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# A Comparative Weblink Analysis among Top Indian, Asian and World universities

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**ABSTRACT**

The article investigates the relationship among top ten world universities (TTWU), top ten Asian universities (TTAU) and top ten Indian universities (TTIU) based on the exploratory study of weblink analysis. Inlinks and outlinks analysis try to explore the relationship among these universities. The findings suggest that although TTIU are generating 3.71 % outlinks to TTWU but receives only 0.67 % inlinks from them. On the other hand, inlinks and outlinks to TTAU are far less than TTWU. An interesting result reflects that the percentage of inlinks and self-links for top ten Indian (30.51% and 69.49%) and Asian universities (31.45 % and 68.55 %) are less than top ten world universities (55.25% and 44.75%).

**Keywords:** Weblink analysis, co-link analysis, Indian university, Asian universities

## 1. INTRODUCTION

It is believed that the study of link analysis helps the possibility of exploring useful information. After studying the references of an article, one can find many useful links or concepts for building up the document. So, there is a link or association among the similar subjects. It's true for all the subjects in the universe. The same analogy may be applied to websites. With this belief, Google used the link-based algorithm for identifying the best webpage. The research on weblink analysis started in 1995-96 including computer science[1] and mathematical structure and complexity analysis[2]; information science[3]. Larson[4] made an exploratory analysis of 'Bibliometrics for the world wide web'. Almind & Ingwersen[5] coined the term 'webometrics', which is the emerging trend in information science research in today, in which weblink analysis is the thrust area of study.

## 2. LITERATURE REVIEW

The studies on hyperlink analysis have extensively undergone by applying existing bibliometric techniques to the web[4,6]. There is a controversy between hyperlinks and citations. Generally, citations are applied in conventional print documents, whereas hyperlinks are applied in a web document.

Egghe[7] rightly indicates that hyperlinks could be bi-directional while references are uni-directional. Brin & Page[8] developed the concept of PageRank at Stanford University as part of a research project basically to develop new search engine powered by PageRank and have an added advantages over others. Later, they developed an excellent search engines called Google, the most admired and used search engines in the world based on PageRank algorithm. Stuart[9] *et al*. investigated the potential of weblinks to act as an indicator of collaboration through detailed classification of 2600 links from universities to government, commercial and other domains. The result showed that the majority of weblinks on university webpages did not reflect the collaboration between the webpage owner and the target webpage owner. Still, significant number of links reflects the collaborative relationships.

Ranking of academic institutions especially universities is of prime attraction in the arena of globalisation. Therefore, university authority may give proper care for the upliftment of their existing ranking not only at the national level but also at the global level. Few studies on ranking of Indian universities[10] and Asian countries[11], African countries, Australian countries, European countries were conducted so far. Besides, national as well as global ranking system has emerged and few notable ranking systems are: Ranking Web of World Universities (RWWU), Shanghai Ranking, Times Higher Education (THE), 4 International and College Universities (4ICU), etc.

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Weblink analysis specifically addresses the collaborative relationship through co-link analysis. Co-link may be of two types: Co-inlinks and co-outlink. It would be an interesting to know how far the Indian universities have established collaborative relationship in academic, teaching and research, and R&D works with top level world universities as well as with the top level Asian universities.

Weblink analysis is the focus of study. The importance of weblinks is duly acknowledged by WWW' founder Berners Lee[12] Larson[4] is one of the pioneers to investigate the link structures in academic web spaces. He used Altavista in a co-citation analysis for earth science related websites and could produce clustering of websites that had topical similarities. Henzinger[13] reviewed link structures analyses from computer science perspective, showing how links could be used by search engine in ranking algorithms. Bjorneborn[14] has contributed the idea of link structure in his PhD thesis which described the link structure of the academic institutions of UK. Besides, a series of link terminology were given. Harries[15] , *et al.* expressed that hyperlinks between academic websites can be used to map disciplinary structures and identified evidence of connections between disciplines. Links within a discipline were found to be a different in character to links between pages in different disciplines.

Earlier link analysis had concentrated on developing metrics to measure the impact of websites. Ingwersen[6] introduced the concept of web impact factor (WIF) to measure the impact of a web site using various types of link counts. Among these, the external WIF was highly used. Smith[16] as well as Björneborn & Ingwersen[17] found that the external inlink count is a better measure than the total inlink count to measure the visibility of a website.

University ranking at the local, regional as well as global level is prime attraction to everyone. Aguillo[18], *et al.* compared popular university ranking systems using a set of similarity measures. The findings showed that there is reasonable similarity between the ranking methodologies.

Hemerks & Van Den Besselaar[19] in their study showed that hyperlinks are the most commonly used alternatives to study websites and structures on the web. They analysed and compared hyperlink networks using a variety of linking units on the different levels of aggregation and specificity. The inter-university web connectivity phenomenon had been studied for African countries[20] and for Kenyan universities[21]. They used link analysis approach to compare Kenyan and South African universities based on several web based indicators such as number of web-pages, number of inlinks and outlinks. Li[22], *et al.* had studied national and international university even at the departmental website interlinking. As departments are subject-oriented, departmental interlinking pattern may be illustrated. Three departments have been taken up like physics, chemistry, and biology in Australia, Canada and UK to study link pattern differences and compared each set of patterns.

Vaughan & You[23] added a new dimension in webometric research by introducing the concept 'word co-occurances on webpages' as a measure of the relatedness of organisation. An experiment was made in a group of telecommunication industry and found that web co-word analysis could potentially be useful for web co-link analysis.

Therefore, the crux of the study aimed at to focus on finding out the hyperlink relationship among top ten universities within themselves as well as with Asian and Indian universities.

## 3. METHODOLOGY

The selection of data set for our study includes TTIU, TTAU and TTWU based on Web Ranking of World Universities (RWWU) January 2011[24] by Cybermetrics Lab, Spain. The names of the universities along with their corresponding codes and domain names are mentioned in Table 1.

Henceforth, the codes may be used to represent these universities in the following tables for optimum use of space. The webpage for all the universities can be calculated using domain: iisc.ernet.in.

The total inlinks for a particular university (say, Indian Institute of Science, Bangalore having domain name iisc.ernet.in) are determined using the query as: linkdomain:iisc.ernet.in – domain: iisc.ernet.in. The same way the inlinks for all the top Indian universities as well as top world universities are retrieved through Yahoo! search engine dated 16-18 February 2011. After collection of data, a series of measures have been applied to know and to find out the nature and degree of hyperlink relationship.

## 4. RESEARCH QUESTIONS

For simplicity, it is assumed that A, B, and C are three different websites having valid domain name. Among these, if two websites A and B are receiving links from third website C then we can call site A and B are co-linked. The analysis of the websites A & B may be termed as co-inlink analysis. On the other hand, if two sites A & B are giving links to third site C then site A & B are called co-linking. The analysis of websites A & B may be called as co-outlink analysis. The sum of other co-inlink analysis and co-outlink analysis may be termed as co-link analysis. On the basis of the fundamental concept, following few research questions may be raised to achieve the objectives and purpose of the study:

**Table 1. Top ten Indian, Asian, and World universities**

| Group | University Name | Code | Domain |
|---|---|---|---|
| Indian universities | IISc Bangalore | IISc | iisc.ernet.in |
| | IIT Kanpur | IITK | iitk.ac.in |
| | IIT Bombay | IITB | iitb.ac.in |
| | IIT Madras | IITM | iitm.ac.in |
| | University of Delhi | DU | du.ac.in |
| | Tata Institute of Fundamental Research | TIFR | tifr.res.in |
| | IIT Delhi | IITD | du.ac.in |
| | IIT Kharagpur | IITKGP | iitkgp.ernet.in |
| | NIT Rourkela | NITR | nitrkl.ac.in |
| | IIIT Hyderabad | IIITH | iiit.ac.in |
| World universities | Massachusetts Institute of Technology | MIT | mit.edu |
| | Harvard University | HU | harvard.edu |
| | Stanford University | SU | stanford.edu |
| | University of California Barkley | UCB | berkeley.edu |
| | Cornell University | CU | cornell.edu |
| | University of Wisconsin Madison | WISC | wisc.edu |
| | University of Michigan | UM | umich.edu |
| | University of Minnesota | UMN | umn.edu |
| | University of Washington | UW | washington.edu |
| | University of Pennsylvania | UP | upenn.edu |
| Asian universities | National Taiwan University | NTU | ntu.edu.tw |
| | University of Tokyo | UT | u-tokyo.ac.jp |
| | Kyoto University | KU | kyoto-u.ac.jp |
| | National Cheng Kung University | NCKU | ncku.edu.tw |
| | National Chiao Tung University | NCTU | nctu.edu.tw |
| | National University of Singapore | NUS | nus.edu.sg |
| | National Central University | NCU | ncu.edu.tw |
| | University of Hong Kong | UHK | hku.hk |
| | Osaka University | OU | osaka-u.ac.jp |
| | Keio University | KEU | keio.ac.jp |

Source: http://www.webometrics.info.

- Is there any relationship between top ranking Indian universities and top ranking world universities with respect to inlinks and outlinks?
- Is there any web inter-connectivity relationship between top ranking Asian universities and top ranking Indian universities?
- How is the link relationship among top ranking Indian universities with top ranking global universities in academic web space?

**Table 2. Query syntaxes**

| Indicators | Query |
|---|---|
| Co-inlinks | linkdomain:A AND linkdomain:B NOT (domain:A OR domain:B) |
| Webpage | domain:A |
| Inlink | linkdomain:A –domain:A |
| Selflink | linkdomain:A domain:A |
| Inlinks | linkdomain:xxx.yyy.zz AND domain:aaa.bbb.cc, where 'xxx' is producing the links and 'aaa' is receiving the links |
| Outlinks | linkdomain:xxx.yyy.zz AND domain:aaa.bbb.cc, where 'xxx' is receiving the links and 'aaa' is producing the links |

- How to measure the degree of collaboration between

  (a) TTIU, and TTAU and

  (b) TTIU, and TTWU?

## 5. RESULTS

To search for answers to the above research questions, following facets have been studied and with followingfindings:

### 5.1 Distribution of Inlinks Received by TTAU from TTIU

Table 3 has shown the number of outlinks to each of the TTWU. It is found that IISc, Bangalore being the number one university is generating maximum outlinks (1916) followed by IIT, Bombay (918) to TTWU as compared to other TTIU.

Table 3 shows that University of Wisconcine Madison (WISC) being the 6th world topper is producing maximum outlinks to Indian no. 1 university, i.e., IISc, Bangalore. Here, the point to be noted that MIT, being the World no.1 University, is producing highest number of outlinks to TTIU as compared other TTWU.

**Table 3. Distribution of outlinks from top ten Indian universities to top ten World universities**

| | MIT | HU | SU | UCB | CU | WISC | UM | UMN | UW | UP | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IISc | 183 | 451 | 155 | 210 | 137 | 383 | 122 | 117 | 97 | 61 | **1916** |
| IITK | 52 | 25 | 64 | 59 | 23 | 20 | 11 | 13 | 24 | 9 | **300** |
| IITB | 188 | 37 | 158 | 176 | 78 | 73 | 47 | 51 | 57 | 53 | **918** |
| IITM | 45 | 4 | 20 | 22 | 7 | 133 | 11 | 7 | 22 | 9 | **280** |
| DU | 199 | 16 | 57 | 22 | 12 | 16 | 26 | 9 | 7 | 62 | **426** |
| TIFR | 313 | 96 | 84 | 44 | 48 | 32 | 26 | 17 | 34 | 18 | **712** |
| IITD | 4 | 4 | 40 | 11 | 1 | 3 | 3 | 7 | 3 | 6 | **82** |
| IITKGP | 5 | 2 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 3 | **16** |
| NITR | 0 | 2 | 0 | 2 | 0 | 1 | 2 | 0 | 1 | 0 | **8** |
| IIITH | 21 | 6 | 19 | 8 | 5 | 2 | 3 | 2 | 12 | 9 | **87** |
| **Total** | **1010** | **643** | **600** | **554** | **312** | **663** | **252** | **223** | **258** | **230** | **4745** |

**Table 4. Distribution of outlinks from top ten Indian universities to top ten Asian universities**

| | NTU | UT | KU | NCKU | NCTU | NUS | NCU | UHK | OU | KEU | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IISc | 3 | 16 | 10 | 5 | 2 | 29 | 0 | 9 | 3 | 4 | **81** |
| IITK | 2 | 3 | 1 | 0 | 2 | 7 | 0 | 5 | 0 | 0 | **20** |
| IITB | 11 | 8 | 6 | 3 | 5 | 33 | 1 | 4 | 2 | 13 | **86** |
| IITM | 3 | 2 | 0 | 3 | 1 | 10 | 0 | 1 | 4 | 2 | **26** |
| DU | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | **6** |
| TIFR | 8 | 9 | 20 | 0 | 1 | 4 | 2 | 0 | 3 | 3 | **50** |
| IITD | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | **2** |
| IITKGP | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | **1** |
| NITR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| IIITH | 1 | 6 | 1 | 0 | 0 | 2 | 4 | 3 | 0 | 0 | **17** |
| **Total** | **28** | **46** | **40** | **11** | **11** | **87** | **8** | **24** | **12** | **22** | **289** |

### 5.2 Distribution of Outlinks from TTIU to TTAU

Table 4 deals with TTAU in which it clearly identified that National University of Singapore (NUS) is providing highest number of outlinks (30.10 %) to TTIU. On the other hand, IIT Bombay is receiving maximum number of outlinks from TTAU followed by IISc Bangalore.

The total outlinks is being calculated with the help of commercial search engine Bing, i.e., bing.com using special webometric keyword linkfromdomain (e.g. linkfromdomain: X, where X represents university's domain name e.g. iisc.ernet.in. Outlinks to TTWU is referred in Table 5 and percentage of outlinks for each Indian university is calculated over total outlinks.

The Table 5 shows that among top ten Indian universities, IISc, Bangalore (iisc.ernet.in) is proving highest outlinks (1.50 %) to TTWU.

**Table 5. Distribution of individual and total outlinks to top ten World universities**

| S. No. | Domain Name | Outlinks to TTWU | Webpage | Total outlinks | Percentage |
|---|---|---|---|---|---|
| 1. | iisc.ernet.in | 1916 | 334000 | 32800 | 1.50 |
| 2. | iitk.ac.in | 300 | 145000 | 16700 | 0.23 |
| 3. | iitb.ac.in | 918 | 267000 | 19000 | 0.72 |
| 4. | iitm.ac.in | 280 | 217000 | 21200 | 0.22 |
| 5. | du.ac.in | 426 | 31500 | 10100 | 0.33 |
| 6. | tifr.res.in | 712 | 53500 | 17900 | 0.56 |
| 7. | iitd.ac.in | 82 | 25200 | 6970 | 0.06 |
| 8. | iitkgp.ac.in | 16 | 19100 | 612 | 0.01 |
| 9. | nitrkl.ac.in | 8 | 24100 | 108 | 0.01 |
| 10. | iiit.ac.in | 87 | 90700 | 2410 | 0.07 |
| **Total** | | **4745** | **1207100** | **127800** | **3.71** |

**Table 6. Distribution of inlinks received by total outlinks to top ten World universities**

| | MIT | HU | SU | UCB | CU | WISC | UM | UMN | UW | UP | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IISc | 27 | 25 | 32 | 21 | 17 | 71 | 14 | 13 | 8 | 23 | **251** |
| IITK | 38 | 7 | 41 | 25 | 17 | 38 | 28 | 13 | 5 | 18 | **230** |
| IITB | 24 | 8 | 48 | 27 | 21 | 170 | 19 | 12 | 9 | 13 | **351** |
| IITM | 25 | 10 | 21 | 14 | 5 | 23 | 14 | 10 | 3 | 9 | **134** |
| DU | 1 | 1 | 6 | 0 | 0 | 1 | 1 | 0 | 1 | 5 | **16** |
| TIFR | 16 | 8 | 35 | 16 | 20 | 6 | 3 | 8 | 5 | 19 | **136** |
| IITD | 3 | 1 | 9 | 5 | 4 | 7 | 1 | 8 | 3 | 6 | **47** |
| IITKGP | 3 | 0 | 15 | 12 | 1 | 3 | 5 | 5 | 5 | 2 | **51** |
| NITR | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | **4** |
| IIITH | 3 | 1 | 6 | 4 | 2 | 441 | 1 | 8 | 5 | 4 | **475** |
| **Total** | **140** | **61** | **214** | **124** | **90** | **760** | **86** | **77** | **44** | **99** | **1695** |

Source: Yahoo! dated 17 February 2011

**Table 7. Distribution of inlinks received by top ten Indian universities to top ten Asian universities**

| | NTU | UT | KU | NCKU | NCTU | NUS | NCU | UHK | OU | KEU | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IISc | 2 | 13 | 2 | 1 | 1 | 18 | 3 | 2 | 3 | 1 | **46** |
| IITK | 10 | 14 | 4 | 2 | 3 | 12 | 0 | 4 | 3 | 7 | **59** |
| IITB | 4 | 1 | 0 | 2 | 0 | 20 | 0 | 2 | 0 | 1 | **30** |
| IITM | 1 | 5 | 1 | 2 | 1 | 24 | 1 | 1 | 1 | 1 | **38** |
| DU | 1 | 2 | 2 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | **9** |
| TIFR | 3 | 34 | 22 | 1 | 13 | 5 | 2 | 0 | 6 | 0 | **86** |
| IITD | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 3 | 1 | **8** |
| IITKGP | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | **3** |
| NITR | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | **1** |
| IIITH | 2 | 1 | 6 | 0 | 0 | 3 | 0 | 3 | 4 | 0 | **19** |
| **Total** | **24** | **71** | **37** | **8** | **20** | **87** | **6** | **14** | **20** | **12** | **299** |

Source: Yahoo! dated 16 February 2011

### 5.3 Distribution of Inlinks Received by TTIU from TTWU

Table 6 has explained total number of inlinks received from each of the TTWU. It is found that IIIT Hyderabad being the 10th rank of Indian university achieved the credit of receiving the highest number of inlinks (475) followed by IIT Bombay (351) from TTWU as compared to other TTIU.

### 5.4 Distribution of Inlinks Received by TTIU from TTAU

Table 7 explains the distribution of inlinks received by TTIU from TTAU. Tata Institute of Fundamental Research (TIFR) received highest number of inlinks from TTAU, especially from University of Tokyo.

It is clear from Table 7 that National University of Singapore (NUS) is producing highest links to TTIU followed by University of Tokyo (UT). Table

**Table 8. Distribution of total inlinks to top ten World universities**

| S. No. | Domain name | Inlinks from TTWU | Self-links | Total inlinks | Inlinks from TTWU (%) |
|---|---|---|---|---|---|
| 1. | iisc.ernet.in | 251 | 166000 | 32400 | 0.10 |
| 2. | iitk.ac.in | 230 | 63300 | 31800 | 0.09 |
| 3. | iitb.ac.in | 351 | 151000 | 48900 | 0.14 |
| 4. | iitm.ac.in | 134 | 74200 | 37700 | 0.05 |
| 5. | du.ac.in | 16 | 14100 | 22600 | 0.01 |
| 6. | tifr.res.in | 136 | 28300 | 22600 | 0.05 |
| 7. | iitd.ac.in | 47 | 10700 | 27800 | 0.02 |
| 8. | iitkgp.ac.in | 51 | 11300 | 10400 | 0.02 |
| 9. | nitrkl.ac.in | 4 | 13000 | 5900 | 0.00 |
| 10. | iiit.ac.in | 475 | 46700 | 13900 | 0.19 |
| **Total** | | **1695** | **578600** | **254000** | **0.67** |

shows the distribution of top total inlinks received anywhere in the world and the percentage of inlinks received from top ten world universities. Total inlinks is being calculated using linkdomain: X–domain: Y (e.g. X= iisc.ernet.in, which is the link receiving domain and Y is the link producing domain). Inlinks from TTWU as have been shown in the Table 3 is referred in Table 6 and based on the data, percentage of inlinks for each Indian university is calculated over total inlinks.

It implies that only less than one percentage inlinks received from TTWU. The link analysis of each university may be done through tabular as well as graphical presentation. But for convenience, only first rank university of each set of data under study have considered for analysis.

### 5.5 Link Analysis of Particular University

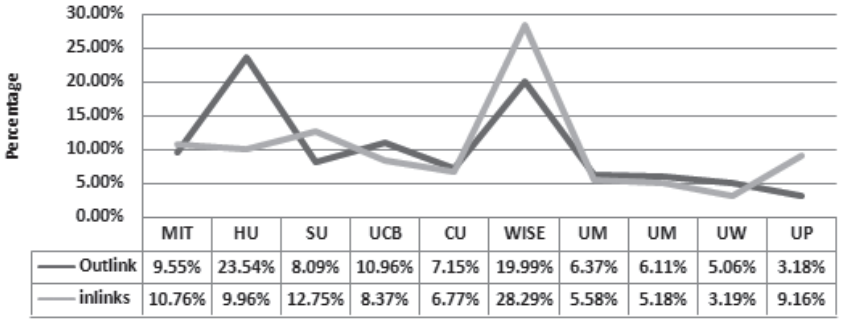
#### *5.5.1 Indian Institute of Science (IISc), Bangalore*

The IISc Bangalore is having the highest number of outlinks (1916). Figure 1 shows the distribution of outlinks and inlinks among the top ten world universities in terms of percentage. It shows that outlinks from IISc Bangalore to Harvard University (23.54 %) and inlinks from IISc to University of Wisconsin Madison (28.29%) were highest.

#### *5.5.2 Massachusetts Institute of Technology (MIT)*

The MIT had only 68 outlinks to all TTIU in which highest outlinks to IISc, Bangalore (41.18 %) followed by IIT Kanpur (25 %) and equal number of outlinks to IIT Bombay (11.76 %) and IIT Madras (11.76%). But, MIT receives 1005 number of inlinks from TTIU in which TTIFR, Mumbai gives highest inlinks (33.13 %) followed by IIT Bombay (19 %).

Figure 2 reflects that MIT generates highest number of outlinks (28) to IISc Bangalore and receives highest number of inliks (333) from TIFR Mumbai.




| | MIT | HU | SU | UCB | CU | WISE | UM | UM | UW | UP |
|---|---|---|---|---|---|---|---|---|---|---|
| Outlink | 9.55% | 23.54% | 8.09% | 10.96% | 7.15% | 19.99% | 6.37% | 6.11% | 5.06% | 3.18% |
| inlinks | 10.76% | 9.96% | 12.75% | 8.37% | 6.77% | 28.29% | 5.58% | 5.18% | 3.19% | 9.16% |

**Figure 1. Distribution of inlinks and outlinks for IISc Bangalore.**

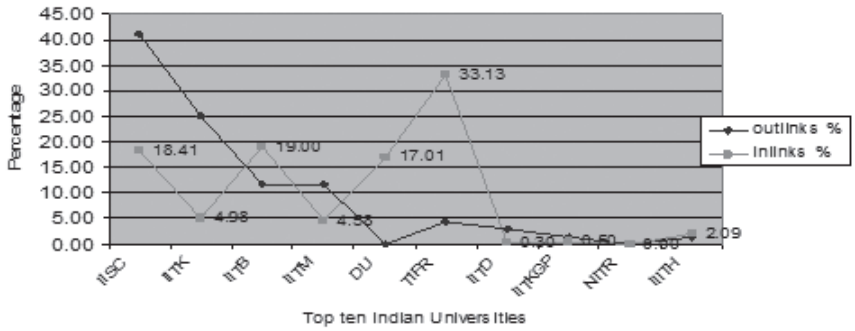



**Figure 2. Distribution of inlinks and outlinks for Massachusetts Institute of Technology.**

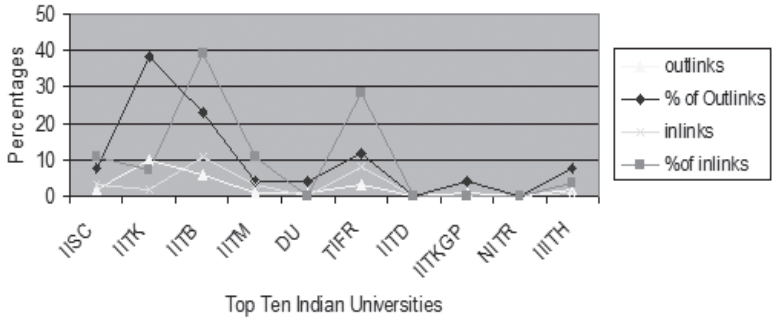



**Figure 3. Distribution of inlinks and outlinks for National Taiwan University.**

*5.5.3 National Taiwan University*

According to Ranking Web of World Universities (www.webometrics.info), National Taiwan University is given the credit of being rank no. 1 university among the Asian countries. Figure 3 shows the distribution of inlinks and outlinks exclusively from and to top ten Indian universities respectively.

Although it seems a very high percentage of outlinks and inlinks, the absolute figure is very pathetic, which is been reflected through the lower line in the Figure 3. The above figure shows that National Taiwan University generates highest number of outlinks (10) to IIT Kanpur and receives highest number of inlinks (11) from IIT Bombay.

**5.6 Co-inlink Matrix for the TTIU**

Co-inlink analysis is one of the important techniques for weblink analysis. The co-inlinks between two websites (say IISc, Bangalore and IIT, Kanpur) can be determined using the query syntax as: linkdomain:iisc.ernet.in AND linkdomain:iitk.ac.in. The matrix formed for TTIU using above query submitted in Yahoo! search engine is mentioned in Table 9.

Table 10 expresses the co-link matrix for the TTIU where both inlinks and outlinks have been shown. The boolean query syntax: linkdomain: X AND domain:Y, where X is the receiving links and Y is generating links.

**5.7 Similarity Measure using Cosine Technique**

One important technique is the application of cosine method. In webometric study, co-link matrix is formed using the query, linkdomain: university-A + site:university-B. The cosine technique can be applied to the whole set of data as retrieved using the above query. In order to build the map, an asymmetrical matrix can be used between the links of all accredited Indian universities. The cosine can be used to calculate the similarity among the websites.

The formula is: $Sin\left(S_i, S_j\right) = \frac{\sum e_i e_j}{\sqrt{\sum \left(e_i\right)^2 \sum \left(e_j\right)^2}}$

**Table 9. Co-link matrix for top ten Indian universities (n=10)**

| S. No. | Domain | IISc | IITK | IITB | IITM | DU | TIFR | IITD | IITKGP | NITR | IIITH | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | IISc | - | 3330 | 3180 | 3290 | 712 | 2140 | 1890 | 1160 | 380 | 688 | **16770** |
| 2. | IITK | | - | 8980 | 8040 | 879 | 806 | 6120 | 2110 | 347 | 336 | **27618** |
| 3. | IITB | | | - | 8350 | 962 | 2220 | 6580 | 2350 | 430 | 442 | **21334** |
| 4. | IITM | | | | - | 1040 | 1100 | 6270 | 2740 | 480 | 884 | **12514** |
| 5. | DU | | | | | - | 453 | 556 | 455 | 197 | 76 | **1737** |
| 6. | TIFR | | | | | | - | 276 | 177 | 99 | 618 | **1170** |
| 7. | IITD | | | | | | | - | 1770 | 369 | 108 | **2247** |
| 8. | IITKGP | | | | | | | | - | 138 | 81 | **219** |
| 9. | NITR | | | | | | | | | - | 62 | **62** |
| 10. | IIITH | | | | | | | | | | - | - |
| **Total** | | | | | | | | | | | | **83671** |

**Table 10. Co-link matrix for top ten Indian Universities (TTIU, where n=10)**

| S. No. | Domain | IISc | IITK | IITB | IITM | DU | TIFR | IITD | IITKGP | NITR | IIITH | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | IISc | - | 106 | 235 | 154 | 2 | 78 | 106 | 68 | 2 | 12 | **763** |
| 2. | IITK | 103 | - | 252 | 167 | 2 | 20 | 50 | 127 | 3 | 12 | **736** |
| 3. | IITB | 129 | 108 | - | 263 | 2 | 46 | 49 | 53 | 2 | 17 | **669** |
| 4. | IITM | 128 | 124 | 191 | - | 154 | 14 | 46 | 58 | 3 | 45 | **763** |
| 5. | DU | 28 | 7 | 7 | 1 | - | 4 | 9 | 0 | 0 | 2 | **58** |
| 6. | TIFR | 45 | 33 | 88 | 10 | 2 | - | 5 | 2 | 0 | 4 | **189** |
| 7. | IITD | 188 | 126 | 279 | 242 | 1 | 6 | - | 58 | 1 | 4 | **905** |
| 8. | IITKGP | 74 | 66 | 84 | 457 | 0 | 2 | 18 | - | 0 | 3 | **704** |
| 9. | NITR | 42 | 1 | 7 | 0 | 0 | 2 | 9 | 1 | - | 0 | **62** |
| 10. | IIITH | 1 | 1 | 11 | 30 | 0 | 3 | 4 | 1 | 0 | - | **51** |
| **Total** | | **738** | **572** | **1154** | **1324** | **163** | **175** | **296** | **368** | **11** | **99** | **4900** |

The matrix can be turned to distances and multidimensional scaling (MDS) map can be formed. Then map may be plotted with SPSS and finally it will be displayed with Ucinet. Cosine value for the group of TTIUs may be calculated using the help of above co-link matrix.

$$= \frac{3341536}{\sqrt{4246676 \times 3513766}} = \frac{33415363}{3862877.9} = 0.8650$$

Therefore, it is found that for the case of top level Indian universities, the cosine value is 0.8650, which implies that there is a strong similarity in hyperlink pattern among TTIU.

### 5.8 Key Indicators

The key webometric indicators are mentioned in Table 11. The impact of website can be measured using some metrics as:

#### *5.8.1 Web Impact Factor (WIF)*

The web impact factor, which may be an indicator for measuring the impact of website is accepted by many scholars although there are many controversies and regarding the acceptance of the result. The WIF can be calculated as: $\mathrm{WIF} = \frac{V}{W}$,

where V denotes as visibility which are measured with number of inlinks. The visibility may be calculated using the Boolean query syntax as: linkdomain:X –domain:X, where X is the domain name. In our study, it is found that Harvard University being 2nd topper is having the highest WIF (1.14), University of Tokyo, being 2nd topper in Asian university having highest WIF (0.53) and University of Delhi being the 6th topper Indian university occupies the highest WIF (0.72)

#### *5.8.2 Measuring Web Usability Factor (WUF)*

The WUF measures the usability of websites. It may be calculated using the formula as: $\mathrm{WUF} = \frac{O}{W}$

where O denotes as outlinks (it is calculated using linkfromdomain:X, where X is the domain name.

**Table 11. Descriptive statistics of the data of top ten Indian universities (TTIU) (n=10)**

| Variables | TTIU | TTAU | TTWU |
|---|---|---|---|
| Average webpage | 1,20,710 | 18,80,100 | 65,55,000 |
| Average inlinks | 25,400 | 5,06,200 | 39,17,600 |
| Average self-links | 57,860 | 1,103,500 | 31,73,000 |
| Highest WIF | 0.74 | 0.53 | 1.14 |
| Percentage of inlinks | 30.51% | 31.45% | 55.25% |
| Percentage of self-links | 69.49% | 68.55% | 44.75% |

#### *5.8.3 Measuring Link Propensity (LP)*

Link propensity may be measured using the formula as: $\mathrm{LP} = \frac{\text{Links from site A to site B}}{[(\text{Pages in site A}) * (\text{Pages in site B})]}$,

where A and B denotes site names and the denominator can be calculated as: linkfromdomain:X AND domain:Y, where X and Y are domain names.

#### *5.8.4 Link Metrics*

Ingwersen's (1998) concept of web impact factor is the primary link metrics. Counting average inlinks per page for a site, counting average inlinks per faculty members (Thelwall, 2001a) are also few examples. Table 11 summaries some key results, which may be of interest to look at a glance the comparative situation among TTWU, TTAU and TTIU through following key variables.

From Table 11, it is clearly visible that average inlinks are very less with compared to top ten World universities. Therefore, it is understood that the variability in the distribution of webpages and inlinks are very high.

## 6. DISCUSSIONS AND CONCLUSIONS

The study has thrown a light on the presence of web interconnectivity:

(i) Between top level Indian universities with top level World universities, and

(ii) Between top level Indian universities with top level Asian universities.

It is found from these studies that there is comparatively weaker web connectivity between top Indian universities with Asian universities in comparison with top level world universities. The study reflects that for the case of top level Indian universities, the cosine value is 0.8650, which implies that there is a strong similarity in hyperlink pattern among top level Indian universities.

The indicators used in ranking under different ranking systems may differ. As a result, the concerned authority should concentrate upon improving those areas or indicators resulting into either improved ranking in the global ranking system. The percentage of inlinks and self-links for top ten Asian universities are 31.45 % and 68.55 % and same figure for top ten Indian universities are 30.51 % and 69.49 % respectively. Interestingly, if we look the same figure for top ten world universities the percentage of inlinks are more than percentage of self-links i.e. inlinks (55.25 %) and self-links (44.75 %).

This phenomenon is completely opposite for the case of Indian and Asian top ten universities. If we closely analyse the data in Table 11, an interesting point may be noted that the average inlinks for

top ten world universities are 150 times more than TTIU; and 7 times more than TTAU; but average webpage for top ten world universities are only 54 times more than TTIU; 3.5 times more than TTIU. Hence, it can be concluded that the visibility of top ten world universities are far more than Asian and Indian universities.

Based on the summary of findings, the administrators and decision makers may take some corrective measures to improve their web performance by enhancing the quality indicators and incorporating the quality teaching learning materials, sharing the R&D outputs, extending the academic cooperation thereby enhancing the visibility of their websites in turn their university.

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**Annexure 1**

**Data collected for top ten World universities**

| S. No. | Name | Domain | Webpage | Inlinks | Self-links | WIF[R] |
|---|---|---|---|---|---|---|
| 1. | Massachusetts Institute of Technology | mit.edu | 9060000 | 4780000 | 4300000 | 0.53 |
| 2. | Harvard University | harvard.edu | 3560000 | 4070000 | 1690000 | 1.14 |
| 3. | Stanford University | stanford.edu | 3990000 | 3430000 | 2020000 | 0.86 |
| 4. | University of California Barkley | berkeley.edu | 3730000 | 2510000 | 1740000 | 0.67 |
| 5. | Cornell University | cornell.edu | 4170000 | 2700000 | 1760000 | 0.65 |
| 6. | University of Wisconsin Madison | wisc.edu | 4210000 | 2030000 | 1620000 | 0.48 |
| 7. | University of Michigan | umich.edu | 2960000 | 2410000 | 1610000 | 0.81 |
| 8. | University of Minnesota | umn.edu | 2540000 | 1760000 | 1290000 | 0.69 |
| 9. | University of Washington | washington.edu | 2780000 | 1290000 | 1370000 | 0.46 |
| 10. | University of Pennsylvania | upenn.edu | 2200000 | 2130000 | 1030000 | 0.97 |

Source: Yahoo! dated 22nd Feb 2011

**Annexure 2**

**Data collected for top ten Asian universities**

| S. No. | University | Domain | Webpage | Inlinks | Self-links | WIF |
|---|---|---|---|---|---|---|
| 1. | National Taiwan University | ntu.edu.tw | 3700000 | 749000 | 2160000 | 0.20 |
| 2. | University of Tokyo | u-tokyo.ac.jp | 2870000 | 1530000 | 1830000 | 0.53 |
| 3. | Kyoto University | kyoto-u.ac.jp | 2650000 | 530000 | 1820000 | 0.20 |
| 4. | National Cheng Kung University | ncku.edu.tw | 1870000 | 228000 | 792000 | 0.12 |
| 5. | National Chiao Tung University | nctu.edu.tw | 2830000 | 252000 | 1170000 | 0.09 |
| 6. | National University of Singapore | nus.edu.sg | 704000 | 259000 | 319000 | 0.37 |
| 7. | National Central University | ncu.edu.tw | 673000 | 333000 | 416000 | 0.49 |
| 8. | University of Hong Kong | hku.hk | 1760000 | 400000 | 1350000 | 0.23 |
| 9. | Osaka University | osaka-u.ac.jp | 684000 | 304000 | 448000 | 0.44 |
| 10. | Keio University | keio.ac.jp | 1060000 | 477000 | 730000 | 0.45 |

Source: Yahoo! dated 22nd Feb 2011