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HYPERLINK ANALYSIS AND WEB IMPACT FACTOR OF WEBSITES OF OBSERVATORY LIBRARIES

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Abstract

This study explores the webometric approach to library websites belongs to the observatory at national and international level. The paper aims to investigate the observatory libraries' websites and their hyperlink analysis, web impact and ranking. The research methods of survey, investigative and descriptive are followed in the present study. The webometric research analysis has been conducted on 41 observatory libraries' websites in the study. The analysis of the results reveals that overall the External Links are higher followed by In Links for the observatory libraries' websites. The Webometric analysis may have a positive impact on the library website and its content. Webometric analysis helps to improve the performance of the website.

Keywords: Webometrics; Link Analysis; Web Impact Factor; Observatory Libraries' Websites

1. INTRODUCTION

Initially, the Internet was used by librarians apart from computer experts, engineers and scientists. The libraries adopted this technology for automating and networking their catalogues. In the later years, World Wide Web (WWW) has been emerged as a powerful medium for communications, networking of computers and much more. The volumes of information available earlier in print media have been made available electronically over the internet either free or for a fee depends on the content developer / publisher. Therefore, it has become a leading information retrieval service over the internet. Websites are used for academic, commercial and many other purposes. All these have led to the exponential growth of the Web with diversity of information. The Web evolved and necessitated the need for analysis of websites, its content / information provided therein. The research and analysis were carried out in various forms such as Evaluation of Websites, Analysis of Websites, Usability of Websites, etc.

The study of the quantitative aspects of web / website and web related phenomena is known as Webometrics. Almind and Ingwersen (1997) introduced the term 'Webometrics'. It tries to measure the World Wide Web to get knowledge about the number and types of hyperlinks, the structure of the World Wide Web and usage patterns. According to Vijayakumar (2012), webometrics is to recognize patterns of interlinking among web creators, which is very alike to bibliometrics. The main tasks of hyperlink analysis are to extract, discover, and link together from vast amounts of data sources, to represent and evaluate the significance of the

related evidence, and to learn patterns to guide the extraction, discovery, and linkage of entities. Hyperlink analysis helps to find out the nature of web impact of academic websites. Ingwersen (1998) introduced Web Impact Factor (WIF) by calculating impact factors for websites. The calculation of impact factors is based on average link frequencies. It has been considered one of the quantitative indicators. The WIF was developed by adopting Journal Impact Factor (JIF) by applying citation techniques to hyperlinks on the Web. There are various types of WIFs, such as Simple WIF, Self-Link WIF, External-Link WIF and Revised Link WIF. Ranking of websites is calculated on the basis of these WIFs.

2. REVIEW OF LITERATURE

Lee and Teh (2001) evaluated the content and design of academic library websites in Malaysia. They have used quantitative and qualitative analyses of academic library websites evaluation. The study has been conducted on twelve library web sites of public and private institutions of higher learning for evaluation. Their findings revealed that the academic libraries in Malaysia generally have set up well-designed and useful websites. However, a few academic library websites have very simple and basic features.

Desikan and others (2002) provided a brief introduction about Hyperlink Analysis and its scope. It is the name given to a collection of techniques that have emerged to analyze the hyperlink structure that exists in the Web. They identified the key dimensions for methodology in Hyperlink Analysis. The analysis can be for a wide variety of purposes, ranging from ranking pages returned from a web search engine to understanding the social dynamics behind the usage of the Web as a whole.

Noruzi (2005) investigated the Web Impact Factors (WIFs) for Iranian universities and introduces a new system of measurement. Links to the web sites of Iranian universities were retrieved from the search engine 'AltaVista'. The WIFs for Iranian universities were calculated by dividing link page counts by the number of pages found in AltaVista for each university at a given point in time. The, these WIFs were compared, to study the impact, visibility, and influence of Iranian university web sites.

Onyancha and Ocholla (2007) used Link Analysis to compare Kenyan and South African universities according to several Web-based indicators. It includes the number of webpages, and the number of in and out-links. They have examined the external out-links in order to determine the institutions targeted by South African and Kenyan universities. The study investigated the networks or links between universities. Web Impact Factors (WIFs) were calculated to compare the universities' web influence. The study revealed that South African universities have made remarkable progress in their web presence. The study concluded that African universities, though not comparable to counterparts in developed countries, can have their websites evaluated webometrically.

Ramesh Babu, Jeyshankar and Nageswara Rao (2010) examined 40 central universities websites in India. Investigated domain systems of the websites, analyses the number of web pages and link pages and calculates the simple web impact factor, self link web impact factor, external link web impact factor and revised web impact factor for Central universities in India and ranks the websites as per the WIF. They also developed a novel network diagram showing link structures between web nodes in webometric analysis. This study warns against taking the analogy between citation analysis and link analysis too far.

Jalal, Biswas and Mukhopadhyay (2010) investigated the effectiveness and relevance of Web Impact Factors (WIFs) for Indian universities' websites. They reviewed WIF as to how this link-based metrics have been developed and applied. They have conducted a case study on universities in West Bengal. The study used SocSciBot 3.0 to generate link data in order to develop/form micro-link topology.

Maharana, Panda and Sahoo (2012) examined and explored the WIF through a webometric study of the present 16 Indian Institute of Technology (IIT) of India. Identifies the domain systems of the websites; analyzes the number of web pages and link pages, and calculates the simple WIF, self link WIF and external WIF of all the IIT. Also the study reflected that some IIT have higher number of web pages, but correspondingly their link pages are very small in number and websites fall behind in their simple, self link and external link web impact factor.

Walia and Gupta (2012) examined the linking on websites of national libraries and found out their web impact factor and amount of information present on these websites in the form of rich files. The research revealed that among the selected national libraries, websites of national libraries' of America, Australia and Britain were more visible and hosted the more content compare to the websites of India, Namibia, and South Africa. A short survey was conducted to find the number of functional national libraries websites in the world. Among the 163 countries, which have national libraries, only 106 countries have the websites and the result shown that 57 remaining national libraries do not have websites.

Madhuri, Surendra Babu and Ramesh (2013) conducted a study to examine and explore Webometric analysis of the websites of 33 state universities in Andhra Pradesh. The analysis includes identifying the domain systems of the websites; collection of statistics about Web Pages, Web Impact Factor (WIF) report etc. The Webometric data have been collected through Google search engine. They have used software 'Webometric Analyst' and Pajek tools to draw network diagram.

3. OBJECTIVES OF THE STUDY

The objective of the study is to investigate the Observatory Libraries' Websites and their hyperlink analysis, web impact and ranking. The main objectives are:

- To identify websites of Observatory Libraries at National and International level;
- To investigate and analyze the number of web pages, the number of link pages, number of self link pages and external link pages of Observatory Libraries' Websites;
- To measure the Web Impact Factor (WIF) of Observatory Libraries' Websites and Ranking;
- To present the Link Network Analysis of Observatory Libraries' Websites.

4. SCOPE AND LIMITATIONS

The study has been carried out on the websites of observatory in the world. An observatory is a location used for observing terrestrial or celestial events. Astronomical observatories are used for observations of astronomical objects such as sunspots, planets, asteroids, comets, stars, nebulae, and galaxies.

For proper comparative analysis, the webometric study was conducted to the specific category of Libraries' websites at national and international level. The study has been

confined to the website specific to Observatory Libraries. It was identified that there are 445 observatory facilities available in 59 countries. Out of which only 24 countries have an observatory library website. However, 16 libraries' websites have provided information on one page / few lines, provided only contact information / catalogue search only and they are excluded from the study. A total of 41 observatory libraries' websites in 19 countries are included in the study.

5. RESEARCH METHODOLOGY

The research methods followed for the study are survey, investigation and descriptive methods. The study followed the webometric approach such as Hyperlink Analysis which analyze the various links between the web pages and their relationship, Web Impact Factor which has been used as a quantitative tool for evaluating, comparing and ranking the websites and Link Network Analysis which has been used to find the connection between web nodes of the websites included in this study and present the link topology.

List of Astronomical Observatories have been identified by referring to Wikipedia. Each observatory website was navigated to find out the availability of library web page / website. Webometric tools such as web crawler software: SocSciBot4 full version (Thelwall, 2009); Search Engine Optimization (SEO) tools; and Pajek 2.03 Software (Batagelj and Mrvar, 2011) for large network analysis were used for this study. For each Library Website, the data extracted using SocSciBot web crawler software and Search Engine Optimization (SEO) tools. The data on Total Number of Web Pages and Out Links or External Links were extracted using SocSciBot software. The data on In-Links or Back Links, Self Links and Total Links were extracted by using SEO tools viz., *backlinkwatch.com*, *www.check-domains.com/seo/tools/link-analyzer/* and *www.webmaste-toolkit.com/link -extractor.shtml* respectively.

6. ANALYSIS OF THE STUDY

The webometric analyses have been done on the collected data. The details of the data collected are presented in the following sections in tabular form. The analysis and interpretations are divided into three parts, viz., i) Hyperlink Analysis; ii) Web Impact Factors and Ranking of Websites; iii) Link Network Analysis.

6.1 Hyperlink Analysis

The hyperlink analysis has been carried out on Observatory Libraries' Websites. For this study, the details such as Number of Web Page (NWP), External Links (EL), In Links (IL), Self Links (SL) and Total Links (TL) have been collected and presented in Table 1.

- NWP is the number of web pages in a particular website. A webpage is a "page" of the World Wide Web, usually in HTML format and with hypertext links to enable navigation from one page or section to another. The web page often uses associated graphics files to provide illustration, and also contain downloadable data files, audio & video files, and hyperlinks to other pages or sites on the Web. The web page created with HTML is a digital document and accessible with a browser.
- EL is the number of external links provided in a particular website. An external link is a link that points at an external domain. In other words, a link to a page outside the same domain is also considered external. External links are links that are all pointing out to other servers on

the Internet, servers that are not physically located on the same website. External links are also known as outgoing links.

- IL is the number of links that particular site received from another site. In-links, incoming links, inbound links, and inward links, are incoming links to a website or web page. It is also known as back-link. In basic link terminology, a back-link is any link received by a web node (web page, directory, website, or top level domain) from another web node. These links are important in determining the popularity (or importance) of a web site.
- SL is the number of links (internal links) within a particular website. A self link is a link to the page itself or to the same domain. Self-link is also known as Internal Link. Internal Links are hyperlinks that point at (target) the same domain as the domain that the link exists on (source). An internal link is one that points to another page on the same website. A self link is a link to the page itself or to the same domain.
- TL is the total number of links in a particular website. The sum of all links in a particular site including internal, external, followed are known as Total Links.
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Table 1: Hyperlink Analysis of the Websites of Observatory Libraries

S. N.	OBS Library and Country	NWP	EL	IL	SL	TL
1	Giant Metrewave Radio Telescope (GMRT) Library, India	3	188	113	3	197
2	Astronomical Library, Australian Astronomical Observatory (formerly the Anglo-Australian Observatory), Australia	97	1036	7261	83	91
3	Royal Observatory Library, Belgium	6	105	1433	13	16
4	National Observatory Library, Brazil	281	3	8045	6	8
5	National Astronomical Observatories Library, Chinese Academy of Sciences, China	114	1740	31	34	61
6	Purple Mountain Observatory Library, China	1	21	1603	20	24
7	Višnjan Observatory Library, Croatia	6481	242099	6426	45	54
8	Astronomical Observatory of Lyon Library, France	1865	45070	1619	66	73
9	Observatoire de la Côte d'Azur Library, France	16	1157	36	28	86
10	Observatoire de Marseille Library, France	209	6227	1953	33	38
11	Paris Observatory Library, France	152	1762	196	23	31
12	European Southern Observatory (ESO) Library, Germany	500	25	99399	103	121
13	Baja Astronomical Observatory Library, Hungary	190	3548	264	18	19
14	Arcetri Astrophysical Observatory Library, Italy	33	400	1014	11	14
15	Astronomical Observatory of Brera Library, Italy	1122	50081	773	26	35
16	Astronomical Observatory of Cagliari Library, Italy	246	6466	1009	41	49
17	Astronomical Observatory of Capodimonte, Italy	17	152	651	15	16
18	Astronomical Observatory of Collurania Library, Italy	74	329	107	39	44

19	Astronomical Observatory of Padova Library, Italy	54	56	1800	72	77
20	Astronomical Observatory of Trieste Library, Italy	175	22	983	39	63

Table 1 (Continued)

S. N.	OBS Library and Country	NWP	EL	IL	SL	TL
21	Catania Astrophysical Observatory Library, Italy	198	6345	3163	18	34
22	Turin Astronomical Observatory Library, Italy	191	41	714	33	74
23	National Astronomical Observatory Japan Library, Japan	1351	3676	255	20	25
24	Nobeyama Radio Observatory Library, Japan	34	33	287	33	35
25	National Astronomical Observatory Library, University of Mexico, Mexico	1	0	263	0	1
26	Lisbon Astronomical Observatory Library, University of Lisbon, Portugal	1803	22496	20329	128	97
27	Astronomy Library, Astronomical Observatory, Universitatea Babes - Bolyai, Cluj-Napoca, Romania	231	6193	3716	132	142
28	South African Astronomical Observatory Library, South Africa	2	447	17572	196	210
29	John Whelan Library, Isaac Newton Group of Telescopes, Spain	36	829	3638	65	73
30	Lund Observatory Library, Sweden	52	682	770	13	13
31	Armagh Observatory Library, UK	1	21	1088	13	23
32	Royal Observatory Edinburgh Library, UK	17	582	2210	50	58
33	Dudley Observatory Library, USA	90	1666	627	62	67
34	Gemini Observatory / Joint Astronomy Centre Library, USA	17	100	11017	24	82
35	Lowell Observatory Library, USA	2	1	6504	17	17
36	McDonald Observatory Library, University of Texas, USA	7	216	3098	17	40
37	National Optical Astronomy Observatory Library, USA	56	723	17195	12	20
38	National Radio Astronomy Observatory Library, USA	260	2155	31800	43	70
39	Observatories of the Carnegie Institution for Science Library, USA	6177	71205	1812	91	396
40	Smithsonian Astrophysical Observatory (SAO) /NASA Astrophysics Data System (ADS) Digital Library, USA	2685	6210	9845	19	40
41	US Naval Observatory Library, USA	1045	10884	13499	34	44

6.1.1 Number of Web Pages (NWP) Analysis

According to highest Number of Web Pages, the Višnjan Observatory Library, Croatia, with 6,481 web pages ranks 1st, Observatories of the Carnegie Institution for Science Library, USA, with 6177 web pages ranks 2nd and Smithsonian Astrophysical Observatory (SAO) / NASA Astrophysics Data System (ADS) Digital Library, USA with 2685 web pages ranks 3rd.

Three Libraries' Websites, viz., Purple Mountain Observatory Library, China, National Astronomical Observatory Library, University of Mexico and Armagh Observatory Library, UK have lowest Number of Web Pages with only 1 page each and ranked at 36th position. South African Astronomical Observatory Library and Lowell Observatory Library, USA has 2nd lowest Number of Web Pages with only 2 pages each and ranked at 35th position.

6.1.2 External Links (EL) Analysis

According to highest number of External Links, the Višnjan Observatory Library, Croatia, with 2,42,099 External Links ranks 1st, Observatories of the Carnegie Institution for Science Library, USA, with 71,205 External Links ranks 2nd and Astronomical Observatory of Brera Library, Italy with 50,081 External Links ranks 3rd.

Nobeyama Radio Observatory Library, Japan has '0' External Links and ranks lowest with the rank of 40th position. Gemini Observatory / Joint Astronomy Centre Library, USA has 2nd lowest number of External Links with just 1 link and ranked at 39th position. National Observatory Library, Brazil has 3rd lowest number of External Links with 3 links and ranked at 38th position.

6.1.3 In Links (IL) Analysis

According to highest number of In Links, European Southern Observatory (ESO) Library, Germany with 99,399 In Links, National Radio Astronomy Observatory Library, USA with 31,800 In Links ranks 2nd and Lisbon Astronomical Observatory Library, University of Lisbon, Portugal with 20,329 In Links ranks 3rd.

National Astronomical Observatories Library, Chinese Academy of Sciences has lowest In Links with 31 links and ranked at 41st position. Observatoire de la Côte d'Azur Library, France has 2nd lowest In Links with 36 links and ranked at 40th position. Astronomical Observatory of Collurania Library, Italy has 3rd lowest In Links with 107 links and ranked at 39th position.

6.1.4 Self Links (SL) Analysis

According to highest number of Self Links, South African Astronomical Observatory Library, South Africa with 196 Self Links ranks 1st, Astronomy Library, Astronomical Observatory, Universitatea Babes - Bolyai, Cluj-Napoca, Romania with 132 Self Links ranks 2nd and Lisbon Astronomical Observatory Library, University of Lisbon, Portugal with 128 Self Links ranks 3rd.

Nobeyama Radio Observatory Library, Japan has '0' Self Links and ranks lowest and positioned at 33rd rank. Giant Metrewave Radio Telescope (GMRT) Library, India has 2nd

lowest Self Links wit0h 3 links and ranked at 32nd. National Observatory Library, Brazil has 3rd lowest Self Links with 6 links and ranked at 31st.

6.1.5 Total Links (SL) Analysis

According to highest number of Total Links, Observatories of the Carnegie Institution for Science Library, USA, with 396 Total Links ranks 1st, South African Astronomical Observatory Library, South Africa with 210 Total Links ranks 2nd and Giant Metrewave Radio Telescope (GMRT) Library, India with 197 Total Links ranks 3rd.

Nobeyama Radio Observatory Library, Japan has lowest Total Links with just 1 link and ranked at 36th position. National Observatory Library, Brazil has 2nd lowest Total Links with 8 links and ranked at 35th position. Lund Observatory Library, Sweden has 3rd lowest Total Links with 13 links and ranked at 34th position.

From Table 1, the analysis shows that 41 Observatory Libraries' Websites have Number of Web Pages with a range from 1 page to 6,481 pages, External Links varies from 0 to 2,42,099, In Links from 31 to 99,399, Self Links from 0 to 132 and Total Links from 1 to 396. The data analyzed and computed reveals that an average of 19,742 web pages and various links exist with a total of 8,09,418 together for 41 Observatory Libraries' Websites. The results of the data analysis for percentage-wise distribution of web pages and various links illustrate that NWP has 3.20%, EL 61.15%, IL 35.10% SL 0.22% and TL 0.33%. Therefore, the analysis indicated that overall the External Links are higher followed by In Links for the Observatory Libraries' Websites.

After the computation of all the links for each website, it is found that Višnjan Observatory Library, Croatia has the highest number of links with 2,48,624 links, followed by European Southern Observatory (ESO) Library, Germany, which has 2nd highest number links with 99,648 links and Observatories of the Carnegie Institution for Science Library, USA has 3rd highest number links with 73,504 links.

Further, when compared to positions of Indian Observatory Library, viz., Giant Metrewave Radio Telescope (GMRT) Library, Narayangaon, has been positioned in 39th place in the total of all links.

6.2 Web Impact Factors (WIFs) and Ranking of Websites

Web Impact Factors are regarded as one of the Webometric indicators. The impact of **website** measured with various types of links is considered Web Impact Factors (WIFs). There are four types of WIFs namely, Simple Web Impact Factor (SWIF), Self Link Web Impact Factor (SLWIF), External Link Web Impact Factor (ELWIF) and Revised Web Impact Factor (RWIF). These WIFs have been calculated by the following formulas.

1) Simple WIF = B/A ; where B= Total Links (TL) and A= Number of Web Pages (NWP)
2) Self-Link WIF = C/A; where C= Self-links (SL) and A= Number of Web Pages
3) External Link WIF = D/A ; where D= External Links (EL) and A= Number of Web Pages
4) Revised WIF = E/A ; where E= In Links (IL) and A= Number of Web Pages

The calculation of various WIFs and the ranking of Websites of Observatory Libraries have been presented in Table 2 and Table 3 respectively.

Table 2: Web Impact Factors (WIFs) of the Websites of Observatory Libraries

S.N.	Observatory Library and Country	NWP (A)	TL (B)	SWIF (B/A)	SL (C)	SLWIF (C/A)	EL (D)	ELWIF (D/A)	IL (E)	RWIF (E/A)
1	Giant Metrewave Radio Telescope (GMRT) Library, India	3	197	65.67	3	1.00	188	62.67	113	37.67
2	Astronomical Library, Australian Astronomical Observatory (formerly the Anglo-Australian Observatory), Australia	97	91	0.94	83	0.86	1036	10.68	7261	74.86
3	Royal Observatory Library, Belgium	6	16	2.67	13	2.17	105	17.50	1433	238.83
4	National Observatory Library, Brazil	281	8	0.03	6	0.02	3	0.01	8045	28.63
5	National Astronomical Observatories Library, Chinese Academy of Sciences, China	114	61	0.54	34	0.30	1740	15.26	31	0.27
6	Purple Mountain Observatory Library, China	1	24	24.00	20	20.00	21	21.00	1603	1603.00
7	Višnjan Observatory Library, Croatia	6481	54	0.01	45	0.01	242099	37.36	6426	0.99
8	Astronomical Observatory of Lyon Library, France	1865	73	0.04	66	0.04	45070	24.17	1619	0.87
9	Observatoire de la Côte d'Azur Library, France	16	86	5.38	28	1.75	1157	72.31	36	2.25
10	Observatoire de Marseille Library, France	209	38	0.18	33	0.16	6227	29.79	1953	9.34
11	Paris Observatory Library, France	152	31	0.20	23	0.15	1762	11.59	196	1.29
12	European Southern Observatory (ESO) Library, Germany	500	121	0.24	103	0.21	25	0.05	99399	198.80
13	Baja Astronomical Observatory Library, Hungary	190	19	0.10	18	0.09	3548	18.67	264	1.39
14	Arcetri Astrophysical Observatory Library, Italy	33	14	0.42	11	0.33	400	12.12	1014	30.73
15	Astronomical Observatory of Brera Library, Italy	1122	35	0.03	26	0.02	50081	44.64	773	0.69
16	Astronomical Observatory of Cagliari Library, Italy	246	49	0.20	41	0.17	6466	26.28	1009	4.10
17	Astronomical Observatory of	17	16	0.94	15	0.88	152	8.94	651	38.29

	Capodimonte, Italy									
18	Astronomical Observatory of Collurania Library, Italy	74	44	0.59	39	0.53	329	4.45	107	1.45
19	Astronomical Observatory of Padova Library, Italy	54	77	1.43	72	1.33	56	1.04	1800	33.33
20	Astronomical Observatory of Trieste Library, Italy	175	63	0.36	39	0.22	22	0.13	983	5.62
21	Catania Astrophysical Observatory Library, Italy	198	34	0.17	18	0.09	6345	32.05	3163	15.97
22	Turin Astronomical Observatory Library, Italy	191	74	0.39	33	0.17	41	0.21	714	3.74
23	National Astronomical Observatory Japan Library, Japan	1351	25	0.02	20	0.01	3676	2.72	255	0.19
24	Nobeyama Radio Observatory Library, Japan	34	35	1.03	33	0.97	33	0.97	287	8.44
25	National Astronomical Observatory Library, University of Mexico, Mexico	1	1	1.00	0	0.00	0	0.00	263	263.00
26	Lisbon Astronomical Observatory Library, University of Lisbon, Portugal	1803	97	0.05	128	0.07	22496	12.48	20329	11.28
27	Astronomical Observatory Library, Romania	231	142	0.61	132	0.57	6193	26.81	3716	16.09
28	South African Astronomical Observatory Library, South Africa	2	210	105.00	196	98.00	447	223.50	17572	8786.00
29	John Whelan Library, Isaac Newton Group of Telescopes, Spain	36	73	2.03	65	1.81	829	23.03	3638	101.06
30	Lund Observatory Library, Sweden	52	13	0.25	13	0.25	682	13.12	770	14.81
31	Armagh Observatory Library, UK	1	23	23.00	13	13.00	21	21.00	1088	1088.00
32	Royal Observatory Edinburgh Library, UK	17	58	3.41	50	2.94	582	34.24	2210	130.00
33	Dudley Observatory Library, USA	90	67	0.74	62	0.69	1666	18.51	627	6.97
34	Gemini Observatory / Joint Astronomy Centre Library, USA	17	82	4.82	24	1.41	100	5.88	11017	648.06
35	Lowell Observatory Library, USA	2	17	8.50	17	8.50	1	0.50	6504	3252.00
36	McDonald Observatory Library, University of Texas, USA	7	40	5.71	17	2.43	216	30.86	3098	442.57
37	National Optical Astronomy Observatory Library, USA	56	20	0.36	12	0.21	723	12.91	17195	307.05

38	National Radio Astronomy Observatory Library, USA	260	70	0.27	43	0.17	2155	8.29	31800	122.31
39	Observatories of the Carnegie Institution for Science Library, USA	6177	396	0.06	91	0.01	71205	11.53	1812	0.29
40	Smithsonian Astrophysical Observatory Library, USA	2685	40	0.01	19	0.01	6210	2.31	9845	3.67
41	US Naval Observatory Library, USA	1045	44	0.04	34	0.03	10884	10.42	13499	12.92

Table 3: Revised WIF Ranking of the Websites of Observatory Libraries

Observatory Library and Country	Revised WIF	Ranking by Revised WIF
South African Astronomical Observatory Library, South Africa	8786	1
Lowell Observatory Library, USA	3252	2
Purple Mountain Observatory Library, China	1603	3
Armagh Observatory Library, UK	1088	4
Gemini Observatory / Joint Astronomy Centre Library, USA	648.06	5
McDonald Observatory Library, University of Texas, USA	442.57	6
National Optical Astronomy Observatory Library, USA	307.05	7
National Astronomical Observatory Library, University of Mexico, Mexico	263	8
Royal Observatory Library, UK	238.83	9
European Southern Observatory (ESO) Library, Germany	198.8	10
Royal Observatory Edinburgh Library, UK	130	11
National Radio Astronomy Observatory Library, USA	122.31	12
John Whelan Library, Isaac Newton Group of Telescopes, Spain	101.06	13
Astronomical Library, Australian Astronomical Observatory (formerly the Anglo-Australian Observatory), Australia	74.86	14
Astronomical Observatory of Capodimonte, Italy	38.29	15
Giant Metrewave Radio Telescope (GMRT) Library, India	37.67	16
Astronomical Observatory of Padova Library, Italy	33.33	17
Arcetri Astrophysical Observatory Library, Italy	30.73	18
National Observatory Library, Brazil	28.63	19
Astronomy Library, Astronomical Observatory, Universitatea Babes - Bolyai, Cluj-Napoca, Romania	16.09	20
Catania Astrophysical Observatory Library, Italy	15.97	21
Lund Observatory Library, Sweden	14.81	22
US Naval Observatory Library, USA	12.92	23
Lisbon Astronomical Observatory Library, University of Lisbon, Portugal	11.28	24
Observatoire de Marseille Library, France	9.34	25
Nobeyama Radio Observatory Library, Japan	8.44	26
Dudley Observatory Library, USA	6.97	27
Astronomical Observatory of Trieste Library, Italy	5.62	28
Astronomical Observatory of Cagliari Library, Italy	4.1	29
Turin Astronomical Observatory Library, France	3.74	30
Smithsonian Astrophysical Observatory (SAO) /NASA Astrophysics Data System (ADS) Digital Library, USA	3.67	31
Observatoire de la Côte d'Azur Library, France	2.25	32
Astronomical Observatory of Collurania Library, Italy	1.45	33
Baja Astronomical Observatory Library, Italy	1.39	34

Paris Observatory Library, France	1.29	35
Višnjan Observatory Library, Croatia	0.99	36
Astronomical Observatory of Lyon Library, France	0.87	37
Astronomical Observatory of Brera Library	0.69	38
Observatories of the Carnegie Institution for Science Library, USA	0.29	39
National Astronomical Observatories Library, Chinese Academy of Sciences, China	0.27	40

Table 3 shows that South African Astronomical Observatory Library ranked 1st position with 17,572 in-links, 2 web pages and 8786.00 RWIF, Lowell Observatory Library, USA occupies 2nd position with 6,504 in-links, 2 web pages and 3252.00 RWIF and Purple Mountain Observatory Library, China occupies 3rd position with 1,603 in-links, 1 web page and 1603.00 RWIF. The ranking position of Indian OBS Library Website viz. Giant Metrewave Radio Telescope (GMRT) Library, Narayangaon is in 16th rank according to Revised WIF (RWIF). From the above analysis and interpretations, it can be observed that the library website with high number of links and less number of web pages proportionately are remaining at top level.

6.3 Link Network Analysis

For this analysis, web crawler software SocSciBot and Pajek were used to extract link data and draw visual network diagram respectively. The network diagram brings out to see visually the connectivity between the web nodes, interconnections between the websites and their relationship. The link network analysis has exhibited the web links between Observatory Libraries in Figure 1 (a) and (b). It shows that the interlinking of 39 web nodes between 41 Observatory Libraries, which have been analyzed. The result of the analysis shows that there are 66 arrows indicating the link from to other websites.

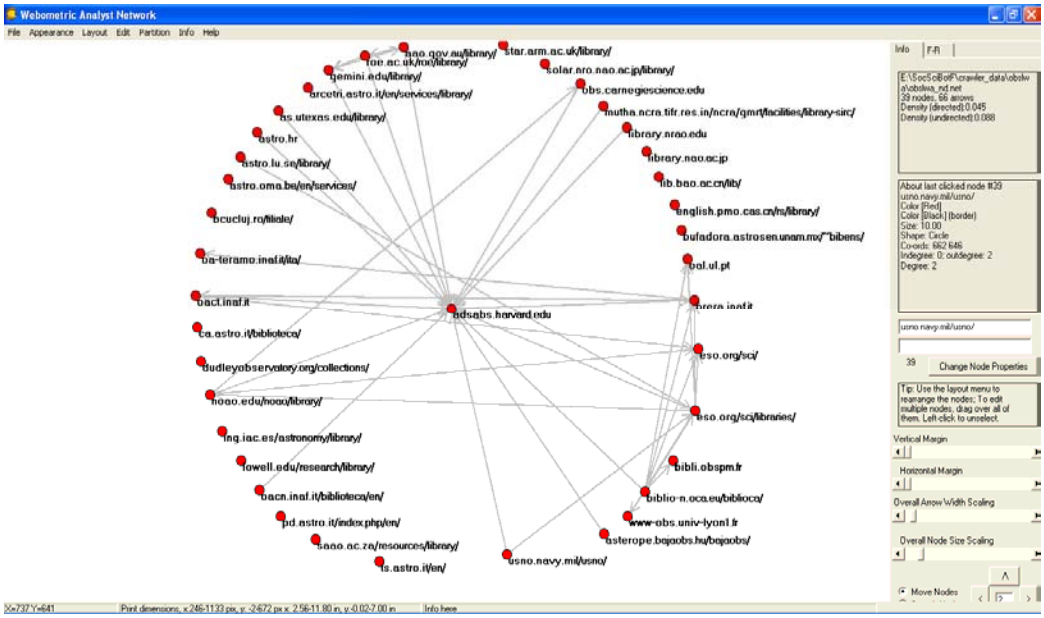

Figure 1 (a): Link Network Topology for Observatory Libraries using SocSciBot

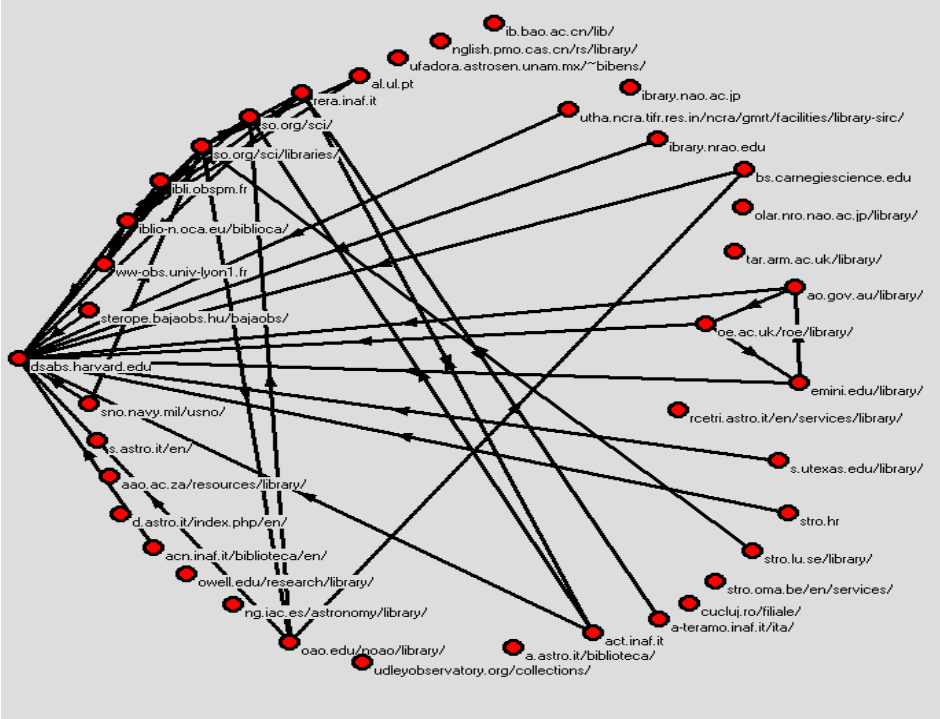

Figure 1 (b): Link Network Topology for Observatory Libraries using Pajek

7. RESULTS OF THE STUDY

From the hyperlink analysis, it was ascertained from the data extracted that there were 25,892 total web pages among 41 observatory libraries' websites. Višnjan Observatory library website, Croatia has the highest number of web pages with total of 6,481 pages and National Astronomical Observatory library website, University of Mexico has lowest number of web pages with only 1 page. Observatory Libraries' Websites have an average of 631 web pages per site; an average of 12,072 external hyperlinks per site; an average of 6,929 in-links received per site; an average of 42 self-links per site; and an average of 65 total links per site. As per Revised WIF (RWIF) analysis, in the ranking of the Observatory Libraries' websites, South African Astronomical Observatory Library ranked 1st with 2 web pages and 17,572 in-links, and National Astronomical Observatory of Japan Library, Japan ranked last with 1,351 web pages and 255 in-links. Therefore, the RWIF analysis indicates that the website with less number of web pages and high number of in-links ranks first.

8. CONCLUSION AND RECOMMENDATION

Hyperlink analysis has been conducted on 41 observatory libraries' websites to extract number of web pages and various links. The collected data have been used for ranking of observatory libraries' websites. From the data analysis, it was found that the website with less number of pages and higher number of links proportionately ranks top among other websites. Webometric analysis helps to improve the performance of the website. It is necessary to update, re-design, additions, modifications of the website regularly, in turn the users will be benefited.

Webometric analysis can be performed to find out web relationship among the library websites of research institutions focused in the same subject areas. Webometric study can be executed for ranking of higher education institutions / universities in India. The results can encourage the Libraries to motivate and be competitive with other library web sites to earn

goodness among the users. Webometric analysis and study will help to improve the web services of the Libraries.

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