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Forecasting of Select Search Engines: An Experiment with Result Fluctuation in the field of Library and Information Science

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Abstract

The paper evaluates a forecasting study on four search engines viz., Google, Bing, Yahoo, and Baidu in order to generate projected data to on collection of data series, using result fluctuation on simple keyword "Dublincore" in the field of Library and Information Science. Data was collected on daily basis for about 100 Days to generate 50 days of projected data using time series analysis, and latter by trend projecting method which reveal that Bing shows a positive secular trend while Google, Yahoo! and Baidu show a downward or negative secular trend.

Keywords

Forecasting, Search engine, Fluctuation, Dublincore, Counter, Terms.

1. Introduction

In the past twenty years the information explosion has reached at its peak as the web provides every bit of information [1]. The major activity performed on web is searching information for research purposes mainly via these engines [2,3]. However the results yielded for a number of queries rank in several thousand or even in millions due to the availability of infinite amount of information. However many studies show that only first few results are browsed by the users [4,5,6,7] which determines the success of a search engine therefore result ranking holds utmost importance in this regard. Result ranking was merely based on term frequency and the inverse document frequency in case of classical IR system [8].Various parameters are taken into account in Web search results ranking as number of links pointing to a given web page [9,10] the anchor text of the links pointing to the web page, the placement of the search terms in the document (terms occurring in title or header may get a higher weight), the distance between the search terms, popularity of the page (in terms of the number of times it is visited), the text appearing in metatags [11] subject specific authority of the web page [12,13] recently in search index and exactness of the hits [14]. There is always an ongoing competition between search engines and Web page authors for users and high ranking respectively, which is why the algorithm ranking are kept a secret by the search engine companies as Google states10, "Due to the nature of our business and our interest in protecting the integrity of our search results, this is the only information we make available to the public about our ranking system". Apart from this search engines keep on updating and

upgrading their algorithm so to improve their ranking of results. Nowadays search engine optimization industries are present which design and redesign Web pages in order to enhance their rankings within a specific search engine (e.g., search engine optimization Inc., www.seoine.com/). Therefore in the crux it can be concluded that the First ten results retrieved for a query have major chances of being visited by the users. In addition to the examination of changes overtime for the top ten results related to a query of the largest search engine, which at the times of first data collection were Google, yahoo and Tacoma (MSN search came out if beta on Feb 1st 2005 in the midst of data collection for the second round [15]. However various transformations between the user's "visceral need" (a fuzzy view of the information problem in user's mind) and the "compromised need" (the way the query is phrased taking into account the limitations of the search tool at hand) [16]. Above all the fluctuation of a result related to a query can only be judged by the user while some researchers claim that it is impractical due to the presence of a large number of documents related to a query and all of them can't be viewed by the user, hence for checking fluctuation a panel of judges is required [17,18,19].

2. PROBLEM

Before graphical user interface, software were usually command driven and few in number. With the proliferation of information, systems such as Archie, Gopher and Veronica became increasingly unable to cope with huge information. The advent of many types of search engines provided solution for literature search using Boolean operators, Proximity searching, Wild cards, Truncation etc. Many search engines developed new versions and techniques to achieve some kind of sophistication but all have not helped to forward the case of access and searching from scholar's perspective. Besides keeping in view different ways of indexing the internet, search engines operate in different ways and retrieve documents in different orders. Further, it does not sift information from scholar's point of view i.e., it retrieves information on a particular topic from different aspects like marketing, advertisement, news and entertainment mixed with some research papers. The academic community attempts to look purely for scholarly information on his topic of interest to have output/ retrieval best in terms of comprehensiveness and devoid of fluctuations etc.

The present investigation attempts to evaluate the performance of the select search engines in terms of result fluctuation captured in two phases to check the consistency of search engines.

3. Objectives

Following are the objectives, laid down for the study:

1. To select search engines.
2. To select search term for the study.
3. To collect data for 100 days.
4. To compare trending by forecasting of time series analysis.

4. Method

The International Standard Organization certifies 230 search engines presently working on the web [12]. These search engines are of various types like general search engine, robotic search engine, Meta search engine, directories and specialized search engines. Most users prefer robotic search engines as they allow the users to compose their own quires rather than simply follow pre specified search paths or hierarchy as in case of directories. Moreover, robotic search engines locate data in a similar way i.e., by the use of crawlers or worms. This distinguishing feature differentiates them form web directories like Yahoo! Where collections of links to retrieve URL's are created and maintained by subject experts or by means of some automated indexing process. However some of these services are also include a robot driven search engine facility. But this is not their primary purposes. This due to this feature Yahoo! Was included for the study.

Meta search engine e.g., Dogpile etc don't have their own database. These access the database of many robotic search engines simultaneously. Thus these were excluded for the study.

Still hundreds of robotic general search engines navigate the web, in order to limit the scope of study after preliminary study, following criteria was laid down for selection of general search engines:-

1. Availability of automated indexing
2. Global coverage to data.
3. Quick response time.
4. Availability of result counter.

Following two general search engines were selected for the study for meeting all the criteria and being comprehensive in nature.

a) Google. b) Baidu.

Since the study relates to the field of Library and Information Science but there is no specialized search engine in the subject so another specialized search engine which relates to the subject area i.e., Bing was taken for study. Thus the search engines undertaken for evaluation of study are:-

a) Google (General)
b) Bing (Specific)
c) Yahoo! (Directory)
d) Baidu (Country Specific)

4.1 SELECTION OF TERMS

Selection of terms is not directly possible in development and multidimensional field like Library and Information Science. Therefore, classification schemes like DDC (18th) and DDC (22nd) were consulted to understand Broad/Narrow structure of Library and Information Science. It helped to get five terms/Fields i.e.,

a. Information System.
b. Digital Library.
c. Library Automation.
d. Library Services.
e. Librarianship.

These terms were then browsed in "LC list of subject Headings" which provided many other related terms (RT) and Narrow terms (NT). Further NT and RT attached to each other preferred or standard terms were also browsed which retrieve a large number of Library and Information Science terms. At first instance 140 Library and Information Science related terms were identified.

Some terms occurred more than once and duplication removed. It reduced the number to 100. Later terms were divided into three broad groups under:

a) Application. b) Transformation. c) Inter-relation.

"Application" denotes utility of Library and Information science in various fields and about 50 terms came under this group. "Transformation" refers to a method of developing or manufacturing library services into practical market and 30 terms fall under this group. "Inter-relation" means transformation/dependence of one subject onto another and 20 terms came under this group.

Further each category is sub-divided into groups. "Application" into four i.e., "Reference service", "Informatics", "Information Retrieval" & "Information Sources". "Transformation" into two i.e., "Digitization" & "Consortia". "Inter-relation" into two i.e., "Library Network" & "Information System".

The terms in each group were arranged alphabetically and each term was given a tag. Later 19% of the terms were selected from each group using "Systematic Sampling" (i.e., first item selected randomly and next item after specific intervals). It further reduced the number to 19. Finally the selected terms were classified into three groups under "Simple", "Compound" & "Complex Terms" (Table:-1.0). This was done in order to investigate how search engines control and handle simple and phrased terms.

"Simple Terms" containing a single word were submitted to the search engine in the natural form i.e., without punctuating marks. "Compound Terms" consisting of two words were submitted to the search engines in the form of phrases as suggested by respective search engines and "Complex Terms" composed of more than two words or phrases, were sent to the search engine with suitable Boolean operator "AND" & "OR" between the terms to perform special searches. From the Simple terms the 3rd Keyword "Dublincore" was taken for the study as the other keywords are already taken for other studies.

S. No	Simple terms	Compound Terms	Complex Terms
1	Catchwork	Bibliometric Classification	Digital Library Open Source Software
2	Citation	Citation Analysis	Health Information System
3	Dublincore	Comparative Librarianship	Library Information System
4	Indexing	Digital Preservation	Library Information Network
5	Manuscript	Electronic Repositories	Multimedia Information Retrieval
6	Plagiarism	Library Automation	
7	Reprints	Semantic web	

Table 1.0: Keywords

5. Fluctuation

As document are being added and removed on the web, the information is growing and changing consistently. These quantitative and qualitative changes are expressed as fluctuations. The quantitative changes are expressed as "Result Fluctuations" and the qualitative changes are expressed as "Document" and "Indexing Fluctuations". A fluctuation may show decrease or increase in number of documents. However, growth in size of the database is a continuous and usual routine of the search engines. Thus increase and decrease is taken into account here.

A "Result Fluctuation" appears when a search engine show increase/decrease in total number of results for a query that is searched at two different intervals of time. In other words the total number of results retrieved for a query in second observation may be less as retrieved in the first observation. Thus result fluctuation appears when there is increase/decrease in the number of results for a query tested over time i.e., the number of results in succeeding observation may be more or less than the results of the preceding observation.

5.1 Forecasting of Result Fluctuation

A forecast is an estimate of a future event achieved by systematically combining and casting forward in predetermined way from the data about the past. It is simply a statement about the future prediction. Forecasts are possible only when a history of data exists. The study collected 100 days of data samples from four search engine out of seven as result-counter was available with Google, Bing, Yahoo and Baidu. The data collection was carried on 15th May, 2016 and ended on 18th of August, 2016 collecting 100 samples for keyword "Dublincore" in four search engines Table:-1.1.

For forecasting process few points were taken into consideration as:

1) Fluctuation of search results and sustainability
2) 100 days of data sampling were taken into consideration (Table:- 1.1).
3) As the data is seasonal, Trend Projection Method was taken into consideration.
4) Total results were taken from result search counter of search engine.
5) A forecast of 50 days was generated (Table:-1.2).
6) The results were evaluated on a scattered graph with regression line

Table 1.1:- Time series data for forecasting of Select Search engines for the keyword "*Dublincore*"

	Google			Bing			Yahoo!			Baidu		
Days (t)	**Result (Y_t)**	**Multiplication of Days and Results (tY_t)**	**Square of Days $(t)^2$**	**Result (Y_t)**	**Multiplication of Days and Results (tY_t)**	**Square of Days $(t)^2$**	**Result (Y_t)**	**Multiplication of Days and Results (tY_t)**	**Square of Days $(t)^2$**	**Result (Y_t)**	**Multiplication of Days and Results (tY_t)**	**Square of Days $(t)^2$**
1	8950000	8950000	1	486000	486000	1	879000	879000	1	790000	790000	1
2	8960000	17920000	4	480000	960000	4	878000	1756000	4	790000	1580000	4
3	8970000	26910000	9	471000	1413000	9	878000	2634000	9	790000	2370000	9
4	8980000	35920000	16	463000	1852000	16	878000	3512000	16	790000	3160000	16
5	8980000	44900000	25	463000	2315000	25	878000	4390000	25	790000	3950000	25
6	8930000	53580000	36	453000	2718000	36	877000	5262000	36	722000	4332000	36
7	8950000	62650000	49	453000	3171000	49	870000	6090000	49	722000	5054000	49
8	8960000	71680000	64	452000	3616000	64	870000	6960000	64	722000	5776000	64
9	8980000	80820000	81	446000	4014000	81	869000	7821000	81	722000	6498000	81
10	9030000	90300000	100	457000	4570000	100	863000	8630000	100	722000	7220000	100
11	9010000	99110000	121	457000	5027000	121	862000	9482000	121	779000	8569000	121
12	9020000	108240000	144	457000	5484000	144	863000	10356000	144	779000	9348000	144
13	9000000	117000000	169	451000	5863000	169	864000	11232000	169	779000	10127000	169
14	8930000	125020000	196	441000	6174000	196	867000	12138000	196	772000	10808000	196
15	8930000	133950000	225	441000	6615000	225	864000	12960000	225	772000	11580000	225
16	8760000	140160000	256	435000	6960000	256	854000	13664000	256	751000	12016000	256
17	8760000	148920000	289	435000	7395000	289	854000	14518000	289	751000	12767000	289
18	8680000	156240000	324	421000	7578000	324	856000	15408000	324	752000	13536000	324
19	8720000	165680000	361	417000	7923000	361	854000	16226000	361	752000	14288000	361
20	8760000	175200000	400	435000	8700000	400	854000	17080000	400	751000	15020000	400
21	8590000	180390000	441	432000	9072000	441	851000	17871000	441	706000	14826000	441
22	8540000	187880000	484	432000	9504000	484	845000	18590000	484	706000	15532000	484
23	9000000	207000000	529	451000	10373000	529	864000	19872000	529	779000	17917000	529
24	8930000	214320000	576	441000	10584000	576	867000	20808000	576	772000	18528000	576
25	8490000	212250000	625	429000	10725000	625	853000	21325000	625	723000	18075000	625
26	8450000	219700000	676	440000	11440000	676	857000	22282000	676	723000	18798000	676
27	8460000	228420000	729	440000	11880000	729	857000	23139000	729	723000	19521000	729
28	8350000	233800000	784	449000	12572000	784	853000	23884000	784	742000	20776000	784
29	8410000	243890000	841	461000	13369000	841	858000	24882000	841	742000	21518000	841
30	8380000	251400000	900	462000	13860000	900	860000	25800000	900	742000	22260000	900
31	8390000	260090000	961	456000	14136000	961	859000	26629000	961	799000	24769000	961

32	8450000	270400000	1024	440000	14080000	1024	857000	27424000	1024	723000	23136000	1024
33	8460000	279180000	1089	440000	14520000	1089	857000	28281000	1089	723000	23859000	1089
34	8350000	283900000	1156	449000	15266000	1156	853000	29002000	1156	742000	25228000	1156
35	8330000	291550000	1225	456000	15960000	1225	858000	30030000	1225	790000	27650000	1225
36	8330000	299880000	1296	449000	16164000	1296	856000	30816000	1296	790000	28440000	1296
37	8330000	308210000	1369	449000	16613000	1369	856000	31672000	1369	790000	29230000	1369
38	8330000	316540000	1444	455000	17290000	1444	853000	32414000	1444	791000	30058000	1444
39	8330000	324870000	1521	453000	17667000	1521	855000	33345000	1521	791000	30849000	1521
40	8320000	332800000	1600	464000	18560000	1600	856000	34240000	1600	791000	31640000	1600
41	8330000	341530000	1681	456000	18696000	1681	858000	35178000	1681	790000	32390000	1681
42	8330000	349860000	1764	449000	18858000	1764	856000	35952000	1764	790000	33180000	1764
43	8330000	358190000	1849	449000	19307000	1849	856000	36808000	1849	790000	33970000	1849
44	8200000	360800000	1936	482000	21208000	1936	860000	37840000	1936	733000	32252000	1936
45	8100000	364500000	2025	492000	22140000	2025	863000	38835000	2025	733000	32985000	2025
46	8090000	372140000	2116	491000	22586000	2116	865000	39790000	2116	734000	33764000	2116
47	8100000	380700000	2209	492000	23124000	2209	863000	40561000	2209	733000	34451000	2209
48	8020000	384960000	2304	492000	23616000	2304	860000	41280000	2304	734000	35232000	2304
49	8020000	392980000	2401	510000	24990000	2401	863000	42287000	2401	746000	36554000	2401
50	7990000	399500000	2500	509000	25450000	2500	860000	43000000	2500	746000	37300000	2500
51	7950000	405450000	2601	509000	25959000	2601	855000	43605000	2601	746000	38046000	2601
52	7930000	412360000	2704	514000	26728000	2704	859000	44668000	2704	753000	39156000	2704
53	7950000	421350000	2809	509000	26977000	2809	855000	45315000	2809	746000	39538000	2809
54	7850000	423900000	2916	514000	27756000	2916	864000	46656000	2916	753000	40662000	2916
55	7850000	431750000	3025	514000	28270000	3025	862000	47410000	3025	700000	38500000	3025
56	7850000	439600000	3136	514000	28784000	3136	861000	48216000	3136	700000	39200000	3136
57	7820000	445740000	3249	514000	29298000	3249	861000	49077000	3249	700000	39900000	3249
58	7820000	453560000	3364	536000	31088000	3364	862000	49996000	3364	691000	40078000	3364
59	7790000	459610000	3481	532000	31388000	3481	863000	50917000	3481	691000	40769000	3481
60	7770000	466200000	3600	532000	31920000	3600	867000	52020000	3600	651000	39060000	3600
61	7730000	471530000	3721	530000	32330000	3721	867000	52887000	3721	651000	39711000	3721
62	7710000	478020000	3844	538000	33356000	3844	869000	53878000	3844	651000	40362000	3844
63	7670000	483210000	3969	537000	33831000	3969	870000	54810000	3969	670000	42210000	3969
64	7650000	489600000	4096	536000	34304000	4096	870000	55680000	4096	677000	43328000	4096
65	7580000	492700000	4225	536000	34840000	4225	566000	36790000	4225	677000	44005000	4225
66	7290000	481140000	4356	527000	34782000	4356	570000	37620000	4356	677000	44682000	4356
67	6410000	429470000	4489	527000	35309000	4489	570000	38190000	4489	658000	44086000	4489
68	5740000	390320000	4624	535000	36380000	4624	562000	38216000	4624	659000	44812000	4624
69	4940000	340860000	4761	535000	36915000	4761	562000	38778000	4761	659000	45471000	4761
70	5050000	353500000	4900	570000	39900000	4900	562000	39340000	4900	686000	48020000	4900
71	4160000	295360000	5041	572000	40612000	5041	562000	39902000	5041	686000	48706000	5041

72	5030000	362160000	5184	581000	41832000	5184	562000	40464000	5184	663000	47736000	5184
73	4870000	355510000	5329	581000	42413000	5329	562000	41026000	5329	663000	48399000	5329
74	4870000	360380000	5476	581000	42994000	5476	556000	41144000	5476	663000	49062000	5476
75	5090000	381750000	5625	582000	43650000	5625	556000	41700000	5625	663000	49725000	5625
76	4850000	368600000	5776	584000	44384000	5776	556000	42256000	5776	652000	49552000	5776
77	4850000	373450000	5929	584000	44968000	5929	556000	42812000	5929	652000	50204000	5929
78	4850000	378300000	6084	593000	46254000	6084	556000	43368000	6084	603000	47034000	6084
79	4850000	383150000	6241	585000	46215000	6241	868000	68572000	6241	613000	48427000	6241
80	4850000	388000000	6400	593000	47440000	6400	556000	44480000	6400	603000	48240000	6400
81	7240000	586440000	6561	581000	47061000	6561	556000	45036000	6561	613000	49653000	6561
82	7240000	593680000	6724	586000	48052000	6724	826000	67732000	6724	613000	50266000	6724
83	7240000	600920000	6889	593000	49219000	6889	556000	46148000	6889	603000	50049000	6889
84	7240000	608160000	7056	581000	48804000	7056	556000	46704000	7056	613000	51492000	7056
85	7240000	615400000	7225	582000	49470000	7225	842000	71570000	7225	545000	46325000	7225
86	7230000	621780000	7396	585000	50310000	7396	843000	72498000	7396	545000	46870000	7396
87	7240000	629880000	7569	578000	50286000	7569	573000	49851000	7569	543000	47241000	7569
88	7210000	634480000	7744	578000	50864000	7744	838000	73744000	7744	543000	47784000	7744
89	7180000	639020000	7921	583000	51887000	7921	587000	52243000	7921	543000	48327000	7921
90	7180000	646200000	8100	583000	52470000	8100	836000	75240000	8100	547000	49230000	8100
91	7120000	647920000	8281	583000	53053000	8281	835000	75985000	8281	547000	49777000	8281
92	7100000	653200000	8464	570000	52440000	8464	837000	77004000	8464	547000	50324000	8464
93	7100000	660300000	8649	572000	53196000	8649	837000	77841000	8649	539000	50127000	8649
94	7100000	667400000	8836	570000	53580000	8836	837000	78678000	8836	547000	51418000	8836
95	7100000	674500000	9025	568000	53960000	9025	838000	79610000	9025	539000	51205000	9025
96	7150000	686400000	9216	569000	54624000	9216	837000	80352000	9216	580000	55680000	9216
97	7150000	693550000	9409	554000	53738000	9409	834000	80898000	9409	580000	56260000	9409
98	7160000	701680000	9604	554000	54292000	9604	834000	81732000	9604	581000	56938000	9604
99	7180000	710820000	9801	561000	55539000	9801	834000	82566000	9801	581000	57519000	9801
100	7190000	719000000	10000	549000	54900000	10000	833000	83300000	10000	574000	57400000	10000
$\sum t$	**$\sum(Y_t)$**	**$\sum tY_t$**	**$\sum(t)^2$**	**$\sum(Y_t)$**	**$\sum tY_t$**	**$\sum(t)^2$**	**$\sum(Y_t)$**	**$\sum tY_t$**	**$\sum(t)^2$**	**$\sum(Y_t)$**	**$\sum tY_t$**	**$\sum(t)^2$**
5050	**767200000**	**36122040000**	**338350**	**50659000**	**2705066000**	**338350**	**79797000**	**3863360000**	**338350**	**69395000**	**3306043000**	**338350**

Time-series forecasting method fits a trend line to a series of historical data points and then projects the line into the future for medium- to long range forecasts. The research has described the trend component with a line visually to a set of points on a graph. The graph, however, is subject to slightly different interpretations. There are three types of trend projection viz.,

a. Positive Secular Trend or Upward Secular Trend:- it describes the data into a upward or raising trend line.
b. Negative Secular Trend or Downward Secular Trend:- it describes the data into lowering trend line
c. Neutral Secular Trend or Straight Secular Trend:- no changes the data is consistent.

For the study 400 samples were taken into account to generate 200 results of projected data which are described in graphs.

The formula derived for the study is:-

$tt=b0 + b1t$

b0 and b1 can be derived as:

$b0 = \bar{y} - b1\bar{t}$

$$b1 = \frac{n\Sigma ty_t - \Sigma t\Sigma y_t}{n\Sigma t^2 - (\Sigma t)^2}$$

Where

t = days

y_t = Result of the search query

The projected result Table 1.2, shows a vast fluctuation both in terms of positive Secular trend and negative secular trend. The estimate is given by a trending line.

Table 1.2:- Projected data using trend projection method for 50 days for the keyword "*Dublincore*"

Days	Google	Bing	Yahoo!	Baidu
1	6083176	595552	697128	573705
2	6014326	600488	692757	568480
3	5944327	605508	688276	563150
4	5873178	610536	683704	557711
5	5800885	615573	679037	552163
6	5727214	620790	674274	546501
7	5650927	625953	669388	539074
8	5573555	631283	664224	531327
9	5494879	636762	658931	523243
10	5415162	642263	653481	514806
11	5335246	648223	647731	505996
12	5253382	654393	641790	498350
13	5170311	660781	635704	490479
14	5085196	667225	629471	482374
15	4996483	673597	623146	473821
16	4905946	680162	616556	464991

17	4808395	686746	609471	455236
18	4708339	693518	602150	445106
19	4603175	700044	594647	434614
20	4496331	706592	586831	423712
21	4387871	713870	578747	412349
22	4270867	721259	570284	399032
23	4148535	728856	561315	385066
24	4038119	737326	552661	372934
25	3922928	745743	543831	360123
26	3789356	754004	534218	345077
27	3649803	762901	524400	329322
28	3505723	772087	514230	312821
29	3352429	781914	503543	296245
30	3195632	792554	492644	278916
31	3031856	803658	481422	260795
32	2862241	814975	469749	244081
33	2688527	826099	457562	223701
34	2508670	837620	444908	202313
35	2317451	849927	431601	180643
36	2117701	863004	417969	159940
37	1909756	876320	403715	138370
38	1693178	890167	388886	115884
39	1467502	904834	373320	92476
40	1232229	920031	357190	68055
41	986382	936363	340427	42563
42	730247	953066	323044	15895
43	462813	970182	304829	-11974
44	183436	988036	285823	-41113
45	-114721	1008232	266169	-74291
46	-431752	1029914	245796	-109207
47	-764761	1052673	224625	-145922
48	-1113780	1076672	202420	-184647
49	-1484240	1101945	179063	-225413
50	-1873726	1129477	154779	-267797

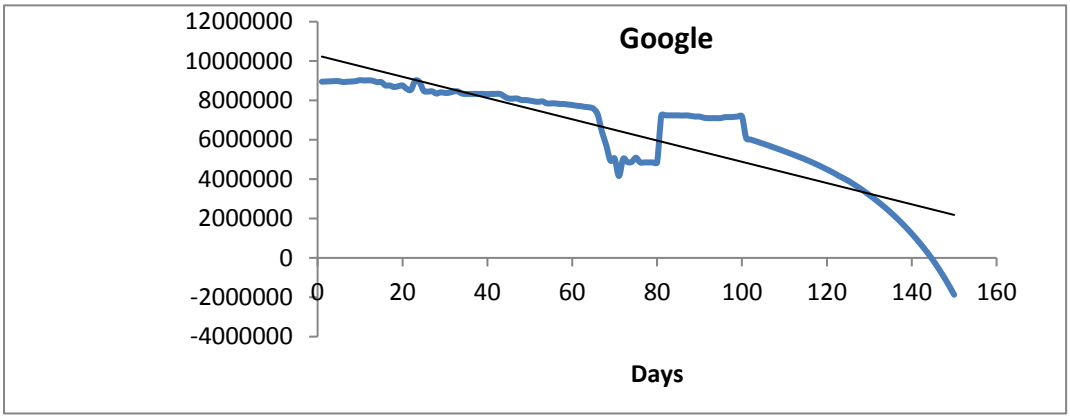

Fig 1.3:- Negative Secular Trend of Google for the keyword "Dublincore"

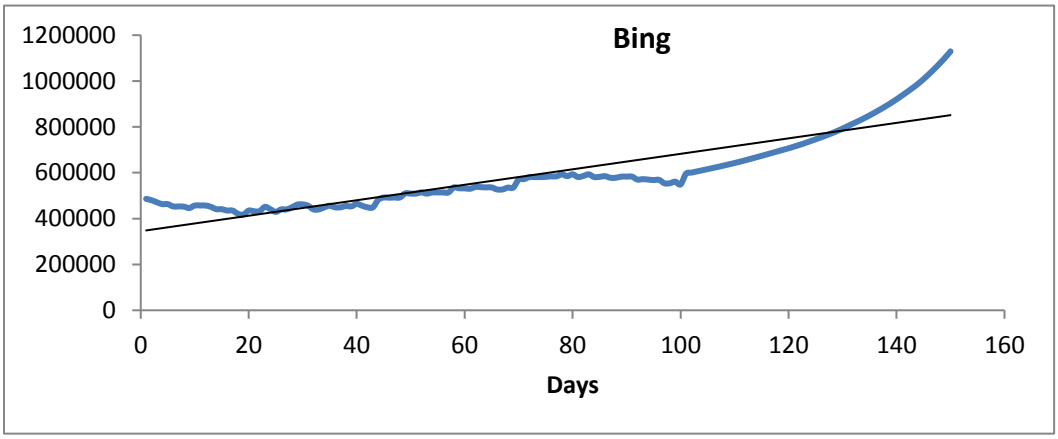

Fig 1.4:- Negative Secular Trend of Bing for the keyword "Dublincore"

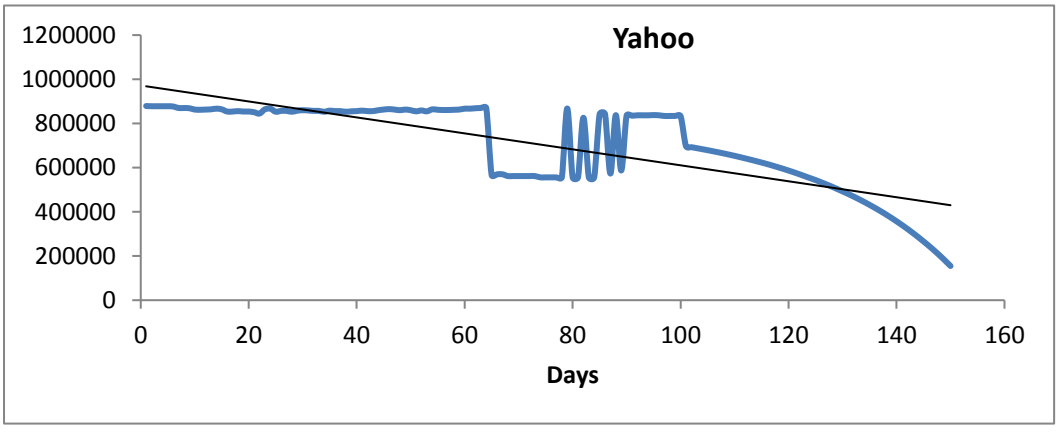

Fig 1.5:- Straight Secular Trend of Yahoo! for the keyword "Dublincore"

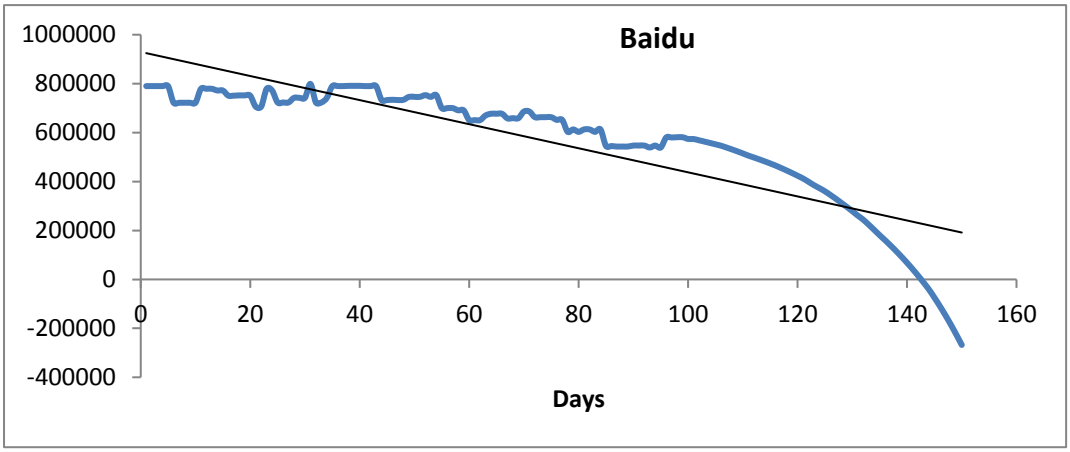

Fig 1.6:- Positive Secular Trend of Baidu for the keyword "*Dublincore*"

6. Conclusion

The trending of the search engines reveal that Google shows negative secular trend while Yahoo! also shows negative secular trend. Bing Shows an upward or positive secular trend, Baidu on the other hand also shows a negative secular trend. The data forecasted show a consistent growth in the database of Bing in terms of result fluctuation. Google, Yahoo! and Baidu drops down showing down secular trending resulting in loss in database.

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