Review Article

Usability Evaluation of Kenyan Universities Websites for Webometrics Ranking

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Abstract - *The study aimed to evaluate the usability of Kenyan universities websites for webometrics ranking using web analysis tools. The target population for the study was the top five (5) universities in the January 2020 edition of webometrics ranking in Kenya. The study collected, analyzed, and evaluated website usability of the following website attributes: URL structure, Website Age, Uptime, Content Management System, website hosting service provider, Responsiveness, Browser compatibility, Color contrast, Domain Authority, Domain Backlinks, Website traffic, Broken Links, Number of Subdomains, Website Speed, Indexed webpages, Website compression, Search Engine Optimization, Website content utility, Website design and Website Accessibility. After analysis, it was noted that Kenyan universities need to improve on some of the usability criteria used in the study where a score of less than 50% was attained, such as Website compression, website speeds, website subdomain, website indexed pages, website traffic, website backlinks, website colour contrast and website design.*

Keywords - *Website evaluation, usability criteria, web analysis tools, Kenyan Universities.*

I. INTRODUCTION

Globalization has made a great impact on society's culture, economy and politics. Institutions of higher education are no exception. An analysis of the university's mission and vision statements indicate a trend in the emphasis on the importance of the institution to be visible in the global arena. Example Kibabii University vision statement is "*To be a global and dynamic University of excellence in Science, Technology and Innovation*". As globalization has become the focal point of higher education, competition has become a central preoccupation [1]. Global competition in higher education brought about the need for global university rankings. There are various global rankings of World Universities, some are more popular than others, and Webometrics ranking by Spanish National Research Council is one of them. Webometrics ranking is strongly linked to the quality and volume of the web content published by institutions of higher education [2]. Institution web resources are usually analyzed and evaluated through web data mining.

Institutions worldwide are encouraged to have an adequate web presence, and their Institutional websites should accurately represent their resources, activities and global performance, providing visitors with a clear vision of the institution [3]. In Kenya, most universities task ICT departments to realize improvement of webometrics ranking [4]. For this reason, this study sought to evaluate the usability of Universities websites for webometrics ranking.

A. Usability

Usability is defined differently by multiple researchers. Reference [5] defines usability as "technology's capability to be used easily and effectively by the specified range of users, given definite training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios" Reference [6] defines web usability as "anyone using any kind of web browsing technology must be able to visit any webpage and get a complete understanding of the information, as well as have the full and complete ability to interact with the website". Reference [7] defines Usability as "ease of use and ease of learning that implies providing users with systems requiring minimum cognitive and physical effort to accomplish users' needs and expectations". While ISO standards defined usability as "the extent to which a product can be used by specified users to achieve specified goals with efficiency, effectiveness and satisfaction in a specified context of use" [8]. We define website usability as the ability of a user to accomplish a task on a website with minimal or no assistance.

Researchers identified different usability principles from various disciplines. For example, a researcher suggested four aspects of usability, namely, effectiveness, learnability, usefulness and attitude [9]. Another researcher identified four usability evaluation criteria focusing on how users accomplish their tasks in using a system, and these were: flexibility, effectiveness, learnability and user attitude [10].

A highly cited researcher in web usability identified five usability attributes these were: memorability; learnability; low error rate, efficiency and subjective satisfaction [11]. While [12] identified 6 attributes of usability, these were: control, ease of use, check ability, speed, confidence and understanding.

B. Website Usability Evaluation Methods

The ultimate goal of website usability evaluation is to identify usability shortcomings that affect user experiences with the sole purpose of solving the usability issues identified [13]. Some usability evaluation methods are: user-based usability evaluation methods, evaluator-based usability evaluation methods and automatic website evaluation tools

The user-based usability evaluation method describes an evaluation where representative users test the system under study as per a predefined set of activities to achieve the targeted goal [14]. User performance metrics collected from this evaluation method are the time taken to accomplish an activity, type and rate of errors observed in accomplishing an activity, user satisfaction, among others [11]-[14].

The evaluator-based usability evaluation method describes an evaluation where experts such as usability designers in the field of study evaluate the system using predefined design standards, tasks, their own knowledge and experiences to identify possible usability issues [15]. The evaluator can inspect the system by employing: heuristic evaluation, guideline reviews, standard inspection and cognitive walkthrough [16]. The heuristic evaluation method is where a group of experts evaluate the usability of the system with reference to design principles. In this method, [11] asserted that one expert could evaluate the system and establish 35% of the usability problems in a system, while [15] affirmed that reasonable results are obtained when more than three experts evaluate the system.

Web analysis tools are software that automates the collection of interface usage data and identify potential web problems. Researchers have used web analysis tools such as Pingdom to test webpage speed, Semrush to test website traffic and Ahref to test domain authority. The study used web analysis tools to evaluate the usability of websites.

C. Website Usability Criteria

General usability principles are achieved through usability criteria, and the criteria provide guidelines to webmasters in developing websites that are usable [17]. This study used website usability criteria such as URL structure, Website Age, Uptime, Content Management System, website hosting service provider, Responsiveness, Browser compatibility, Color contrast, Domain Authority, Domain Backlinks, Website traffic, Broken Links, Number of Subdomains, Website Speed, Indexed webpages, Website compression, Search Engine Optimization, Website content utility, Website design and Website Accessibility.

D. Research Objective

The research objective was to evaluate the usability of Kenyan universities websites for webometrics ranking

II. RELATED STUDIES

Various studies have made efforts to evaluate the usability of websites. A study evaluated the Hellenic Open University website using heuristic evaluation, and this study assessed match between the real world and system; user freedom and control; system status visibility; recognition rather than recall; standards and consistency; efficiency and flexibility of use; error prevention; minimalist design and aesthetic; diagnose and recover from errors, help users recognize and finally help and documentation [18]. Other researchers have evaluated the usability of the top fifty United State universities websites in order to assess their effectiveness. . They explored four website elements that are; understanding the information, finding the information, supporting user tasks, and presenting the information [19]. Lund University website was also evaluated using heuristic analysis, user feedback and automated analysis tools. The researcher evaluated website elements that included content, navigation, design and search engine [20]. Using heuristic analysis, a researcher evaluated the usability of university websites in Saudi Arabia, and the study looked into the following website elements: links and navigation, visual design and consistency, information truth and precision, privacy and security, data entry forms, search functionality, as well as, help, feedback and error tolerance [21]. Another study conducted a heuristic evaluation of twenty-four academic websites through data mining techniques. They used a System for Evaluation of Usability of Web sites (SIRIUS) which contained a tool to generate usability evaluations of Web sites called Prometheus. They explored 10 website elements, namely: Structure and Navigation, Multimedia Elements, Labeled, Page Layout, Understandability and ease of interaction, Identity and Information, Control and Feedback, Search and Help [22]. In another study, ten universities websites in Nigeria have been evaluated using an automated online tool called SortSite to conduct an evaluation of accessibility usability to test conformance against W3 Web Content Accessibility Guidelines (WCAG) 2.0 and US Federal (Usability.gov) guidelines [23]. Other researchers evaluated the usability of the University website using user-based analysis, and they explored five website usability elements, namely: efficiency, controllability, helpfulness, attractiveness and learnability [24].

Prior studies have investigated website usability evaluation of academic websites using user questionnaires, heuristic evaluators and web analysis tools. In most of these studies, the evaluated websites were found to have poor usability in some elements under study. Researchers have given recommendations to overcome usability issues on academic websites. However, the recommended guidelines are not anchored towards improving webometrics ranking.

III. RESEARCH METHODOLOGY

The target population for the study was the top 5 universities in the January 2020 edition of webometrics ranking in Kenya. In this research, the Universities are identified as Varsity1 to Varsity5 as they appear in the January 2020 webometrics ranking. Web analysis tools were used to assess and evaluate the usability of websites. Web tools such as nibbler. silktide, semrush, seositecheckup and Ahrefs were used in this study. Simulation procedure entailed: Open web analysis tool example: woorank on any browser, Login to the page if required, In the displayed textbox, enter university URL and press enter button on the keyboard to analyze a website attribute, Website attribute performance scores were loaded after a while. Performance scores for various attributes were recorded for analysis. A simulation was done between June 14th, 2021 to August 14th, 2021.

IV. RESEARCH FINDINGS

The researcher collected, analyzed, and evaluated the website usability of the following website attributes using free simulation tools. For each usability criteria analyzed, a reference is made to Harvard University since it was ranked the best university globally in the July 2021 webometrics ranking edition. Harvard University was used as a point of reference in deriving the usability score for some website attributes in the study.

A. Evaluate Website URL Structure

Using automated tool site checker. Pro and nibbler. silktide, researchers were able to collect website URL length size and URL format. Table 1 displays website URL scores for the five sampled universities in Kenya with reference to Harvard University.

Table 1. Website url structure usability score

University	URL Length Symbols	URL Format	URL Length Score%	URL Format Score%	URL structure Score%
Harvard	24	10	79	100	90
Varsity1	24	10	79	100	90
Varsity2	26	10	77	100	89
Varsity3	20	8	83	80	82
Varsity4	30	7.6	74	76	75
Varsity5	23	10	80	100	90

The tool "what-is-url" recommended a maximum URL length of 115 symbols. URL length score was derived from $((115 - \text{actual URL length})/115)*100$. The tool "nibbler. silktide" used the scoring system between zero and ten, ten being the highest score in estimating the appropriateness of the URL format. URL format score was derived from (Actual URL format value/10) * 100. The evaluation tools checked: keywords in URL, URL length, URL id parameters and URL file extensions. The average score for the URL structure was derived from the mean value of the URL length and URL format.

From the results in Table I, Harvard University URL length was represented by 79% and URL format by 100%; on average, URL structure for Harvard University was 90%. Varsity1 URL length was represented by 79% and URL format by 100%; on average, URL structure for Varsity1 was 90%. Varsity2 URL length was 77% and URL format by 100%; on average, URL structure for Varsity2 was 89%. Varsity3 URL length was represented by 83% and URL format by 80%; on average, URL structure for Varsity3 was 82%. Varsity4 URL length was represented by 74% and URL format by 76%; on average, URL structure for Varsity4 was 75%. Varsity5 URL length was 80% and URL format by 100%; on average, URL structure for Varsity5 was represented by 90%. Varsity5 (90%), Varsity1 (90%) and Harvard University, represented by 90%, are all clustered around the same value. It can be observed all sampled universities scored over 50%. From the results, it is evident that a short URL length leads to a higher Webometrics ranking. Consequently, a higher score in URL format leads to a higher Webometrics ranking.

B. Evaluate Website Age

Using the automated tool domain-age-checker, researchers were able to estimate Universities website age. Table II display website age for the five sampled universities in Kenya with reference to Harvard University.

Table 2. Website age usability score

University	Website Age (Years)	Website Age Score%
Harvard	36	100
Varsity1	22	61
Varsity2	19	53
Varsity3	21	58
Varsity4	20	56
Varsity5	22	61

Harvard University website age was a point of reference in deriving the score of this website attribute. Website age score was derived from (Actual Year/ reference value) *100. The evaluation tool checked the date when the domain was first created as well as the date when it was last updated.

From the results in Table II, Usability evaluation of website age for Varsity1 was represented by 61%, Varsity2 by 53%, Varsity3 by 58%, Varsity4 by 56% and Varsity5 by 61%. There was a difference in website age between Harvard University and Kenyan Universities. Varsity1 (61%) was the next nearest to Harvard University, represented by 100%. It can be observed all sampled universities scored over 50%. From the results, older website domain age leads to a higher webometrics ranking.

C. Evaluate Website Uptime

Using automated tool test-your-website, researchers were able to conduct a website uptime test. Table III display website uptime data for the five sampled universities.

Table 3. Website uptime usability score

University	Uptime	Uptime Score %
Harvard	10	100%
Varsity1	10	100
Varsity2	10	100
Varsity3	10	100
Varsity4	10	100
Varsity5	10	100

The tool used the scoring system between zero and ten, ten being the top score. The evaluation tool tested website availability in various locations worldwide.

From the results in Table III, usability evaluation of website uptime for Varsity1 was represented by 100%, Varsity2 by 100%, Varsity3 by 100%, Varsity4 by 100% and Varsity5 by 100%. The five Kenyan universities and Harvard University represented by 100% are all clustered around the same value. It can be observed all sampled universities scored over 50%. From the results, a reliable website server uptime leads to a higher webometrics ranking.

D. Evaluate Website Content Management System

Using automated tools what cms, researchers were able to identify the website content management system used. Table IV displays the content management system used for the five sampled universities with reference to Harvard University.

Table 4. Website content management system analysis

University	The content management system used
Harvard	WORDPRESS
Varsity1	DRUPAL
Varsity2	JOOMLA
Varsity3	JOOMLA
Varsity4	JOOMLA
Varsity5	WORDPRESS

The evaluation tool tested: asset files, "x-powered-by" header, directory structures, <meta name="generator"> tag, JavaScript code, among others, in detecting all of the major content management systems.

From the results in Table IV, Varsity1 employed Drupal, Varsity2 employed Joomla, Varsity3 employed Joomla, Varsity4 employed Joomla and Varsity5 employed WordPress. Joomla was used by 3 out of 5 universities, Drupal was used by 1 out of 5, and WordPress was used by 1 out of 5 universities. It was not possible to quantify this website attribute because the sample size was not big enough for possible statistical estimation.

E. Evaluate Website Hosting Service Provider

Using automated tool who-is, researchers were able to identify the companies hosting university websites. Table V display the website hosting company for the five sampled universities.

Table 5. Website hosting company analysis

University	Website hosting company
Harvard	FASTLY
Varsity1	KENET
Varsity2	KENET
Varsity3	KENET
Varsity4	KENET
Varsity5	UNIFIED LAYER

The evaluation tool checked the company that manages the servers on which website information is stored, IP address for the server hosting the website and nameservers.

From the results in Table V, Usability evaluation of website hosting companies was not possible due to a descriptive output that would not be quantified. However, Varsity1 is hosted by KENET, Varsity2 by KENET, Varsity3 by KENET, Varsity4 by KENET and Varsity5 by Unified Layer. Harvard University is hosted by Fastly. 4 out of 5 Kenyan universities were hosted by KENET, and 1 out of 5 universities were hosted by Unified layer. It was not possible to quantify this website attribute because the sample size was not big enough for possible statistical estimation.

F. Evaluate Website Responsiveness

Using the automated tool Silktide, researchers were able to estimate website responsiveness. Table VI display website responsiveness data for the five sampled universities.

Table 6. Website responsiveness usability score

University	Responsiveness Value	Responsiveness Score%
Harvard	10	100
Varsity1	10	100
Varsity2	9.6	96
Varsity3	10	100
Varsity4	8.6	86
Varsity5	10	100

The tool used the scoring system between 0 and 10, 10 being the top score. Responsiveness score was derived from (Actual responsiveness value /10) * 100. The evaluation tool tested the meta viewport tags (defines the surface of the browser window) for viewing on a mobile phone or a tablet and elements of Adobe Flash. Flash is commonly used to add interactivity or video to a website, but it can only be viewed on devices that have the Flash plugin. The Flash plugin is not always available to many mobile phones and tablets, so they cannot view Flash content.

From the results in Table VI, usability evaluation of website responsiveness for Varsity1 was represented by 100%, Varsity2 by 96%, Varsity3 by 100%, Varsity4 by 86% and Varsity5 by 100%. Varsity1 (100%), Varsity3 (100%), Varsity5 (100%) and Harvard University represented by 100% are all clustered around the same value. It can be observed all sampled universities scored over 50%. From the result, a higher score in website responsiveness leads to a higher webometrics ranking.

G. Evaluate Website Browser Compatibility

Using automated tool browser compatibility, researchers were able to estimate website browser compatibility evaluation. Table VII display website browser compatibility data for the five sampled universities.

Table 7. Browser compatibility usability score

University	Browser compatibility Issues found	Browser compatibility Score%
Harvard	1	98
Varsity1	2	95
Varsity2	3	93
Varsity3	1	98
Varsity4	1	98
Varsity5	2	95

The tool tested 41 pages of each University URL. Browser compatibility score was derived from ((41 - actual browser issues)/41)*100. The evaluation tool checked: HTML tags not supported by some browsers, CSS features not supported by some browsers, Technologies not supported by some browsers (e.g. SVG on old Android phones) and Image formats not supported by all browsers (e.g. some transparent PNGs don't display correctly on old versions of Internet Explorer).

From the results in Table VII, usability evaluation of website browser compatibility for Varsity1 was represented by 95%, Varsity2 by 93%, Varsity3 by 98%, Varsity4 by 98% and Varsity5 by 95%. Varsity3 (98%), Varsity4 (98%) and Harvard University, represented by 98%, are all clustered around the same value. It can be observed all sampled universities scored over 50%. From the result, a higher score in the website browser compatibility leads to a higher webometrics ranking.

H. Evaluate Website Color Contrast

Using automated tool colour.a11y, researchers were able to estimate website colour contrast evaluation. Table 4.8 displays website colour contrast data for the five sampled universities.

Table 8. Website color contrast usability score

University	Color contrast ratio	Color contrast Score%
Harvard	11.90	164.4444
Varsity1	4.47	-0.6667
Varsity2	2.30	-48.8889
Varsity3	2.81	-37.5556
Varsity4	3.99	-11.3333
Varsity5	1.16	-74.2222

The required minimum colour contrast ratio for the tool is 4.5. The colour contrast score is derived from ((actual ratio-4.5)/4.5)*100. The evaluation tool tested how bright or dark colours appear against each other on screens with regard to the relative, grey-scale luminosity as perceived by the human eye.

From the results in Table VIII, usability evaluation of website colour contrast for Varsity1 was represented by -0.67%, Varsity2 by -48.89%, Varsity3 by -37.56%, Varsity4 by -11.33% and Varsity5 by -74.22%. The negative score indicates that usability evaluation of website colour contrast for the Kenyan Universities are below the minimum required reference value of 4.5. There was a difference in website colour contrast between Harvard University (164.44%) and Kenyan Universities (negative values). It can be observed all sampled universities scored less than 50%. From the result, a higher score in the website colour contrast leads to a higher webometrics ranking.

I. Evaluate Website Domain Authority

Using the automated tool domain-authority-checker, the study was able to estimate domain authority evaluation. Table IX display website domain authority data for the five sampled universities with reference to Harvard University.

Table 9. Domain authority usability score

University	Domain authority %
Harvard	94
Varsity1	60
Varsity2	39
Varsity3	55
Varsity4	38
Varsity5	47

The tool used a score range of zero to hundred, hundred being the highest score. The evaluation tool tested various items: number of unique backlinks, number of quality backlinks, how closely institution websites are connected to trusted websites (trusted websites are .edu or .gov sites), Social Engine Friendliness, the quality of web site's content and shared content on social media among others.

From the results in Table IX, usability evaluation of website domain authority for Varsity1 was represented by 60%, Varsity2 by 39%, Varsity3 by 55%, Varsity4 by 38% and Varsity5 by 47%. There was a difference in website domain authority between Harvard University and Kenyan Universities. Varsity1 (60%) was the next nearest to Harvard University, represented by 94%. It can be observed three out of five sampled universities scored less than 50%. From the result, a higher score in the website domain authority leads to a higher webometrics ranking.

J. Evaluate Website Backlinks

Using automated tool semrush, the study was able to conduct website domain backlinks evaluation. Table 4.10 displays domain backlinks data for the five sampled universities with reference to Harvard University.

Table 10. Domain backlinks usability score

University	Backlinks	Backlink Score %
Harvard	674,325,131	100
Varsity1	2,691,531	0.3991
Varsity2	3,327,226	0.4934
Varsity3	634,890	0.0942
Varsity4	588,530	0.0873
Varsity5	69,086	0.0102

Harvard University domain backlinks was a point of reference in deriving the score of this attribute. Backlink score was derived from (actual backlink/674,325,131)*100. The evaluation tool checked the number of unique backlinks, number of quality backlinks and number of backlinks from trusted websites.

From the results in Table X, usability evaluation of website domain backlinks for Varsity1 was represented by 0.40%, Varsity2 by 0.49%, Varsity3 by 0.09%, Varsity4 by 0.09% and Varsity5 by 0.01%. The low score indicates that usability evaluation of website domain backlinks for the

Kenyan Universities is below the reference value of 674,325,131. There was a difference in website domain backlinks between Harvard University and Kenyan Universities. It can be observed all sampled universities scored less than 50%. From the result, a higher score in the website domain backlinks leads to a higher webometrics ranking.

K. Evaluate Website Traffic

Using automated tool semrush, the study was able to estimate website traffic for the month of July 2021. Table XI displays website traffic data for the five sampled universities with reference to Harvard University.

Table 11. Website traffic usability score

University	Traffic in July	Traffic score%
Harvard	67,100,000	100
Varsity1	998,000	1.4873
Varsity2	97,100	0.1447
Varsity3	835,000	1.2444
Varsity4	139,000	0.2072
Varsity5	362,000	0.5395

Harvard University website traffic was a point of reference in deriving the score of this website attribute. Traffic score was derived by (actual traffic/67,100,000)*100. The evaluation tool estimated the overall monthly traffic, total number of actual visitors, total page views, average visit duration and bounce rate.

From the results in Table XI, Usability evaluation of website traffic for Varsity1 was represented by 1.49%, Varsity2 by 0.14%, Varsity3 by 1.24%, Varsity4 by 0.21% and Varsity5 by 0.54%. The low score indicates that usability evaluation of website traffic for the Kenyan Universities are below the reference value of 67,100,000. There was a difference in website traffic between Harvard University and Kenyan Universities. It can be observed all sampled universities scored less than 50%. From the results, a higher score in the website traffic leads to a higher webometrics ranking.

L. Evaluate Website Indexed Webpages

Using automated tool semrush, the study was able to estimate website indexed webpages. Table XII displays website indexed webpages estimations for the five sampled universities with reference to Harvard University.

Table 12. Website indexed webpages usability score

University	Indexed webpages	Indexed webpages Score%
Harvard	89,739,518	100
Varsity1	64,866,268	72.2828
Varsity2	2,172,500	2.4209
Varsity3	4,679,779	5.2148
Varsity4	4,367,565	4.8669
Varsity5	602,455	0.6713

Harvard University website indexed webpage was a point of reference in deriving the score of this website attribute. Indexed pages score was derived from (actual webpage value/89,739,518)*100. The evaluation tool estimated the number of web pages that a search engine has visited, analyzed and added to its database.

From the results in Table XII, usability evaluation of website indexed webpages for Varsity1 was represented by 72.28%, Varsity2 by 2.42%, Varsity3 by 5.21%, Varsity4 by 4.87% and Varsity5 by 0.67%. There was a difference in website indexed webpages between Harvard University and Kenyan Universities. Varsity1 (72.28%) was the nearest to Harvard University, represented by 100%. It can be observed that four (4) sampled universities scored less than 50%. From the result, a higher score in the website indexed web pages leads to a higher webometrics ranking.

M. Evaluate Website Broken Links
Using automated tool semrush, the study was able to estimate website broken links. Table XIII display broken links data for the five sampled universities with reference to Harvard University.

Table 13. Website broken links usability score

University	Indexed webpages	Broken links	Broken links Score%
Harvard	89,739,518	524	99.9994
Varsity1	64,866,268	8,372	99.9871
Varsity2	2,172,500	5,991	99.7242
Varsity3	4,679,779	9,972	99.7869
Varsity4	4,367,565	7,587	99.8263
Varsity5	602,455	9,681	98.3931

Since broken links affect SEO and user experience, they should not exist; thus, a broken link score was derived from ((Institution's All indexed pages - Broken pages)/ Institution's All indexed pages)*100. The evaluation tool estimated the number of broken links in websites by considering 503 Service Unavailable Error, 404 Page Not Found errors and 500 Internal Server Error.

The percentage of broken links in relation to indexed webpages for Varsity1 was established to be 99.987%, Varsity2 was 99.724%, Varsity3 was 99.787%, Varsity4 was 99.826, and Varsity5 was 98.393%. Varsity1 (99.987 %) and

Harvard University, represented by 99.999%, are all clustered around the same value. It can be observed all sampled universities scored over 50%. From the result, a higher percentage of broken links in relation to indexed webpages leads to a higher webometrics ranking.

N. Evaluate Website Subdomains
Using an automated tool subdomain finder, the study was able to estimate website subdomains. Table XIV display the number of subdomains for the five sampled universities with reference to Harvard University.

Table 14. Subdomains usability score

University	Subdomains	Subdomains Score%
Harvard	31385	100
Varsity1	512	1.6314
Varsity2	101	0.3218
Varsity3	125	0.3983
Varsity4	104	0.3314
Varsity5	69	0.2199

The number of subdomains for Harvard University was a point of reference in deriving the score for this attribute. Subdomain score was derived from (actual subdomain value/31385)*100. The evaluation tool estimated the number of subdomains by looking up DNS (A) records for a domain.

From the results in Table XIV, usability evaluation of the number of subdomains for Varsity1 was represented by 1.63%, Varsity2 by 0.32%, Varsity3 by 0.40%, Varsity4 by 0.33% and Varsity5 by 0.22%. The low score indicates that usability evaluation of website subdomains for the Kenyan Universities are below the reference value of 31385. There was a difference in the number of subdomains between Harvard University and Kenyan Universities. It can be observed all sampled universities scored less than 50%. From the result, a higher score in the number of subdomains leads to a higher webometrics ranking.

M. Evaluate Website Speed
Using automated tool seositecheckup, the study was able to estimate website speed. Table XV display website speed estimations for the five sampled universities.

Table 15. Website speed usability score

University	Load time seconds	Load time Score%
Harvard	2.06	58.8
Varsity1	8.12	-62.4
Varsity2	7.37	-47
Varsity3	12.58	-151.6
Varsity4	42.06	-741.2
Varsity5	1.34	73.2

This tool recommends an average maximum loading speed of 5 seconds. Website speed was derived from ((5 - actual speed)/5)*100. The evaluation tool estimated page speed by considering the following criteria: Minimized HTTP requests, enabled Gzip compression, HTTP caching, minified CSS file, minified JS files, including external CSS files before external JS files, optimized images, reduced redirects and reduced number of plugins among others.

From the results in Table XV, usability evaluation of website speed for Varsity1 was represented by -62.40%, Varsity2 by -47%, Varsity3 by -151.60%, Varsity4 by -741.20% and Varsity5 by 73.2%. The negative score indicates that usability evaluation of website speed for the Kenyan Universities is below the average maximum loading speed of 5 seconds. Varsity5 (73.2%) scored highly than Harvard University, represented by 58.80%. It can be observed all sampled universities scored less than 50%. From the result, a higher score in the website speed leads to a higher webometrics ranking.

O. Evaluate Website Compression

Using the automated tool gzip-checker, researchers were able to perform compression evaluation tests for the institution's websites. Table XVI display website compression estimations for the five sampled universities with reference to Harvard University.

Table 16. Website compression usability score

University	Original Size (KB)	Compressed Size (KB)	Compression Score%
Harvard	203	44	78
Varsity1	125	125	0
Varsity2	297	297	0
Varsity3	264	264	0
Varsity4	114	114	0
Varsity5	58	15	75

The tool used a score range of zero to hundred, hundred being the highest score. The evaluation tool checked whether Gzip compression was enabled on the website's server by comparing the original requested webpage size against compressed webpage size.

From the results in Table XVI, usability evaluation of website compression for Varsity1 was represented by 0%, Varsity2 by 0%, Varsity3 by 0%, Varsity4 by 0% and Varsity5 by 75%. Four Kenyan universities had not enabled Gzip compression on their servers. Varsity5 (75%) and Harvard University, represented by 78%, are all clustered around the same value. It can be observed 4 out of 5 sampled universities scored less than 50%. From the result, a higher score in the website compression leads to a higher webometrics ranking.

P. Evaluate Website Search Engine Optimization, Website Content Utility Performance, Website Design and Website Accessibility

Using an automated tool site-analyzer, researchers were able to estimate website search engine optimization performance, content performance, design performance and accessibility performance. Table XVII display the various website performance estimations for the five sampled universities with reference to Harvard University.

Table 17. Usability of search engine optimization performance, content utility performance, design performance and accessibility performance

University	SEO Score %	Content Utility Score%	Design Score%	Accessibility Score%
Harvard	69.9	62.5	81.9	100
Varsity1	44.9	56.1	63.8	66.4
Varsity2	44.6	67.8	55.7	66.4
Varsity3	44.8	50.7	43	66.4
Varsity4	51.6	50.4	62.0	58.0
Varsity5	45.5	52.8	63.8	60.6

The tool used a score range of zero to hundred, hundred being the highest score. The evaluation tool estimated search engine optimization score by considering various criteria: Page title, Meta description, Meta robots, Robots.txt, SiteMap, WWW redirection 301, Link canonical, Alternative text, internal links, Nofollow link and External links, among others. The evaluation tool estimated content performance score by considering various criteria: text/code ratio, H1 to h6 titles, Microdata, Keywords density and frequency of uploads, among others. The evaluation tool estimated design performance score by considering various criteria: Doctype specifying rules of syntax, Charset used in order to minimize display problems in your texts, No flash content, technologies installed on your web server, ipv6 compatibility, DNSSEC enabled, X-XSS-Protection, Https, No frame or iframe and Page does not use design with tables among others.

From the results in Table XVII, Usability evaluation of website search engine optimization for Varsity1 was represented by 44.90%, Varsity2 by 44.60%, Varsity3 by 44.80%, Varsity4 by 51.60% and Varsity5 by 45.50%. Varsity4 (51.60%) was the nearest to Harvard University, represented by 69.90%. It can be observed 4 out of 5 sampled universities scored less than 50%. From the result, a higher score in the website search engine optimization leads to a higher webometrics ranking.

From the results in Table XVII, usability evaluation of website content utility performance for Varsity1 was represented by 56.10%, Varsity2 by 67.80%, Varsity3 by 50.70%, Varsity4 by 50.40% and Varsity5 by 52.80%. Varsity2 (67.80%) scored highly than Harvard University,

represented by 62.50%. It can be observed all sampled universities scored over 50%. From the result, a higher score in the website content utility performance leads to a higher webometrics ranking.

From the results in Table XVII, usability evaluation of website design for Varsity1 was represented by 63.80%, Varsity2 by 55.70%, Varsity3 by 43%, Varsity4 by 62% and Varsity5 by 63.80%. Varsity1 (63.80%) and Varsity5 (63.80%) were the nearest to Harvard University, represented by 81.90%. It can be observed 1 out of 5 sampled universities scored less than 50%. From the result, a higher score in the website design leads to a higher webometrics ranking.

From the results in Table XVII, Usability evaluation of website accessibility for Varsity1 was represented by 66.40%, Varsity2 by 66.40%, Varsity3 by 66.40%, Varsity4 by 58% and Varsity5 by 60.60%. Varsity1 (66.40%), Varsity2 (66.40%) and Varsity3 (66.40%) were the nearest to Harvard University, represented by 100%. %. It can be observed all sampled universities scored over 50%. From the result, a higher score in website accessibility leads to a higher webometrics ranking.

V. CONCLUSION AND FUTURE RESEARCH

The study outlined usability evaluation of the website attributes for the five sampled universities with reference to the University that was ranked the best university globally in the July 2021 webometrics ranking edition. The Kenyan universities need to improve on some of the usability criteria used in the study. After analysis, it was noted that Kenyan universities need to improve on some of the usability criteria used in the study where a score of less than 50% was attained, such as Website compression, website speeds, website subdomain, website indexed pages, website traffic, website backlinks, website colour contrast and website design. The study objective was achieved.

In this study, a score of 50% was used as the criteria for identifying poor performance for a given attribute. A future study should be carried out to determine whether the use of a 50% score in deciding a study attribute that was below expectation was appropriate or a higher score was desirable.

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