# Application of Webometrics Techniques for Measuring and Evaluating Visibility of University Library Websites in Sri Lanka

Kokila Harshan Ramanayaka<sup>1</sup>, Xianqiao Chen<sup>2</sup>, Bing Shi<sup>3</sup>

#### Abstract

A library website plays an enhanced role compared to its traditional physical library while providing a wide variety of library services to its users. Evaluation of library websites is a key to realize the extent of user acceptance of the website and to improve the overall quality of the website. Under such backdrop, this paper provides a framework for ranking university library websites in Sri Lanka based on two standard webometric methods. The proposed framework consists of quantitative web presence measuring attributes namely; size, visibility, rich files and scholars along with simple and comprehensible mathematical calculations. The library administrators can get awareness about whether their website has effectively represented itself on the internet with better performance from the ranking results. The findings of the study will guide to the librarians to evaluate the strengths and weaknesses accordingly with the performance of their library websites. In general, the effective presence of these library websites on the internet can be passed on as the top by having proper number of site pages in the website that impact their perceivability through web search tools and accordingly the quantity of received external links. Meanwhile, libraries having low rich files can publish more rich files on the web to improve their overall rank. The research approach, criteria and their relative impact provide useful information in monitoring the effectiveness of the current websites and provide strategic suggestions to develop enhanced websites.

*Keywords:* Performance-Evaluation, Web sites-Ranking, University libraries, Webometrics, WIF, WISER

<sup>&</sup>lt;sup>3</sup> The School of Computer Science & Technology, Wuhan University of Technology, Wuhan, P.R. China. Email: 7440472499@qq.om



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<sup>&</sup>lt;sup>2</sup> The School of Computer Science & Technology, Wuhan University of Technology, Wuhan, P.R. China. Email: chenxq@whut.edu.cn

# Introduction

The World Wide Web has become a major information provider for academic and research activities. The websites provide a public interface for societies around the world as the easiest and the effective way to operationalize exchange of information and a global gateway into the knowledge repositories of academic bodies. Effective websites bring imminent benefits including attracting visitors, giving services on time, research impact and media interest. Therefore, it is a necessity to monitor the effectiveness of websites to provide effective information delivery services to the community (Vaughan & Thelwall, 2005). In this background, website owners need to develop descriptive and lengthy content websites together with continuous monitoring and updating the content (Shadpour, Teimourpour, & Asadi, 2013).

Today, website is considered as the lifeline of libraries and websites are mainly used as a virtual image and promotional platform of the library that displays information and services given by a library. Battleson et al. expressed this as "Library websites are acting as an information and service gateways, opening to access diverse collection of resources and services, to outside world, and finally, the internet at large" (Battleson, Booth, & Weintrop, 2001). Nowadays, library website evaluation has attracted increasing concern amongst librarians as the library website serves as a key entry to library services. Presently, university libraries in Sri Lanka have used websites to spread intended information and services to its users virtually. As a contribution to addressing this need, this study was aimed to elicit the present webometric status of university library websites in Sri Lanka using two different approaches namely; Web Impact Factor (WIF) and Web Indicators for Science, Innovation and Research (WISER) and secondly, a framework for an automated webometric ranking and recommendation system based on the findings of web presence measuring attributes.

# **Research Objectives**

The major objective of the study is to analyse webometrics of university library websites with impact in the web environment based on standard webometric methods in Sri Lanka. The other inter-linked objectives are to:

- i. Identify and analyze links of university library websites in Sri Lanka
- ii. Rank library websites according to WIF and WISER webometric ranking approach
- iii. Calculate the correlation between WIF, WISER and their indicators for the case of studied websites
- iv. Design a framework for automated library website ranking and recommendation system

# **Literature Review**

Over the most recent couple of decades, a few webometric studies have been directed towards examining the webometric status of websites in different countries. For example, studies by Qiu et al. ranked the websites of Chinese universities based on WIF with external backlink count (Qiu, Chen, & Wang, 2004). Aguillo and others have applied cybermetric measuring tools to rank world universities while explaining the advantages of cybermetric measuring tools (Aguillo, Granadino, Ortega, & Prieto, 2006). Elgohary investigated the WIF of 99 Arab universities representing 20 Arab countries and finally the study examined that there had a strong correlation between external links and web presence (Elgohary, 2008). Aminpour et al. have conducted a webometric analysis study in Iranian universities of medical sciences based on WIF and investigated that websites which have higher number of web pages and external links became last positions while websites with a few web pages and external links were in top places in the ranking (Aminpour, Kabiri, Otroj, & Keshtkar, 2009). Jeyshankar and Babu have studied the webometric status of the Tamil Nadu university websites in India referencing WIF method and found that the websites which have a higher number of web pages but a few in-link count were in lower positions in the ranking (Jeyshankar & Ramesh Babu, 2009).

Jalal, Biswas and Mukhopadhyay have conducted a comparative study to rank the central universities in India according to the webometric indicators (Jalal, Biswas, & Mukhopadhyay, 2010). Shekofteh et al. have applied WIF method to rank the Iranian universities of medical sciences websites (Shekofteh, Shahbodaghi, Sajjadi, & Jambarsang, 2010); Zahedi, Shirazi and Dehghani have identified that they had a significant correlation between the number of external links and the impact factor while conducting a webometric analysis of ISI medical journals using Yahoo, AltaVista and all

the web search engines (Zahedi, Shirazi, & Dehghani, 2010); Islam and Alam have conducted a webometric analysis of private university websites in Bangladesh. The investigation uncovered that though a few universities had high quantities of website pages, their very low quantities of links brought down their positioning in the ranking (Islam & Alam, 2011); Vijayakumar, Kannappanavar and Santosh Kumar have analysed the behaviours of web presence and web link patterns among South Asian countries (Vijayakumar, Kannappanavar, & Santosh Kumar, 2012); Madhusudhan and Prakash have investigated whether there is a close relationships between the WISER, WIF (inlinks) and World Ranking methods while conducting a comparative study of ranking of Indian Institutes of Technology websites (Madhusudhan & Prakash, 2013). Shadpour, Teimourpour and Asadi have applied standard webometric methods to rank the Iranian hospital web sites (Shadpour et al., 2013). Elhouri, Elkabani, and Hamandi have conducted an analytical webometric study to evaluate 24 Lebanon university websites based on WIF and WISER webometric ranking methods (Elhouri, Elkabani, & Hamandi, 2014). The ranking of world astronomy and astrophysics library websites using WISER conducted by Lihitkar has expressed that a website with high number of rich files and high number of results from Google Scholar becomes first in ranking (Lihitkar, 2015). Gupta and Walia have examined the web presence of ten African national libraries' websites. The study highlighted the fact that the ranking based on WIF was not much reliable and it was biased towards the small number of web pages and in-links (Gupta & Walia, 2016).

# Methodology

# Library Website Identification

Fifteen university library websites were selected for this study (University Grants Commission-SriLanka, 2016) and the URLs of these websites were obtained from the parent university websites. Furthermore, the study examined whether the URLs were in separate domains and subject directory indexed. Herein, only nine library websites satisfied the above conditions and they are presented in Table 1.

Library	Home URL
Sabaragamuwa University of Sri Lanka	http://www.lib.sab.ac.lk
The Open University of Sri Lanka	http://lib.ou.ac.lk
University of Colombo	http://www.lib.cmb.ac.lk
University of Jaffna	http://www.lib.jfn.ac.lk
University of Moratuwa	http://www.lib.mrt.ac.lk
University of Peradeniya	http://www.lib.pdn.ac.lk
University of Ruhuna	http://www.lib.ruh.ac.lk
University of Sri Jayewardenepura	http://lib.sjp.ac.lk
University of Visual & Performing Arts	http://lib.vpa.ac.lk

# Table 1. URLs of university library websites

#### Calculating the Web Impact Factor (inlinks)

The WIF represents the quality of data furnished by the site together with the size of a site and is commonly characterized as the proportion between the quantity of links received and the total of site pages of a specific site (Khan & Idrees, 2015). There are three kinds of links in particular: outlinks or external links which are HTML code on the site which permits visitors to get to other sites, inlinks or backlinks which are hyperlinks on another site that direct visitors to the intended website, and self-links which are navigational links utilized as a part of a site to guide visitors to navigate from one page to another page inside the website. However, Noruzi has articulated that selflinks for the site under assessment can give vague outcomes, as the quantity of self-links can be controlled by various means by site proprietors. For instance, in some cases, self-link counts increment based on email addresses related with sites which is distinguished by the web crawler as links to that particular domain. Along these lines, self-links are less significant than inlinks since self-links can be utilized for navigational purposes rather than for endorsing the contents (Noruzi, 2006). Moreover, inlinks make greater visibility on the web and conceivably more traffic to the website and better coverage via web search tools together with higher positioning in list items (Vaughan & Thelwall, 2005).

The WIF (inlinks) is the result of excluding self-links for a website, thus establishing an analogous impact factor (Khan & Idrees, 2015). Therefore, in

this study, we calculated the WIF (inlinks) for websites in university libraries in Sri Lanka as shown in *Equation 1* below:

Web Impact Factor (inlinks) = 
$$\frac{X}{Y}$$
 (1)

where, the variable X represents the inlinks (external backlinks) to the website and Y represents the number of web pages on the website.

*Calculating Web Indicators for Science, Innovation and Research (WISER)* WISER has taken the quantity of site pages in a site (size), number of external links it gets (visibility), the total number of scholastic records (rich files) and the total number of highly cited research papers (scholars) distributed on the site (Elhouri et al., 2014; Madhusudhan & Prakash, 2013) to calculate the webometric index. The calculation process is as follows:

Size (S) - The number of web page count can be obtained from the search engines and other third party software tools and then the results should be log-normalized to 1 for the highest value. For example, let W<sub>A,i</sub>, W<sub>B,i</sub> and W<sub>C,i</sub> be the number of web pages of a specific website (*i*) given from A, B and C tools and let W<sub>A,MAX</sub>, W<sub>B,MAX</sub>, and W<sub>C,MAX</sub> be the maximum number of web pages found from A,B and C tools among all websites.

$$W_{A,MAX}$$
 = maximum( $W_{A,i}$ ),  $i = 1$  to 9

A log normalized values,  $NW_{A,i}$ ,  $NW_{B,i}$  and  $NW_{C,i}$  of the number of web pages of website *i* collected from A, B and C tools can be calculated from *Equation 2*.

$$NW_{A,i} = \frac{\log(W_{A,i}+1)}{\log(W_{A,MAX}+1)}; \ NW_{B,i} = \frac{\log(W_{B,i}+1)}{\log(W_{B,MAX}+1)}; \ NW_{C,i} = \frac{lo}{log}$$
(2)

Then the log values except the maximum and minimum values in each website  $(NW_i, i=1 \text{ to } 9))$  are sorted and ranks are assigned accordingly.

• Visibility (V) - The number of external links count can be obtained from the search engines and other third party software tools and then the

ranking can be done as the same way as explained above using in *Equation 2*.

- **Rich Files (R)** The total number of academic files including Adobe Acrobat (.pdf), Adobe PostScript (.ps), Microsoft Word (.doc/.docx) and Microsoft PowerPoint (.ppt/.pptx) can be extracted using google search engine and then the ranking can be done in the same way as explained above using in *Equation 2*.
- Scholar (Sc) The total number of highly cited research papers published on the website can be extracted from the google scholar database and then the ranking can be done in the same way as explained above using in *Equation 2*.

Finally, the WISER ranking can be calculated by combining the above four ranks where each one has a different weight according to the *Equation 3* (Aguillo et al., 2006).

 $WISER \ ranking = log \ (Visibility \ 50\%) + log \ (Size \ 20\%) + log \ (Rich \ files \ 15\%) + log \ (Scholars \ 15\%)$ (3)

Correlation between Rankings of WIF and WISER and Webometric Indicators

The relationships between WIF, WISER and webometric indicators can be presented through the correlation coefficient which is concerned about the strength and direction of the linear relationship between two factors. Correlation always varies between -1.0 and +1.0 and if it is positive, then the two variables have a positive relationship. Otherwise, there is no relationship between them (Elhouri et al., 2014; Madhusudhan & Prakash, 2013). In the present study, the authors decided to use the Spearman's Rank Correlation as shown in *Equation 4* to find the relationship between WIF, WISER, and webometric indicators of university library websites in Sri Lanka.

$$Correlation Coefficient(r) = \frac{N \sum XY - (\sum X) * (\sum Y)}{sqrt ([N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)]}$$
(4)

In above equation, x and y represent the two variables that are needed to check the relationship.

#### Data Collection Strategy

The study has utilized Yahoo, Google, and Google Scholar search engines and SEO CHAT application tool to gather quantitative information. The two search engines and SEO CHAT application instrument can be utilized to gather the quantity of site pages and the external links; while Google can be utilized to locate the quantity of rich documents and Google Scholar can be utilized to locate the quantity of scholars. The reason to propose the utilization of two search engines and a software instrument is to cross-check the outcomes of the indexing techniques applied by search engines and other instruments. The particular search keywords allocated by the search engines to recover the required data alongside search syntax have been introduced in the Table 2.

Search	inlinks (external	Number of web	Number of rich	
engine	backlinks) to the website	pages	files	
Google	link:www.lib.ruh.ac.lk - site:ruh.ac.lk	site: www.lib.ruh.ac.lk	site: www.lib.ruh.ac.lk filetype:pdf	
Yahoo	(link: www.lib.ruh.ac.lk/ AND NOT (link: www.lib.ruh.ac.lk/ AND url: www.lib.ruh.ac.lk/)) OR (link: www.lib.ruh.ac.lk/ AND NOT (url: www.lib.ruh.ac.lk/ AND link: www.lib.ruh.ac.lk/))	site: lib.ruh.ac.lk		
Majestic SEO*	"External Backlink" parameter from the "FreshIndex"	value of indexed URL parameter		

#### Table 2. Search syntax

Note: \*The planet's largest link index database, 2017

The original data for each criterion, i.e. size, visibility, rich files and scholars were accumulated based on search syntax shown in Table 2 and data were

collected on three different occasions in the year 2017. As information was gathered under various time frames, the average value of each criterion was taken for counts.

# **Data Analysis and Results**

*Presence of University Libraries on the Web: Real Visibility and Impact* The number of page count, inlink/external backlink count, rich files, scholar count, WISER and WIF (inlinks) index values in each library website are shown in Table 3 and the final ranking results for the Sri Lankan university library websites using WIF (inlinks) and WISER are shown in Table 4.

Table 3. Number of page count, external backlink count, rich files, scholar count, WISER and WIF (inlinks) index values in each library website

Library name	Page count	External backlink count	Rich files	Scholars	WISER index value	WIF(inlinks) index value
Sabaragamuwa University of Sri Lanka	262.333	22.000	2	0	286.333	0.084
The Open University of Sri Lanka	3330.000	40.000	3	165	3538.000	0.012
University of Colombo	922.000	125.667	2	9	1058.667	0.149
University of Jaffna	73.667	10.333	1	0	85.000	0.125
University of Moratuwa	336.000	149.000	1	10	496.000	0.442
University of Peradeniya	362.000	110.000	2	4	478.000	0.310
University of Ruhuna	1194.333	59.333	3	5	1261.667	0.051
University of Sri Jayewardenepura	314.500	111.667	1	1	428.167	0.330
University of Visual & Performing Arts	54.667	1.667	1	0	57.333	0.030

The results showed that the library website in the Open University of Sri Lanka ranked  $1^{st}$  in WISER index while it ranked  $6^{th}$  according to the visibility rank. University of Colombo library website came in  $2^{nd}$  place in WISER index while it ranked in the  $3^{rd}$  position in the scholar rank and

richness rank. On the other hand, the University of Visual & Performing Arts library website secured the 9<sup>th</sup> place in WISER index while it ranked in the 4<sup>th</sup> position in the scholar rank. According to the WIF index, library website of University of Moratuwa ranked 1<sup>st</sup> while it ranked 4<sup>th</sup> in WISER index. University of Sri Jayewardenepura library website came 2<sup>nd</sup> in WIF index while ranked 7<sup>th</sup> according to WISER index.

				Rich		
	Size	Visibility	Scholar	File	WISER	WIF
Library	Rank	Rank	Rank	Rank	Rank	Rank
Sabaragamuwa						
University of Sri						
Lanka	7	7	4	3	6	6
The Open						
University of Sri						
Lanka	1	6	1	1	1	9
University of						
Colombo	3	2	3	3	2	4
University of						
Jaffna	8	8	4	6	8	5
University of						
Moratuwa	5	1	2	6	4	1
University of						
Peradeniya	4	4	8	3	5	3
University of						
Ruhuna	2	5	7	1	3	7
University of Sri						
Jayewardenepura	6	3	9	6	7	2
University of						
Visual &						
Performing Arts	9	9	4	6	9	8

 Table 4. Ranking of Sri Lankan university library websites according to

 WIF (inlinks) and WISER

# Correlations of Webometric Variables

The correlation between WISER ranking and WIF (inlinks) is having negative value i.e. -0.01744, which means that the relation between two ranking systems was inversely related. This says that there was not much association or closeness between WISER ranking index and WIF (inlinks).

The value of correlation coefficient between WIF (inlinks) and external backlink is +0.814, which has a positive value shows positive relationship

between external backlink and WIF (in-links) which implied that there is much association or closeness between external backlink and WIF (inlinks). In other words, there is very less difference and closeness between external backlinks and WIF (in-links). The correlation between WIF (in-links) and page count is -0.41905. This says that there is not much association or closeness between page count and WIF (in-links).

Table 5 presents the inter-correlations of webometric indicators of the Sri Lankan university library websites, (comma is not needed here) including wiser index value, size, visibility, richness and scholars.

WISER value, Size, Visibility, Richness and Scholars						
	WISER					
Variables	index value	Size	Visibility	Richness	Scholars	
WISER						
Value	1					
Size	0.821014457	1				
Visibility	0.410115796	-0.06069	1			

0.763295

0.943116

-0.09107

-0.14758

1

0.562165 1

Richness

Scholars

0.768215554

0.687608439

Table 5. Correlation between Sri Lankan university library websites'WISER value, Size, Visibility, Richness and Scholars

As seen, the calculated correlation between WISER index value and size, WISER index value and visibility, WISER index value and richness, WISER index value and scholars, WISER index value and size, size and richness, size and scholars, richness and scholars were positive, which means that the relation between WISER index value, size, visibility, richness and scholars are much associated and close. Furthermore, there is more significant correlation between WISER index value and size than between WISER index value and richness and scholars.

# Proposed Framework for an Automated Ranking and Recommendation System

This section introduces the proposed automated webometric ranking framework to rank automatically given websites and then generate recommendations that will help to improve the present status. Herein, the recommendations will be generated by comparing the present status of each indicators of specified website with other websites' indicator values. The proposed system consists of five major components including user interface, fetch values from search engines, ranking, recommendations and database as shown in Figure 1. The user interface component is responsible to add, update and delete website information, input the values of external backlink and page count collected manually from SEO CHAT tool, send request to the fetch values from search engine, ranking and recommendation components and display results in good manner. On the other hand, the fetch values from search engine modules collects the values of size, visibility, rich files and scholar indicators from Google, Yahoo and Google scholar search engines relevant to the requested domain and then store them in the database. The ranking module does the final calculations and presents the ranking results accordingly with each indicator as well as WISER.



# Figure 1. Proposed framework for an automated ranking and recommendation system

The technologies that are planned to be applied for this web-based application are PHP, MySQL, HTML, and CSS. Besides, the application will

provide a fully graphical web interface, which fully considers the efficiency of the application. The overall business logic will be implemented using PHP while MySQL will be used to provide the database functionality in the application to store intermediate data. The PHP web pages and a MySQL database engine are hosted by the Apache server in a Linux operating environment. The database management, maintenance, data retrieval and other various operations will be completed through the MySQL function library. Moreover, PHP technology and MySQL database are a completely free and open source development tool favoured by a lot of programmers in web development because of its' simple, efficient and dynamic scripting capabilities with the advantages of cross-platform and powerful database support. HTML and CSS will be used to design the front end of the application as these are the market proven technologies for building attractive and reliable web application all over the world. The development process will be made by using a convenient GUI text editor.

# Discussion

The main objective of this study was to rank the state university library websites while proposing the webometric ranking framework. The extent to which each website represents itself on the World Wide Web can be identified from the ranking results. The present webometric status of the website can be increased by expanding the number of web pages including rich files that influence visibility through search engines as the result increases the number of received external links. There is a clear correlation with size and WISER index value in university library websites in Sri Lanka. Hence, librarians can publish more information on their websites to enlarge the website size as a result increasing the richness to bring their websites to a higher level. On the other hand, the external backlink counts and WIF (inlinks) are significantly correlated in university library websites. Therefore, the main factor that can raise WIF (inlinks) of these websites is the establishment of new websites and web logs under the main website and linking them to their affiliate universities, university libraries, international websites, internet guides and search engines with appropriate information resources (Aminpour et al., 2009).

As to the realistic contribution, the study proposed the systematic route to evaluate the current status of library websites. This evaluation process will be able to help librarians to improve the visibility and usability of library websites. Moreover, the present study is evidence based. Therefore, the methodology applied in this study might be helpful for libraries to compare with other library websites and identify the visibility and usability problem areas of their respective websites. Further, the proposed framework makes it suitable for libraries having limited budgets to ensure that they develop a more effective library website with maximum information.

There are 15 state universities in Sri Lanka. The university libraries chosen for this study were only nine as the other six university library website URLs were published under their parent university web domains and not as a separate domain. Therefore, the current study has revealed an issue in finding the page counts, external backlink counts, rich files and scholar articles of these six library websites from the search engines. Although the results generated from web search engines 100% accurate, they are still an applicable tool. Most obviously, several researchers noted that, current search engine technology cannot be relied upon to provide comprehensive and reliable data (Ingwersen, 1998). Therefore, the main limitation of the study was the variability of results of the same search engine over different times. However, the data was collected on three rounds to minimize this dilemma.

Finally, the proposed framework is planned to implement a real computerized automated system to measure and evaluate the visibility of websites in the near future to make it more widely applicable.

# Conclusion

The present study attempts to evaluate the webometric status of university library websites in Sri Lanka according to webometric methods namely, WIF (inlinks) and WISER while proposing the framework for automated library website ranking and recommendation system. The ranking results can be used to examine the strength and weakness points of related websites. The study has concluded that the 6,850 average web pages, 630 average external backlinks, 16 rich files and 194 scholarly articles were found from these nine university library websites. The library website of the Open University of Sri Lanka ranked 1<sup>st</sup> under the WISER index while the library website of University of Moratuwa ranked 1<sup>st</sup> under the WIF (inlinks) index. The

calculated correlation between the two methods, WIF and WISER was negative and thus they were inverse to each other. Our study found significant linear relationship between the WISER index value and size than the WISER index value and richness and scholars. Also there is a positive relationship between the external backlink and WIF (inlinks) indicating that there is a close association between them.

The outcomes of this study would contribute significantly to the benefit of the technological society in the area of web design and its performance evaluation. In addition, it would also contribute towards indicating the extent to which each library has successfully represented itself on the internet and provides the basis for future research in web evaluation, usability and other related areas.

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