	5	20	1	4
9	Software	Link to a web resource from where a software program can be downloaded or bought	0	0	0	0	0	0
10	Service site	Portals for staff and students	9	1	6	4	1	1
11	Higher body	Link to the web resource of a higher authority (controlling entity)	0	0	0	0	1	0
12	Subordinate body	Link to the web resource of a structural unit of the university, such as faculties, departments, bursaries, and other sub-divisions	48	8	2	2	0	3
13	Government	Link to the web resources of government authorities	0	0	0	0	0	0
14	Event sponsor	Link to the web resources of event sponsors	0	0	0	0	0	0
15	Commercial/ Professional organisation	Link to the web resources of commercial organizations and professional associations	0	0	3	0	0	0
16	News feed	Link to news outlets, such as e-newspapers, blogs, forums	0	2	2	17	8	10
17	Ad links & banners	Advertising links and banners	0	0	2	0	0	0
18	Leisure & tourism	Link to information on leisure and tourism	0	0	0	0	0	0
19	Non-categorized	All links not mentioned above	14	30	6	3	5	1
20	Broken link	Pseudo-motivation	0	0	0	0	0	1
		<b>Total number of hyperlinks</b>	<b>412</b>	<b>86</b>	<b>59</b>	<b>58</b>	<b>80</b>	<b>83</b>

U1: University of Nigeria, Nsukka (unn.edu.ng)

U2: University of Port-Harcourt (uniport.edu.ng)

U3: Kwara State University (kwasu.edu.ng)

U4: OlabisiOnabanjo University, Ago-Iwoye (oouagoiwoye.edu.ng)

U5: Fountain University, Osogbo (fountainuniversity.edu.ng)

U6: Nigerian-Turkish Nile University, Abuja (ntnu.edu.ng)

**Table 3. Generalized table of motivations and frequencies**

	Motive	Federal	State	Private	Total
		Hyperlink count			
1	Students' learning material	135	8	4	<b>147</b>
2	Information	323	282	106	<b>711</b>
3	Research support	1416	127	269	<b>1812</b>
4	Higher body	20	7	1	<b>28</b>
5	Educational institution & subordinate body	702	83	54	<b>839</b>
6	Social media	907	238	291	<b>1436</b>
7	Business organisation	137	18	77	<b>232</b>
8	Non-categorized	163	68	138	<b>369</b>
9	Broken link	43	0	3	<b>46</b>
	<b>Total number of hyperlinks examined</b>	<b>3846</b>	<b>831</b>	<b>943</b>	<b>5260</b>

From Table 3, it can be concluded that federal universities are superior (in terms of hyperlink count) for each motive. The table shows that all the 3 university categories pay little or no attention to links pointing to a higher authority, such as the country's Ministry of Education and the National Universities Commission.

There are not many references to students' learning materials on the websites of state-owned and private universities in Nigeria. The websites of these two university categories contain very few broken hyperlinks. There are many non-categorized hyperlinks on the websites of federal and private universities. Federal university websites contain much information about research support, such as libraries, publications, funds and grants. All the universities investigated devote much attention to such services as blogs, forums, personal profiles of staff and students, and more especially portals. There is less advertising on the sites of state universities in Nigeria.

However, it must be noted that these three university categories (federal, state and private) being investigated are unequal in terms of number of universities. As stated earlier, 38 federal universities, 41 state-owned universities and 28 private universities were investigated. It should also be noted that "Research support" links occupy about 34% of the total number of links investigated, while "Broken link" and "Higher body" links account for just 0.9% and 0.5% respectively. The above-mentioned could positively or negatively affect numerical indicators for the particular Nigerian university categories involved.

## 5 PEARSON'S CHI-SQUARE TEST OF INDEPENDENCE

### 5.1 Chi-Square Test

In pursuit of the goal of obtaining a clearer picture of the reasons why people cite external hyperlinks, this paper applies the chi-square test of independence [14] [11] for the two nominal variables (*motive* and *university categories*). A chi-square test allows to test how likely it is that *interlinking motive* and *university category* are completely independent; or in other words, how likely it is that distribution of hyperlink creation motives among federal, state and private universities is due to chance. Pearson's chi-square test verifies whether the empirical evidence supports the assumed *null hypothesis* of the distribution of the general population [25] [5]. *The null hypothesis in this case is that interlinking motives and university categories are independent of one another.*

For the test of independence, a chi-squared probability (*p*-value) of less than or equal to the statistical significance ( $\alpha=0.05$ ) is commonly interpreted as justification for rejecting the null hypothesis of that the row variable is independent of the column variable [14]. The null hypothesis is accepted if the *p*-value is more than 0.05.

The test of independence can be applied to Table 3 (observations) because the observations are expressed in a contingency table [25]. Nevertheless, before

**Table 4. Observed frequencies (total number of hyperlinks examined)**

	Motive	Federal	State	Private	Total
1	Students' learning material	134	8	3	<b>145</b>
2	Information	310	282	99	<b>691</b>
3	Research support	1404	127	267	<b>1798</b>
4	Higher body	700	7	1	<b>708</b>
5	Educational institution & subordinate body	874	83	53	<b>1010</b>
6	Social media	20	238	262	<b>520</b>
7	Business organisation	130	18	74	<b>222</b>
8	Non-categorized	161	68	132	<b>361</b>
9	Broken link	41	<b>0</b>	<b>3</b>	<b>44</b>
	<b>Total number of hyperlinks examined</b>	<b>3774</b>	<b>831</b>	<b>894</b>	<b>5499</b>

applying this test, the table needs to be processed further. It was indicated earlier that out of the 107 university websites examined, there were 38 federal universities, 28 state-owned universities and 41 private universities.

To ensure similar and fair analysis conditions for all the three university categories, the same number of sites was chosen from each of the three university categories – 28 from each category, i.e. 28 federal, 28 state and 28 private universities. The number 28 was chosen because it is the smallest number among 38, 41 and 28. The sites were selected randomly using a random number generator to avoid bias [7]. As a result, Table 4 was obtained from Table 3. In Table 4, the total number of hyperlinks investigated was reduced to 5,499 from 5,620.

Let the variable *A* designate the set of motives 1-9 (see Table 4), and *B* the set of university categories (see Table 4). We now test the hypothesis of whether there is a relationship between *A* and *B*. That is, we set the null hypothesis to be:

***H<sub>0</sub>: Interlinking motive is independent of university category***

This null hypothesis is accepted if the *p*-value is equal to or more than 0.05, else it is rejected, meaning that interlinking motive is **not** independent of university category. There is nothing mathematically

magic about 0.05, it was chosen rather arbitrarily during the early days of statistics; people could have agreed upon 0.04, or 0.025, or 0.071 as the conventional significance level [11].

## 5.2 Expected Frequencies

An *observed frequency* is the **actual** frequency that is obtained from the experiment, while an *expected frequency* is a **theoretical predicted** frequency obtained from an experiment presumed to be true until statistical evidence in the form of a hypothesis test indicates otherwise. An expected frequency is computed by *multiplying the probability that an event occurs by the total number of possible times that the event could occur*.

Let  $F_{ij}$  be the array of observed frequencies for the *ij*-th cell, and  $E_{ij}$  - the array of expected frequencies for the *ij*-th cell under the assumption that the null hypothesis is true. Here, *i* is the row number and *j* is the column number. The expected frequencies are listed in Table 5. They are calculated using the formula

$$E_{ij} = \frac{F_{i0} E_{0j}}{F_{00}},$$

where  $F_{i0}$  is the sum of row *i*,  $F_{0j}$  is the sum of column *j*, and  $F_{00}$  is the total number of links.



**Table 5. Expected frequencies (derived from Table 4 by the above formula)**

<i>i/j</i>	Motive	Federal	State	Private	Total
1	Students' learning material	99.51	21.91	23.57	<b>145</b>
2	Information	474.24	104.42	112.34	<b>691</b>
3	Research support	1233.98	271.71	292.31	<b>1798</b>
4	Higher body	485.91	107	115.10	<b>708</b>
5	Educational institution & subordinate body	693.17	152.63	164.2	<b>1010</b>
6	Social media	356.88	78.58	84.54	<b>520</b>
7	Business organisation	152.36	33.55	36.09	<b>222</b>
8	Non-categorized	247.76	54.55	58.69	<b>361</b>
9	Broken link	30.2	6.65	7.15	<b>44</b>
	<b>Total number of hyperlinks examined</b>	<b>3774</b>	<b>831</b>	<b>894</b>	<b>5499</b>

**Table 6. Deviations of observed frequencies (Table 4) from expected frequencies (Table 5)**

<i>i/j</i>	Motive	Federal	State	Private
1	Students' learning material	11.95	8.83	17.96
2	Information	56.88	301.98	1.58
3	Research support	23.43	77.07	2.19
4	Higher body	94.33	93.45	113.11
5	Educational institution & subordinate body	47.17	31.76	75.31
6	Social media	318	323.41	372.52
7	Business organisation	3.28	7.21	39.82
8	Non-categorized	30.38	3.31	91.57
9	Broken link	3.86	6.65	2.41

Having obtained the expected values, we now calculate the *p*-value using the *CHITEST* function in Microsoft Excel. The *p*-value is equal to 0 and since it is less than  $\alpha=0.05$  (significance level), we rejected the null hypothesis and conclude that *interlinking motive is not independent of the category of universities*.

Consequently, we can conclude that there is a very strong relationship between attributes *A* (interlinking motive) and *B* (university category). In other words, the difference between the data sets (expected and observed frequencies) is statistically significant and it

did not occur by chance but rather it is a real difference.

### 5.3 Interpretation of Results

Going further to ascertain the reason behind such strong relationship, we calculate the deviations. We denote the deviations of the observed frequencies from the expected frequencies as

$$G_{ij} = \frac{(F_{ij} - E_{ij})^2}{E_{ij}}$$

Table 6 shows the values  $G_{ij}$ . The highlighted cells show the greatest deviations between the corresponding values in Table 4 and Table 5 (either the observed frequencies are higher than the expected or the other way round).

Analysing Table 6 and comparing Table 4 with Table 5, some conclusions can be deduced from those cells highlighted in Table 6. For example, it is obvious that most state-owned and private universities in Nigeria give enough attention to social media, such as *Facebook*, *Twitter* and *LinkedIn*, university blogs and forums and university portals for staff and students. Federal universities on the other hand give insufficient attention to social media. The websites of most private universities feature many “non-categorized” links. The sites of state-owned universities contain “sufficient” information for students, applicants, and staff, such as work opportunities, application dates, call for papers, information on student loans, scholarship.

State and private universities pay almost zero “web” attention to higher authorities, such as Ministry of Education, Ministry of Finance, and the National Universities Commission of Nigeria mentioned above, which have direct influence on the universities. Similar lack of attention is accorded to other government bodies that have an indirect influence on the universities, such as the earlier mentioned Joint Admissions and Matriculations Board (JAMB), West African Examinations Council (WAEC) and National Examination Council (NECO). Federal universities are on the other hand not lacking in this domain.

## 6 DISCUSSION AND CONCLUSION

It is difficult to classify academic interlinking motivations by just studying the source and target pages. There could be many possible reasons available: it may be difficult to guess the true intentions of creators of links; multiple reasons may exist. The first research question is partially addressed by the use of statistical tests applied to the sets of categorical data.

External interlinking motives are completely different among categories of universities in Nigeria. The research has shown that for each of the three university categories (federal, state-owned and private universities), there are dominant external hyperlinking motivations. The citations of higher authorities and government bodies dominated among federal universities. The websites of most state-owned universities contained mostly non-academic information for students and staff and social media references. Mostly “non-categorized” sites and references to the social media dominated private university sites. Strong links to social media, such as *Facebook*, *Twitter*, *LinkedIn*, university blogs and

forums and university portals for staff and students could imply that the staff of these universities are not yet accustomed to using e-mail services and information systems, and are hence stimulated to such activity.

One of the main conclusions is therefore that for Nigerian universities, ***link creation motivations are strongly dependent on university categories***. For now, one cannot give a non-disputable explanation for these differences observed. For example, federal university websites have much links pointing to the sites of higher authorities and government bodies. It could be interpreted that federal universities in Nigeria are in dire need of attention from the authorities (in the form of financial support, academic funding, favourable policies, etc.). However, it could also mean that federal universities enjoy sufficient attention from the authorities, and hence, the need for such mentioning.

Research referencing is not prevalent in Nigerian university sites. It could be said that the issue of financial support for research is fully resolved, or maybe vice versa -- there is intensive research. The non-dominant position of hyperlinks pointing to *Students' learning material* (almost in all the university categories) can be attributed to one of the findings in [27]: “...there is a very low use of direct student educational materials of one university at other universities”. This problem may even be more profound due to lack of such educational materials, and as a consequence, lack of links to them. However, this does not exclude the possibility of creating hyperlinks to educational resources of the universities of other English-speaking countries. It should be noted, however, that low link metrics may indicate low-quality superstructure rather than the core of research activity at a university.

This study did not venture deep into the topic of academic interlinking motivations, a point that is made very clear by comparison with citation analysis [4] [6]. Further study is needed to assess the applicability of the findings in other developing countries, where the use of hyperlinks as a web communication tool is still at an infant stage. More research is needed to evaluate other statistical methods that may achieve better and clearer results. Studies are also required to determine whether the classification scheme should be improved or replaced. A possible next step is to organise interviews with web page authors in order to further validate or even reassess the research results of this paper in view of the new findings.

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