



Enhanced Webometric Ranking of Nigerian Public Universities

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Authors' contributions

This work was carried out in collaboration between both authors. Author BAO designed the study, managed some literature searches and edited the manuscript. Author AA managed the analyses and design of the study, some literature searches and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Webometric Ranking of Universities provides a way to evaluate these institutions based on their web content and presence. Such an endeavour motivates institutions on improving the presence of their academic activities on their websites to help publicize their various achievements. Previous works emphasized on the objective features of Universities that do not sufficiently give account of the activities of Universities. In this paper, an enhanced Webometric System that incorporates subjective features is proposed for ranking Federal Universities in Nigeria. The features are: social media presence, existence of beneficiary programs to the Government and educational impact programs on the society. The accuracy level of the proposed system as measured with Spearman Rank Correlation, showed a significant impact level of the ranking metrics introduced. A social acceptance survey was conducted with the aid of questionnaires on the proposed model and it had above 70% acceptance.

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1. INTRODUCTION

The World Wide Web is a major tool being used among scholars for enhancing online visibility and publicity of academic findings. The Web has become a key medium for promoting and developing the academic, scientific and educational competence of a university. The Web can hence be used as a way to attract students, scholars and funding from other places, spreading the prestige of these educational institutions all over the world. This has provoked competition among universities to achieve an advantageous visibility on the Web and to improve their position in search engine results (Ortega and Aguillo [1]). As a matter of fact, scholars are turning to the Internet to find scientific information and academic institutions are devoting more and more resources to improving their presence on the web. Web presence is a collection of Web files on a particular subject that includes a beginning file called a home page. Webometrics describes the study of web based content using quantitative techniques (Thelwall [2]). It could also be defined as web measured on the basis of web characteristics or presence on the Internet (NUC [3]). The measurement can be done using various attributes or features of the Web such as Web Impact Factor (WIF) (Ingwersen [4]). WIF may be defined as the number of web pages in a web site receiving links from other web sites, divided by the number of web pages published in the site that is accessible to the crawler.

According to Aguillo et al. [5], Universities are ranked using four basic parameters namely: number of pages linking to university web pages representing visibility, number of web pages on university web site representing size of university web, number of published Adobe Acrobat, Adobe Postscript, Microsoft Word and Microsoft PowerPoint documents representing the number of educational materials that the university publishes and number of scientific papers indexed by Google Scholar representing university scientific production. Although Aguillo et al. [5] started ranking of world universities with the noble intention of raising academic public awareness about the importance of publishing information on the university websites, their results would have been better if they had improved on the method of conceptualization of the research and data collection (Kresmir [6]). They focused mainly on the central universities'

domains and ignored all subdomains present in the websites for some universities which led to irregularities in the ranking method. The scope of the ranking method was also limited to just four factors which do not sufficiently rank universities (Kresmir [6]).

Existing research on webometrics has focused majorly on visibility and size in according excellence to Universities which does not put into consideration what the public desires in an institution and there is a need to consider other factors that can help reflect inner activities and accessibility of the institutions. This paper proposes a webometrics model for public university ranking in Nigeria using a combination of objective and subjective features.

Section 2 of this article presents a review of related concepts and works; the proposed method is described in Section 3, while Section 4 presents the experimental results and discussion and system evaluation. Finally, the conclusion and recommendations are presented in section 5.

2. LITERATURE REVIEW

Academic rankings are conducted using different metrics to provide statistical information on the relative performance of universities. They are among the most common ways to measure the performance of universities. These rankings include several different criteria related to the quality of education, research faculty, employability of students and international orientation. According to Docampo [7] and Dehon et al. [8], among these criteria, the ones related to the quality of research have significant impact on the ranking results.

Rankings were first introduced by magazines, such as US News and World Report in 1983 and The Financial Times in 1999 as an attraction to their readers. However, these rankings were done primarily for marketing certain universities and their coverage was limited. They focused on either universities in a specific country or specific academic disciplines such as MBA programs.

The first global ranking of universities was Academic Ranking of World Universities (ARWU). It was launched by Shanghai Jiao Tong University in 2003 and extensively covered by the media. Even though the result of this ranking which is being published annually is still of

international importance (Aminpour [9] & ARWU [10]) many other ranking systems have come up. For example, Times Higher Education Supplement (THES) started to be published jointly by the UK's Times Higher Education and Quacquarelli Symonds in 2004.

Other well-known international university rankings are "Leiden Ranking" which was developed by Leiden University's Centre for Science and Technology Studies (CWTS), "The Webometrics Ranking of World Universities", which was developed by Cybermetrics Lab of Spain, and "The Performance Ranking of Scientific Papers for World Universities", which was developed by the Higher Education Evaluation and Accreditation Council of Taiwan. In addition to these international university rankings, several countries are issuing their national university all around the world.

An OECD study (Hazelkorn [11]) shows that university leaders' concern about ranking systems has consequences on the strategic and operational decisions they take to improve their institutions' research performance. In this context, two main types of policy response arise. The first type of response aims to improve the position of national or regional institutions with respect to the existing rankings and the second aims to devise new ways to assess quality.

Aguillo et al. [5] developed a Webometric Ranking of World Universities. They described webometrics as the ranking of universities by their presence on the Internet. Their objective was to design a webometric ranking system for universities. The system was built using a combined indicator called WR that takes into account the number of published web pages (S) (25 percent), the number of rich files, those in pdf, ps, doc and ppt format (R) (12.5 percent), the number of articles gathered from the Google Scholar Database (Sc) (12.5 percent,) and the total number of external in links (V) (50 percent).

$$WR=2S +R+Sc+4V \quad (1)$$

Abrizah et al. [12] conducted a study of the web performance of Asian institutional repositories through global visibility and performance of Asian top-ranked universities in the archiving and sharing their research output through institutional repositories, based on the Ranking Web of World Repositories (RWWR). Their findings signify Japan as the biggest contributor of Asian repositories, followed by India and Taiwan. The study also revealed that only forty eight of the

institutions were listed in the Top 400 RWWR, showing that only 12% of the Asian institutional repositories were visible and incorporate good practices in their web publication. Anwarul and Saiful [13] analysed the websites of private Universities in Bangladesh according to the webometrics indicator. The work was motivated by the need to study the performance of Bangladesh Universities in the world ranking. Their objectives include analyzing the websites of private Universities in Bangladesh, calculating the number of web pages, link pages, self link pages and external link pages of the private Universities websites in Bangladesh and rank them by number of web pages and the overall Web Impact Factor (WIF) of private Universities in Bangladesh. The research sampled all the private Universities with exclusive websites in Bangladesh. The methodology of evaluation of web engines is addressed by Clarke and Willett [14].

Kresimir [6] pointed out the inconsistencies with the Aguillo university ranking method. He noticed that they publish only ranks of the university, rather than absolute results that would allow the verifiability of the results. The objective of Kresmir's work was to determine the extent of errors in ranking created by enforcing the rule of one domain per university in Aguillo's research. University of Zagreb was selected as example and study was conducted in July 2011 and corrected methodological inconsistencies conducted by Aguillo et al. [5] during the research by not including results for all domains of the University of Zagreb.

Osunade and Ogundele [15] evaluated the University of Ibadan website based on rich files, size, Google Scholar and visibility. The University of Ibadan website was ranked first in Nigeria in July 2006. In the January 2011 webometric results, the University of Ibadan website slipped to the eleventh position. They wanted to identify the reasons for the poor performance in the recent ranking. The objective was to evaluate the University of Ibadan website using the webometric ranking parameters developed by Cybermetrics. Qualitative approach was used for the analysis of the University of Ibadan website. The tools that were used are observation and comparison with the ranking metrics. This study was carried out by repeated interaction with the University website between February and March 2011. The website was examined for design issues, content, use and impact. The notes from the interactions with the website were then

grouped. The grouped interactions used the ranking metrics of size, visibility, rich files and Google scholar. After a review of all these works, it was discovered that subjective features were missing out in most of these works. This work reported in this paper is therefore motivated by the need to study the addition of subjective features for ranking universities. Incorporating subjective features have been found to produce improved results in other domains in previous works relating to online presence (Ojokoh et al. [16]; Igbe and Ojokoh [17]).

Another work by Pechnikov and Nwohiri [18] studied the academic web of Nigeria as a whole. The work tried to study the relationship between universities and other institutions in Nigeria. Their investigation reveals a weak connectivity in the set of websites studied. It was also deduced that the connectivity tends to become stronger when

all the Universities are taken into account. This work did not rank Universities.

3. THE PROPOSED SYSTEM

The proposed system ranked Nigerian Federal Universities majorly on their objective and subjective features. The system has three major components: Subjective Features (SF), Objective Features (OF) and the Webometric Ranker (WR). The first two components (SF and OF) feed their output as input to the WR which then performs the ranking task. OF and SF are both sub-divided into three sub-components. Both components have required weights assigned to each of their sub components such that the subjective features make up 15%, and the objective features 85% of the total weight.

The proposed system architecture is shown in Fig. 1.

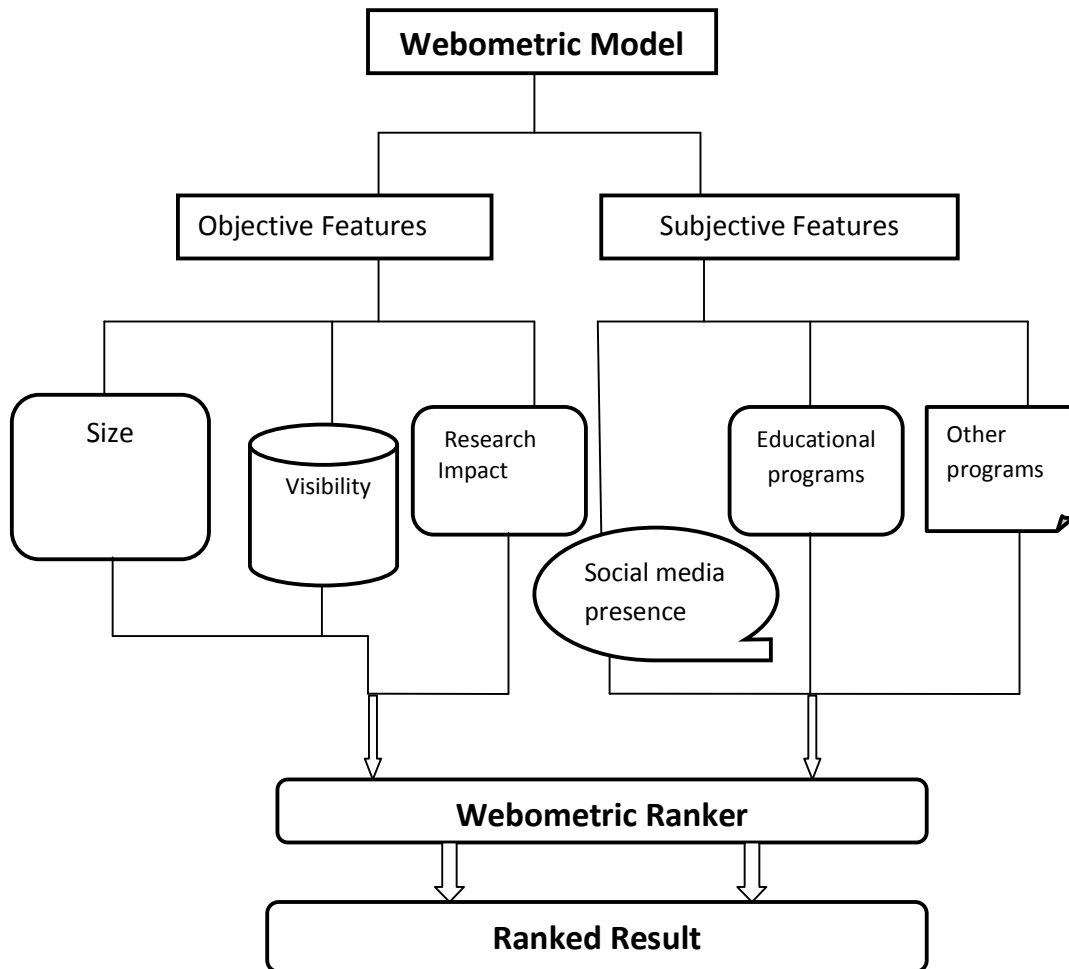


Fig. 1. Proposed system architecture

3.1 Objective Features

Aguillo et al. [5] (as referenced in Docampo [7] and Dehon et al. [8]) model is adopted for the objective features. The objective features include: size, visibility, and research impact. They are all described as follows:

a) Size (X)

This is regarded as the volume of information published. It comprises of two parameters with a total weight of 50% apportioned to it out of the percentage of the ranking features. The parameters involved are:

- i. **Number of pages:** This entails the number of web pages on a university's website. These pages may include primary pages which are pages on the website that can be accessed directly with menu or link on the site, and secondary pages; which are pages that are accessible or reached from primary pages. This constitutes 25% of the ranking features.

$$tn = \sum_{i=1}^p \sum_{j=1}^m s_{i,j} \quad (2)$$

such that p , m and $s_{i,j}$ denotes total number of primary pages, subpages and distinct pages respectively. tn represents the overall number of pages.

- ii. **Number of rich files:** Rich files describe the forms in which scholarly literatures exist, which includes PDFs, power points (PPT), word documents (DOC), and web documents (HTML). These rich files depict how vast a particular file can target audience or the level of content rendering preferences it possesses. This data is gathered from Scimago group (www.scimagojr.com/) that has details regarding the domain of discourse for 5200 Universities and Google Scholar. Number of rich files contributes 25% to the ranking features.

b) Visibility (V)

Visibility considered two parameters namely: number of external links and number of referring domain. This indicator contributes 30% to the ranking features.

Referring domains: This is also known as ref. domain; they are pages on different websites

that point to resources in the University domain. It is a main domain for links that redirect visitors to the University website. One referring domain can have more than one link to different pages in an institution's website, for example a link in a referring domain to postgraduate school of Federal University of Technology Akure, and another link in the same domain to School of Sciences of the same Institution. Values for the referring domains were gathered with the aid of Web Crawlers like Majestic Search Engine Optimization (SEO) (<https://majestic.com/>) and ahrefs (<https://ahrefs.com/>).

- i. **Number of Backlinks:** These are also known as incoming links, inbound links, inward links and inlinks. They are links received by a web page from another web page. The number of backlinks is one indicator of the popularity or importance of a website as it is a major factor in ranking. It can also be of a significant personal, cultural or semantic interest that indicates those paying attention to a Website. These were measured with the aid of ahrefs web crawler and Majestic SEO.

c) Research Impact (R)

The research impact measures the international collaboration, scientific talent pool, excellence with leadership, specialization and normalized impact of each university. The value returned for each university is the total of all the features listed. This data is gathered from Scimago group that has details regarding the domain of discourse for 5200 Universities, which includes Nigerian Universities.

3.2 Subjective Features (S)

This indicator measures Universities' social contributions to the society, especially to their closest communities. It depicts the level of academia and social services influence on the people in and out of their community. The service includes social media presence, beneficiary programs to government, and education impact programs on the society. The subjective feature S, contributes 15% to the entire ranking features.

a) Social media presence

This reflects the social media responses from the universities' websites. The social media that were put into consideration are Twitter, Facebook, Googleplus, LinkedIn, and Pinterest

pin. SEO web analyzer (www.seowebpageanalyzer.com/) and Google were used in capturing the data for the ranking criterion.

b) Beneficiary Programs to Governmental or Private Organizations

The existence of beneficiary programs to governmental or private organizations (BPG) describes the establishment of solution centers in the university environment that provide solutions to real life problems within the country or globally. The solution center refers to the existence of research centers. The center is expected to carry out research that contributes to the economy of the country by providing or proposing solutions to current challenges faced by the society. The research center becomes beneficiary when it accepts the challenges from the government or private parastatals. The BPG is captured for each university via their website special research menu and also interviews with IT personnel in some of the Universities.

c) Educational Impact on Society (EIS)

EIS connotes self-empowerment programs set by the University. This measures the level of social responsibilities of the University to its immediate community. EIS may include existence of entrepreneurship programs, craftsmanship programs for the unskilled, such that people can learn and become better persons in the society. The services may require small amount of money from the participant that is, affordable price compared to what is required outside the University environment. Statistics for this parameter is gathered through web pages of Universities with the aid of a Web Ripper.

3.3 Webometric Ranker (WR)

The Webometric Ranker (WR) comprises of values and weights from the parameters of subjective and objective features indicators. The corresponding weights for the indicators are outlined as follows: Weight of size (w_s) = **0.5**, such that weight for number of pages and number of rich files are each 0.25; Weight of visibility (w_v) = **0.3**, such that the weight for number of referring pages and number of links are each 0.15; Weight of research impact (w_r) = **0.05**, Totality of subjective features (w_{sf}) make up **0.15** (each parameter having 0.05).

Total score γ obtained by a particular University can be represented as:

$$\gamma = \psi + S \tag{3}$$

such that γ is the total score for each of the Universities; ψ is the total score obtained from the objective features and S is the total score obtained from the subjective features.

$$\psi = X + V + R \tag{4}$$

such that X denotes the total score returned for parameter size, V denotes score returned for parameter visibility and R denotes the score value for the research impact.

$$X = \sum_i^n x_i w_i \quad \text{where } i > 0 \tag{5}$$

such that n denotes the number of parameters existing in size, x_i any instance of parameters in size and w_i is the corresponding weight of the parameter.

$$V = \sum_l^z v_l w_l \quad \text{where } l > 0 \tag{6}$$

such that z denotes the number of parameters existing in visibility, v_l , any instance of parameters in visibility and w_l , corresponding weight of the parameter

$$R = r w \tag{7}$$

such that r is an instance of research impact parameter and w is its corresponding weight.

$$S = \sum_j^m F_j \quad \text{where } j > 0 \tag{8}$$

such that F_j denotes each instance of parameters in subjective features and m denotes the total number of parameters in subjective features.

$$F_j = \begin{cases} 0, & \text{Not Existing} \\ w, & \text{Existing Online} \end{cases} \tag{9}$$

Therefore, Webometric Rank W for universities will be based on the aggregate score; the university with the highest score is ranked highest and the next in score appears next in that order, as shown in equation 10.

$$W = (\gamma_r^k > \gamma_{r+1}^k > \gamma_{r+2}^k > \dots > \gamma_{r+n-1}^k) \quad (10)$$

where rank position $r > 0$
for any university with total score γ

4. EXPERIMENTAL RESULTS AND DISCUSSION

This section gives detailed results and discussion of the proposed system. Thirty nine (39) Federal Universities in Nigeria were

ranked based on the features described earlier. Fig. 2 shows the computed weight for each University.

Fig. 3 displays the final ranking page of the universities. The ranking can be done based on subjective features, objective features and a combination of both subjective and the objective features. Table 1 displays the ranks of the Universities considered and shows their individual positions.

Table 1. Proposed webometric rank table

Rank	Institution	Subjective	Objective	Total
1	University of Agriculture, Abeokuta	88.39116	5919.7583124	6008.15
2	Federal University, Oye-ekiti	54.044595	5853.76691	5907.81
3	Ahmadu Bello University, Zaria	17.248275	2337.1802402	2354.43
4	Obafemi Awolowo University, Ile-ife	59.349065	1961.7535424	2020.9
5	University of Ilorin	349.66503	1600.438667	1950.1
6	University of Lagos	153.034695	1641.4233618	1794.46
7	University of Ibadan	34.59654	1500.1615456	1534.76
8	Federal University of Technology, Akure	78.942105	1373.2667048	1452.21
9	National Open University of Nigeria, Lagos	121.937805	1311.26236	1433.2
10	University of Nigeria, Nsukka	26.647335	1270.1272118	1296.77
11	Nnamdi Azikwe University, Awka	107.839215	1175.3925324	1283.23
12	University of Port-harcourt	58.9941	989.4233444	1048.42
13	Modibobo Adama University of Tech. Yola	1.349865	1009.06628	1010.42
14	Federal University of Technology, Owerri	83.29167	892.595625	975.89
15	University of Maiduguri	16.9983	699.155039	716.15
16	University of Jos	64.043595	619.95702	684
17	Bayero University, Kano	93.340665	571.935505	665.28
18	Federal University of Technology, Minna	153.28467	370.75521	524.04
19	University of Abuja, Gwagwalada	6.29937	455.87098	462.17
20	Nigerian Defence Academy, Kaduna	254.17458	124.51565	378.69
21	University of Uyo	49.045095	303.971441	353.02
22	University of Calabar	31.146885	275.546914	306.69
23	Abubakar Tafawa Balewa University, Bauchi	16.79832	197.03102	213.83
24	Federal University, Ndufu-Alike, Ebonyi	16.148385	178.071685	194.22
25	University of Benin	8.79912	179.4815	188.28
26	Federal University, Otuoke	15.548445	167.41804	182.97
27	Usmanu Danfodiyo University, Sokoto	10.848915	170.82365	181.67
28	Federal University of Petroleum Resources	2.09979	172.62514	174.72
29	University of Agriculture, Makurdi	18.69813	121.70997	140.41
30	Federal University, Lokoja	39.146085	93.959935	133.11
31	Federal University, Dutsin-Ma, Katsina	8.949105	113.41312	122.36
32	Federal University, Dutse	8.9991	109.261805	118.26
33	Federal University, Lafia	1.69983	113.41652	115.12
34	Federal University, Wukari, Taraba	11.49885	81.460855	92.96
35	Michael Okpara Uni. of Agric., Umudike	15.148485	62.59774	77.75
36	Federal University, Kashere, Gombe	2.749725	67.30793	70.06
37	Federal University Birnin-Kebbi	5.89941	19.850985	25.75
38	Federal University Gusua	8.249175	16.0004	24.25
39	Police Academy Wudil	0	0	0

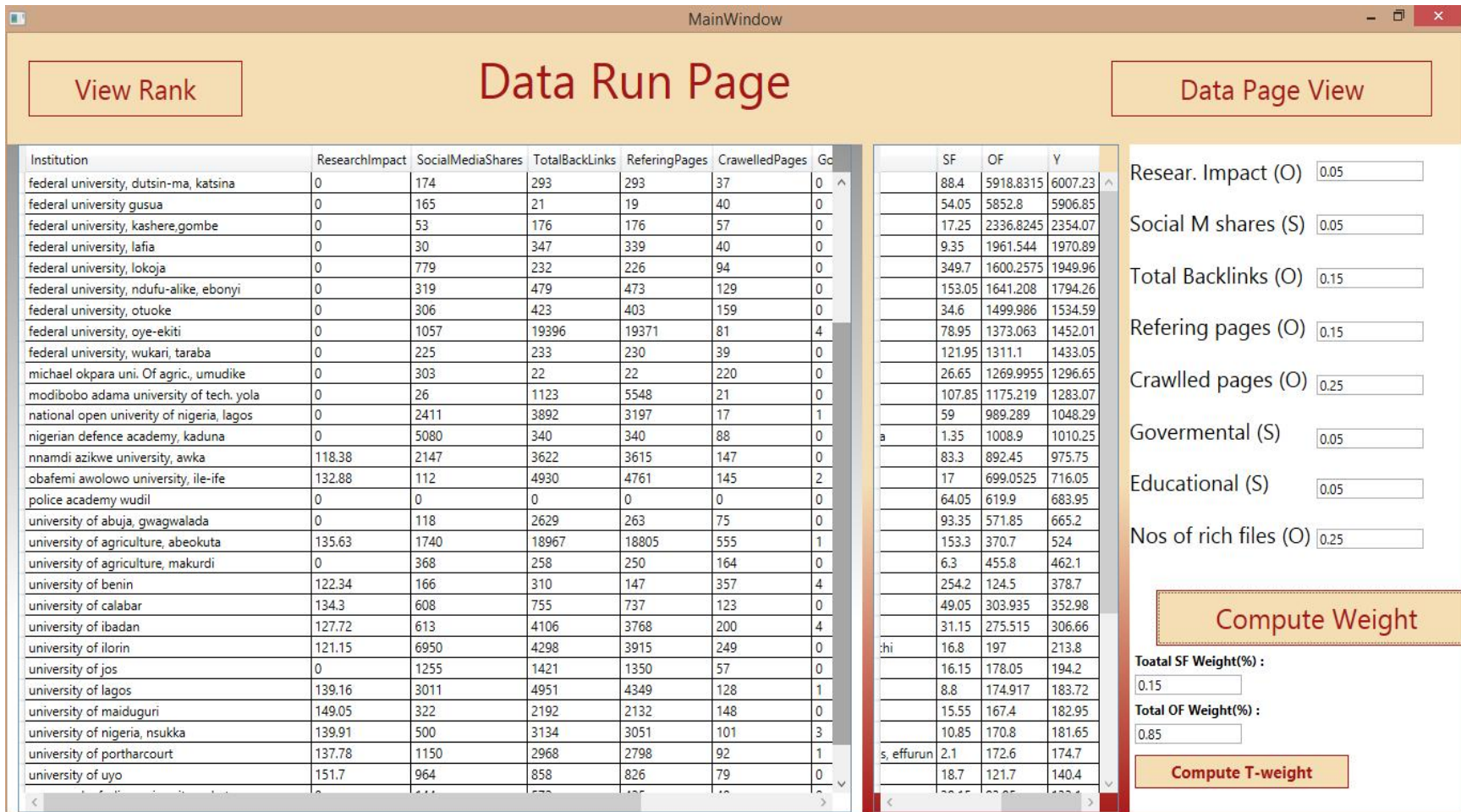


Fig. 2. Computed weight for each University

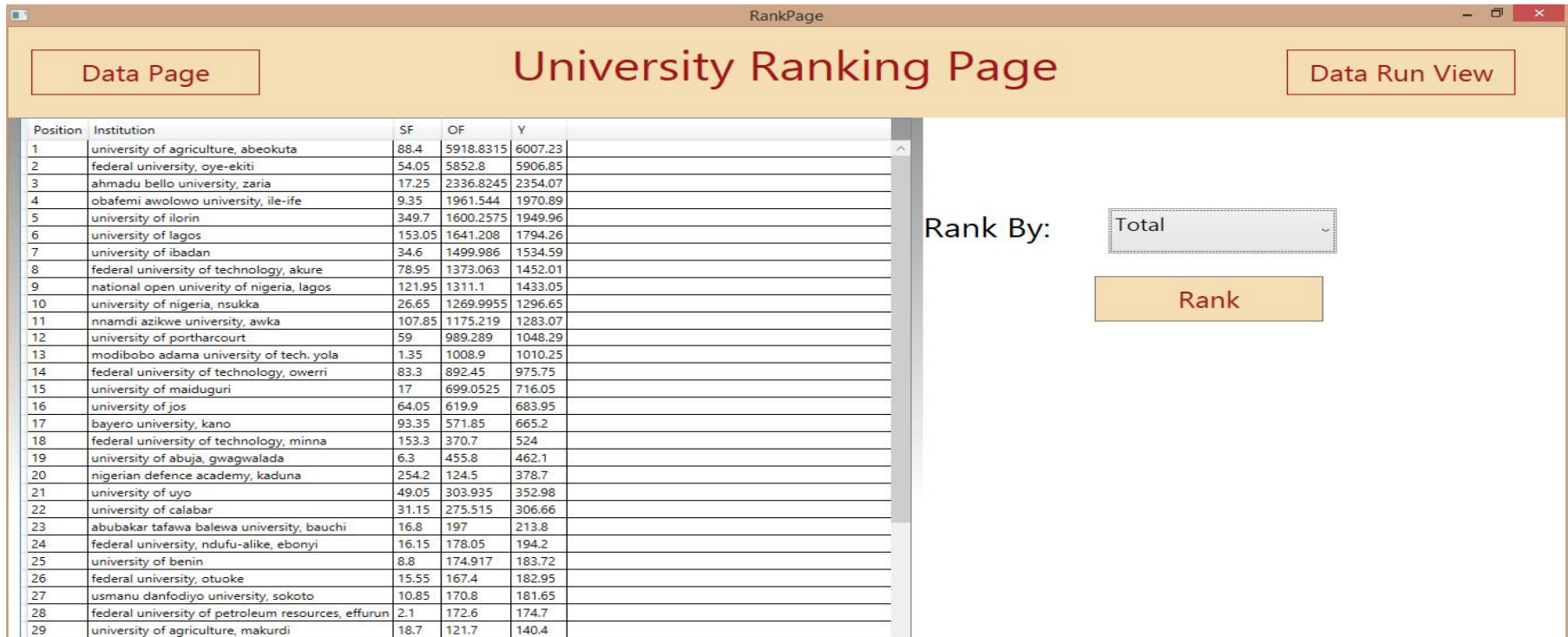


Fig. 3. Ranking based on the objective and subjective features

4.1 Comparison of the Existing Ranking System and the Proposed System

Table 2 gives a comparison of the existing webometrics ranks for Nigerian universities and the proposed system. It shows the institution's name, the existing webometrics rank and the proposed model rank. The table shows that Obafemi Awolowo University was ranked 2nd in the existing webometrics model, and was ranked 4th in the proposed model done based on subjective and objective features with ratio of 0.15:0.85. This shows a decline in position due to the lower score obtained by the school based on the ranking features. Furthermore, schools that

fall between the range of 1st and 3rd positions have improved on their Web presence and majorly the ranking criteria such as visibility, size and social media presence and scored higher marks than OAU. In other words, these results will help keep Universities on their toes as regarding improving their web presence.

Fig. 3 shows a bar chart representation of nine Universities with our proposed system rank compared with the existing webometrics rank. It indicates the close range of the existing ranking system and the proposed model due to the small percentage of the introduced ranking features to the proposed model.

Table 2. Comparison of the existing webometrics ranking and the proposed model

Institution	Existing webometrics rank	Proposed model rank
Obafemi Awolowo University	1 st	4 th
University of Ibadan	2 nd	7 th
University of Lagos	3 rd	6 th
University of Ilorin	4 th	5 th
University of Agriculture, Abeokuta	5 th	1 st
Ahmadu Bello University	6 th	3 rd
Federal University of Technology Akure	7 th	8 th
University of Nigeria	8 th	10 th
University of Benin	9 th	25 th
University of Port Harcourt	10 th	12 th
Federal University of Technology Minna	11 th	18 th
Federal University Dutsin Ma	12 th	31 st
University of Jos	13 th	16 th
Federal University Oye Ekiti State	14 th	2 nd
Federal University of Technology Owerri	15 th	14 th
University of Calabar	16 th	22 nd
National Open University of Nigeria	17 rd	9 th
University of Uyo	18 th	21 st
Bayero University Kano	19 th	17 th
Nnamdi Azikiwe University	20 th	11 th
Federal University Ndufu Alike Ebonyi State	21 st	24 th
University of Maiduguri	22 nd	15 th
Usmanu Danfodiyo University	23 rd	27 th
Federal University of Agriculture Makurdi	24 th	29 th
Federal University Dutse Jigawa State	25 th	32 nd
Abubakar Tafawa Balewa University	26 th	23 rd
Nigerian Defence Academy Kaduna	27 th	20 th
Federal University Otuoke Bayelsa	28 th	26 th
Federal University of Petroleum Resources Effurun	29 th	28 th
Michael Okpara University of Agriculture Umudike	30 th	35 th
Federal University Lokoja Kogi State	31 st	30 th
Modibbo Adama University of Technology Yola	32 nd	13 th
Federal University Wukari Taraba State	33 rd	34 th

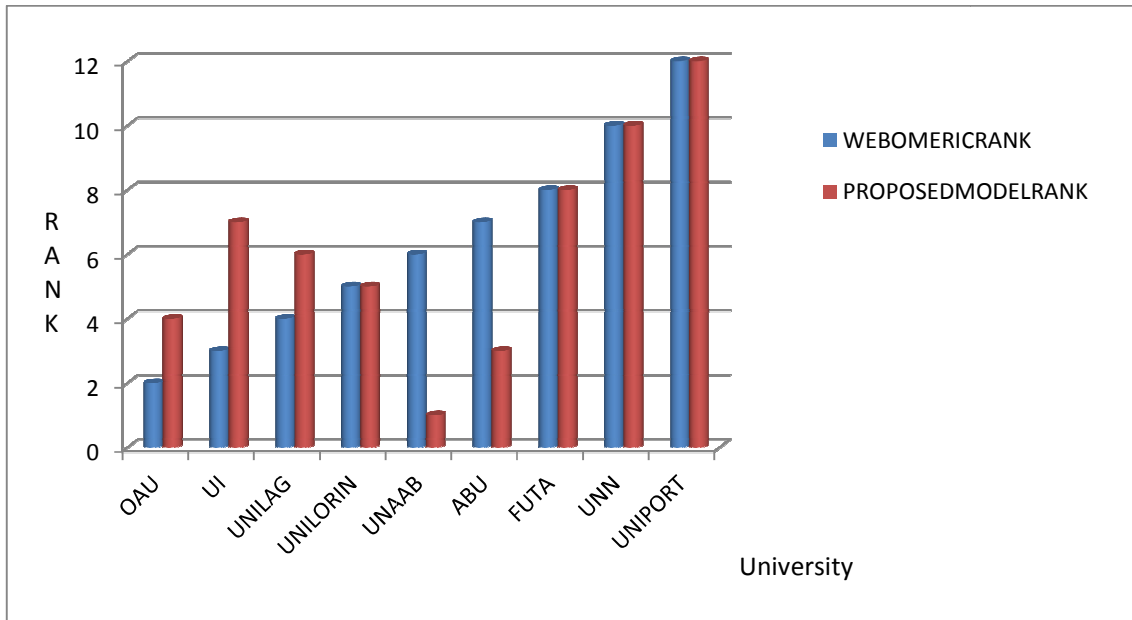


Fig. 4. Webometrics rank versus proposed model rank

Table 3. Proposed model rank table (0.5:0.5) ratio

Rank	Institution	Subjective	Objective	Total
1	University of Agriculture, Abeokuta	294.6372	3482.210772	3776.85
2	Federal University, Oye-Ekiti	180.14865	3443.3923	3623.54
3	University of Ilorin	1165.5501	941.43451	2106.98
4	University of Lagos	510.11565	965.543154	1475.66
5	Ahmadu Bello University, Zaria	57.49425	1374.811906	1432.31
6	Obafemi Awolowo University, Ile-Ife	197.81355	1153.972672	1351.79
7	National Open University of Nigeria, Lagos	406.45935	771.3308	1177.79
8	Federal University of Technology, Akure	263.14035	807.803944	1070.94
9	Nnamdi Azikwe University, Awka	359.46405	691.407372	1050.87
10	University of Ibadan	115.3218	882.447968	997.77
11	Nigerian Defence Academy, Kaduna	847.2486	73.2445	920.49
12	University of Nigeria, Nsukka	88.82445	747.133654	835.96
13	Federal University of Technology, Owerri	277.6389	525.05625	802.7
14	University of Port-harcourt	196.647	582.013732	778.66
15	Federal University of Technology, Minna	510.9489	218.0913	729.04
16	Bayero University, Kano	311.13555	336.43265	647.57
17	Modibobo Adama University of Tech. Yola	4.49955	593.5684	598.07
18	University of Jos	213.47865	364.6806	578.16
19	University of Maiduguri	56.661	411.26767	467.93
20	University of Uyo	163.48365	178.80673	342.29
21	University of Abuja, Gwagwalada	20.9979	268.1594	289.16
22	University of Calabar	103.82295	162.08642	265.91
23	Federal University, Lokoja	130.48695	55.27055	185.76
24	Abubakar Tafawa Balewa University, Bauchi	55.9944	115.9006	171.9
25	Federal University, Ndufu-Alike, Ebonyi	53.82795	104.74805	158.58
26	Federal University, Otuoke	51.82815	98.4812	150.31
27	Usmanu Danfodiyo University, Sokoto	36.16305	100.4845	136.65
28	University of Benin	29.3304	105.188596	134.52
29	University Of Agriculture, Makurdi	62.3271	71.5941	133.92
30	Federal University of Petroleum Resources	6.9993	101.5442	108.54

Rank	Institution	Subjective	Objective	Total
31	Federal University, Dutsin-Ma, Katsina	29.83035	66.7136	96.54
32	Federal University, Dutse	29.997	64.27165	94.27
33	Michael Okpara Uni. of Agric., Umudike	50.49495	36.8222	87.32
34	Federal University, Wukari, Taraba	38.3295	47.91815	86.25
35	Federal University, Lafia	5.6661	66.7156	72.38
36	Federal University, Kashere, Gombe	9.16575	39.5929	48.76
37	Federal University Gusua	27.49725	9.412	36.91
38	Federal University Birnin-Kebbi	19.6647	11.67705	31.34
39	Police Academy Wudil	0	0	0

Table 4. Existing/Proposed/Objective/Subjective rank comparison

Institution	Existing rank	Proposed model rank	Objective features rank	Subjective features rank
Obafemi Awolowo University	1 st	6 th	4 th	12 th
University of Ibadan	2 nd	10 th	7 th	17 th
University of Lagos	3 rd	4 th	5 th	4 th
University of Ilorin	4 th	3 rd	6 th	1 st
University of Agriculture, Abeokuta	5 th	1 st	1 st	8 th
Ahmadu Bello University	6 th	5 th	3 rd	21 st
Federal University of Technology Akure	7 th	8 th	8 th	10 th
University of Nigeria	8 th	12 th	10 th	19 th
University of Benin	9 th	28 th	24 th	31 st
University of Port Harcourt	10 th	14 th	13 th	13 th
Federal University of Technology Minna	11 th	15 th	19 th	3 rd
Federal University Dutsin Ma	12 th	31 st	31 st	30 th
University of Jos	13 th	18 th	16 th	11 th
Federal University Oye Ekiti State	14 th	2 nd	2 nd	14 th
Federal University of Technology Owerri	15 th	13 th	14 th	9 th
University of Calabar	16 th	22 nd	21 st	18 th
National Open University of Nigeria	17 rd	7 th	9 th	5 th
University of Uyo	18 th	20 th	20 th	15 th
Bayero University Kano	19 th	16 th	17 th	7 th
Nnamdi Azikiwe University	20 th	9 th	11 th	6 th
Federal University Ndufu Alike Ebonyi State	21 st	25 th	24 th	24 th
University of Maiduguri	22 nd	19 th	15 th	22 nd
Usmanu Danfodiyo University	23 rd	27 th	26 th	28 th
Federal University of Agriculture Makurdi	24 th	29 th	29 th	20 th
Federal University Dutse Jigawa State	25 th	32 nd	32 nd	29 th
Abubakar Tafawa Balewa University	26 th	24 th	22 nd	23 rd
Nigerian Defence Academy Kaduna	27 th	11 th	28 th	2 nd
Federal University Otuoke Bayelsa	28 th	26 th	27 th	25 th
Federal University of Petroleum Resources	29 th	30 th	25 th	36 th
Michael Okpara University of Agriculture U	30 th	33 rd	36 th	26 th
Federal University Lokoja Kogi State	31 st	23 rd	33 rd	16 th
Modibbo Adama University of Technology	32 nd	17 th	12 th	38 th
Federal University Wukari Taraba State	33 rd	34 th	34 th	27 th

Table 3 shows the proposed webometric rank table for the thirty nine Federal Universities in Nigeria. The ratio changed to 0.5:0.5 so as to easily compare with the existing webometric ranks and identify the changes in the rank table.

Table 4 shows the existing Webometric model ranks for the Federal Universities in Nigeria with

a working websites, the proposed model rank in 0.5:0.5 ratio, the subjective features rank and the objective features rank. It clearly displays the close association in the existing webometric rank and the objective features rank as the two uses almost the same ranking metrics with only research impact introduced to the proposed model objective features. University of Lagos

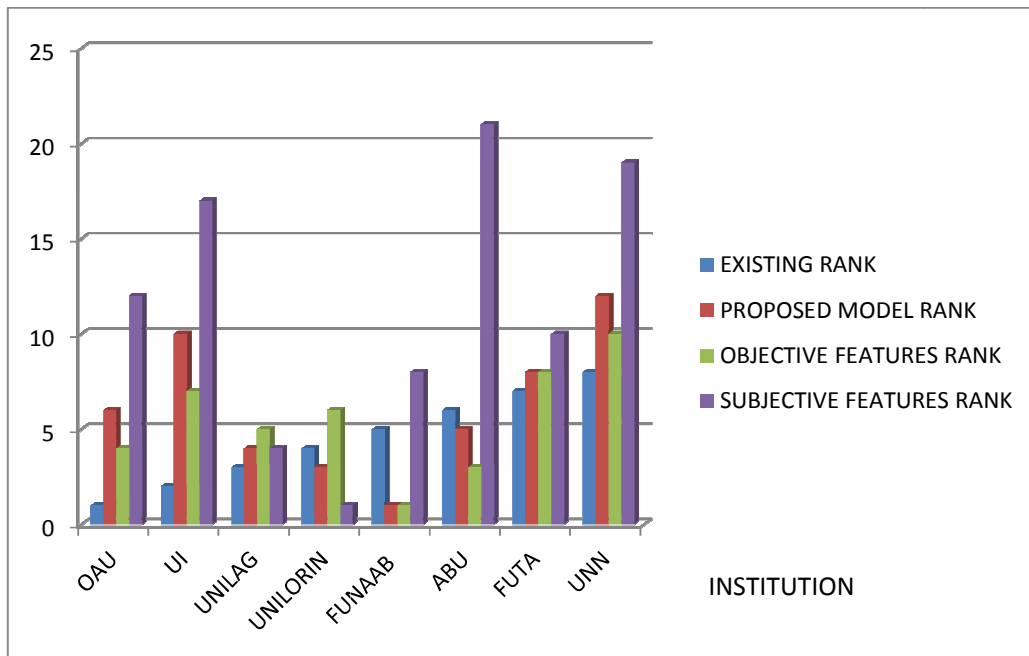


Fig. 5. Existing/Proposed/Objective/Subjective rank comparison

was ranked 3rd in the existing model and 5th in the objective features of the proposed model. University of Ilorin was ranked 4th in the existing model and 6th in the objective features of the proposed system. Table 4 also indicates the changes in the ranks when the subjective features were introduced to the objective features as it is seen in the total column, this indicates the effect of the ranking subjective metrics introduced to the webometrics university ranking system. University of Lagos was ranked 3rd, 5th, and 4th respectively in the existing ranking system, objective features ranks and the proposed model ranks. It displays the subjective features ranks which are clearly different from the others as it introduced new ranking metrics to the system. For example, Obafemi Awolowo University Ile-Ife was ranked 1st, 6th, 4th, and 12th in existing model, proposed model, objective features rank and subjective features rank respectively.

Fig. 5 gives a graphical representation of seven of the ranked Universities in the four different categories shown in Table 3.

4.2 System Evaluation

4.2.1 System accuracy

To measure the system accuracy level of the proposed system, Spearman Rank Correlation was used.

Spearman Rank Correlation: It is a statistical measure of the strength of a monotonic relationship between paired data (Spearman [19]). The formula is given in equation (11).

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} \tag{11}$$

$$d_i = x_i - y_i \tag{12}$$

where x_i represents individual rank positions for Universities in the existing Webometrics model, and y_i represents individual rank positions for Universities in the proposed model and n is the total number of the Institutions ranked. The closer the value of ρ is to 1, the stronger the monotonic relationship.

The rank correlation for existing webometric ranking model and proposed model ((ratio 0.5:0.5), (ratio 0.85:0.15), existing webometric ranking model and objective features rank table, existing webometric ranking model and subjective features rank table were calculated.

a) Existing Webometric Ranking Model and Proposed Model (Ratio 0.85:0.15)

Table 3 was used for the rank correlation computation. The sample statistic computed is:

1590, with rho (ρ) = 0.7342914 and p-value = 2.919e-06

Based on the sample correlation coefficient estimate i.e. rho (ρ) = 0.7342914, there exists a strong and positive relationship between the two ranks (that is, Webometrics & the proposed rank). Moreover, this relationship is significant at $\alpha = 5\%$ since the p-value is less than the level of significance.

b) Rank Correlation for Existing Webometrics Ranking Model and Proposed Model (Ratio 0.5:0.5)

Table 4 was used to calculate the rank correlation for the proposed model and existing model. The sample statistics computed is: 1590, with rho (ρ) = 0.68248 and p-value = 1e-05. Based on the sample correlation coefficient estimate, that is rho (ρ) = 0.68249, there exists a significant and positive relationship between the two ranks (that is, Webometrics and the proposed rank). Moreover, the level of relationship significance reduced due to the change in the objective and subjective features ratio.

c) Existing Webometrics Ranking Model and Subjective Features Rank Table

Table 4 was used to find the rank correlation between the existing model and the objective features ranks. The sample statistics computed is: 1590, with rho (ρ) = 0.47481 and p-value = 0.00524. Based on the sample correlation coefficient estimate, that is rho (ρ) = 0.47627, there exists a less significant and positive relationship between the two ranks. Moreover, the level of relationship significance for the two is closer to 0 than 1 which implies a distant relationship between the subjective features ranks and the existing model ranks for the institutions considered.

d) Existing Webometrics Ranking Model and Objective Features Rank Table

Results from Table 4 were used to find the rank correlation between the existing model and the subjective features ranks. The sample statistics computed is: 1590, with rho (ρ) = 0.7524 and p-value = 0. Based on the sample correlation

coefficient estimate, that is rho (ρ) = 0.7524, there exists a significant and positive relationship between the two ranks. Moreover, this indicates the closeness between the existing webometric ranks and the objective features ranks as they both have similar ranking metrics.

4.2.2 Criteria based comparison

A criteria based comparison with existing ranking metrics was conducted via administered questionnaire. Table 5 shows a detailed analysis of the comparison.

This compares three of the existing Universities ranking methods with the proposed model, based on the criteria used. The Universities ranking system compared with the proposed model are Webometric University ranking system done by Cybermetrics Laboratory in Spain (Webometrics) (Aguillo et al. [5,20]; Aguillo [21]; Aguillo and Labajos [22] academic ranking of world Universities in China (ARWU) (<http://www.shaghairanking.com>) and QS ranking system in the United Kingdom (<http://www.topuniversities.com>). Table 5 indicates that the proposed model has more ranking criteria than the various existing ranking systems compared. The criterion with "YES" indicates the presence of the ranking factor, while the criterion with "NO" indicates the absence of the ranking factor.

4.2.3 Social acceptability survey

The social acceptability survey was used to measure the level of acceptance of the ranking criteria introduced to the ranking model. For the analysis, sixty (60) questionnaires were administered to workers, IT personnel and students in a Tertiary Institution in Nigeria, and all were returned. Eight (8) of the respondents had poor knowledge on webometric ranking, two (2) had a good knowledge and fifty (50) had a very good knowledge of Webometrics ranking. Responses of the fifty (50) respondents with good knowledge were used for the analysis of social acceptability of the proposed system. Table 6 presents the results of the analysis. Fig. 6 shows a bar chart representation of the social acceptability survey. It gives a graphical representation of the social acceptability of the proposed system, which has up to 70% acceptance rate.

Table 5. Ranking criteria comparison

Criteria	Proposed model	Webometrics	ARWU	QS
Size	Yes	Yes	Yes	No
Visibility	Yes	Yes	No	No
Social media presence	Yes	No	No	No
Governmental programmes	Yes	No	No	No
Research impact	Yes	No	Yes	No
Societal impact	Yes	No	No	No
Teaching	No	No	Yes	Yes
Prestige	No	No	Yes	Yes
Internationalisation	No	No	No	Yes

Table 6. Social acceptability of the proposed system

Criteria	Accepted	Partially accepted	Indifference	Not accepted
Social media shares	35	5	8	3
Existence of beneficiary programmes	40	7	2	1
Research impact	48	2	0	0
Informal Educational impact	30	15	3	2
Existence of the aforementioned criteria	39	8	3	0

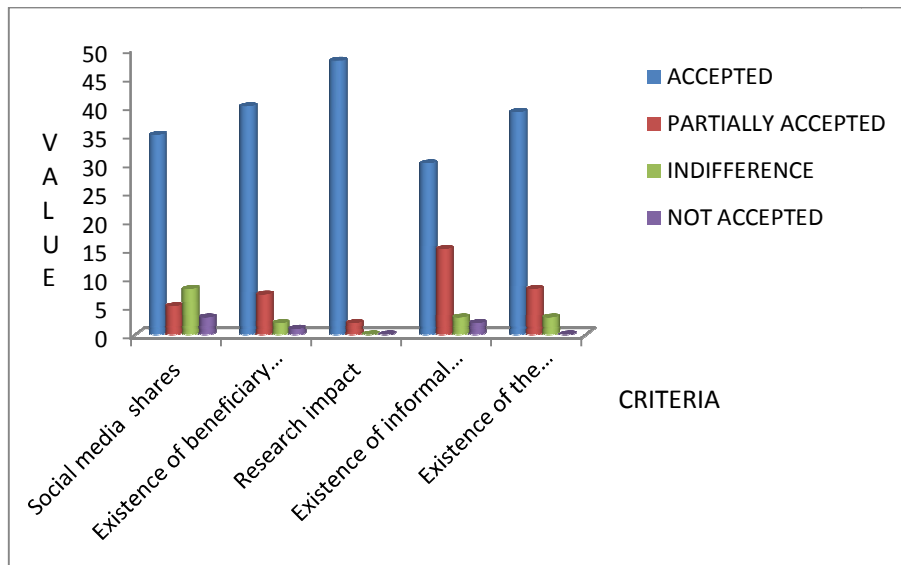


Fig. 6. Bar chart representation of proposed model acceptability

5. CONCLUSION

In this paper, an enhanced Webometric System is developed for University Ranking, with the introduction of subjective features, including number of social media shares, governmental programmes and beneficiary educational programmes to the society to the Webometric University ranking system features. Each of the features is assigned different weights that can be varied, which is multiplied by values returned for

each of the universities. The final result displays the total of the subjective features and objective features. The results show that the newly introduced features are important and will contribute to evaluating the impact of Universities. The work in the future could consider extending beyond only Public Universities and creating a more automatic method of obtaining values for the different features.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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