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OVERLAPPING, PRECISION AND RELATIVE RECALL  
OF SEARCH ENGINES: A COMPARATIVE STUDY OF SEARCH ENGINES  
WITH META SEARCH ENGINES IN THE FIELD OF MEDICAL  
TOURISM IN KERALA

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**ABSTRACT**

This paper presents a webometric study on six search engines. The search engines namely, Bing , Google and Lycos and metasearch engines namely lxquick, Dogpile and Webcrawler are taken together to find out the extent of overlapping, precision and relative recall among them in the field of Medical Tourism in Kerala in which web resources are the only reliable information sources due to the multidisciplinary nature of Tourism. From this study it is revealed that Bing stands high in overlapping, precision and

relative recall and metasearch engines show precision in similar range and low level relative recall in comparison with search engines.

**KEYWORDS** :webometrics, Search engines, overlap, precision, Relative recall.

**INTRODUCTION**

In this technological era, internet is the information superhighway and World Wide Web is one of the most popular internet services. It is a collection of websites and a network of web pages. These pages are the entities of information on the web. This is the information store of the internet. There are certain tools used to search information from the World wide web. They are called search engines. They search through all the web sites and create an index of the information of the web sites.



E.g.:-, Google, Lycos, Bing etc. Quantitative analysis of the World Wide Web is named as webometrics by Almind and Ingwersen (1997). Webometrics is defined by Bojorneborne and Ingwersen (2004), as the study of the quantitative aspects of the construction and use of information resources and technologies on the web, drawing on bibliometrics and informetric approaches. In short webometrics is concerned with measuring aspects of the web: domain, web sites, web pages, words in web pages, links, web search engine results and web impact factor (Jeyshankar, 2011). Webometric research has fallen into two main categories namely link analysis and search engine evaluation. Search engines are also used to collect data for link analysis.

There are some other tools called metasearch engines which search, collect and index the results from several other search engines and/or databases and aggregate and display the results into a single list. These search tools search through all the web sites and create an index of the information of the web sites with keywords and display them in a search engine result page (SERP). The SERP includes hyperlinks and brief description of the contents found. This study deals with the quantitative analysis and comparison of six search engines, of these three are metasearch engines, in terms of their overlapping, precision and relative recall in the field of Medical Tourism in Kerala.

### **MEDICAL TOURISM IN KERALA**

Medical tourism is any kind of travel to make a person or a member of his family healthier. It can be broadly defined as provision of 'cost effective' private medical care in collaboration with the tourism industry for patients needing surgical care and other forms. Kerala, the God's own country has become one of the leading medical tourism destinations of India and is marketed for its Allopathy, Ayurveda and Dental packages. There are a number of speciality hospitals in Kerala that offer specialized care for complex medical conditions. Patients from all over the world are becoming medical tourist in Kerala for low cost and health restorative alternative treatments. Many of the hospitals offer a complete package that includes consultancy with a medical specialist, diagnosis, appropriate medical treatment, pre and post operative care etc.

The Confederation of Indian Industry (CII) has declared 2006-2007 as Medical Tourism Year in Kerala and they organized an International conference and exhibition on Health tourism in 2013 at Kochi, Kerala. According to the CII-Mc Kinsy report medical tourism industry in Kerala is expected to be worth \$4 billion by 2017.

Kerala is also known as land of Ayurveda for its traditional medicines which aim at providing rejuvenation, longevity and relaxation to stressed and strained. More over Kerala has a potential to attract tourists around the world due to its cultural diversity, perfect beaches and fabulous cuisine mixed with a pinch of oriental mysticism.

Medical tourism is a combination of various components like airlines, hotels, resorts, travel companies and agencies, transportation, food outlets, a number of best hospitals, their infrastructure facilities, medical treatments and human resources. But printed documents and other reference sources are very rare in this topic. Nascent information in primary sources are scattered in the journals of various disciplines like tourism, medicine, business, economics, management etc. due to its multidisciplinary nature.

But there are a number of information sources in the World Wide Web on medical tourism in Kerala. They are essential to plan, organize and to manage medical tourism packages. So this study is to conduct a webometric study on the topic Medical Tourism in Kerala using six search engines to evaluate their retrieval efficiency in terms of their overlap, precision and relative recall.

### **REVIEW OF RELATED STUDIES**

The review of literature revealed that a number of studies are going on to analyse the capabilities of search engines in terms of overlap, precision and recall. The best search engine for one subject field may not be the best in other subject area. Research on web search engines have evolved as an important area of web research since the mid 1990s. Bharat and Border (1998) measured overlap among websites indexed by Hotbot, Altavista, Excite, and Infoseek using 10,000 queries carried out at two different intervals of time in June 1999 and November 1999, and found that the overlap was very small, less than 1.4 percent of the total coverage. Chignell, Gwizdka, and Bonder (1999) found little

overlap in the results returned by various search engines and describe meta-search engines as useful. Ding and Marchionini (1996) studied Infoseek, Lycos and Open Text for precision, duplication and degree of overlap using five complex queries. The first twenty hits assessed for precision show that the best results are obtained from Lycos and Open Text. Leighton and Srivastava (1997) searched fifteen queries on AltaVista, Excite, HotBot, Infoseek and Lycos taking the first twenty hits for evaluation of precision. Chu and Rosenthal (1996) have investigated AltaVista, Excite and Lycos for their search capabilities and precision. The authors have used ten search queries of varying complexity by evaluating the first ten results for relevance assessment and revealed that AltaVista outperformed, and Excite and Lycos both in search facilities and retrieval performance.

Clarke and Willett (1997) searched thirty queries of varying nature on AltaVista, Excite and Lycos and obtained best results in terms of precision, recall and coverage from AltaVista. Bar-Ilan (1998) investigated six search engines using a single query "Erdos". All 6,681 retrieved hits examined for precision, overlap and an estimated recall report that no search engine has high recall. Bar-Ilan (2005) discusses a statistical comparison of overlap in web search engines. Shafi and Rather (2005) studied precision and recall of five search engines in the field of Biotechnology in retrieving scholarly information and found out Scirus, the special search engine for Science and Technology is most comprehensive in retrieval. Bar-Yossef and Gurevich (2006) discuss methods for comparing web search engine indexes. Isfandyari Moghaddam (2006) carried out a comparative study on overlapping of search results in meta search engines and their three common underlying search engines. Therefore, the performance capabilities and limitations of web search engines, and the differences between them, is an important and significant research area (Spink et al., 2006).

Rather, Lone and Shah (2008) conducted a study of five search engines in terms of their overlap in web search results and found out overlapping is comparatively greater between Alta Vista and Hot Bot. Mohammadesmaeil, Lafzighazi and Gilvari (2008), carried out a study entitled: "Comparing Search Engines and Meta Search Engines in Pharmaceutic Information Retrieval and findings showed that Yahoo retrieved the most pharmaceutic documents and scored the highest rank (34%). AOL had (62%) precision and (21%) recall and retrieved the most relevant pharmaceutic documents. Dogpile retrieved the most pharmaceutic documents and scored the highest rank(22%), followed by Metacrawler(21%) and Info(19%). Excite had (62%) precision and (22%) recall and retrieved the most relevant pharmaceutic documents. Finally researchers concluded that, search engines and meta search engines are suitable tools for amateur or professional users and they have suitable search capabilities and facilities. Sampath Kumar and Prakash (2009) conducted a study on Google and Yahoo and found out precision and relative recall varies with the nature of queries, that is the results varies with simple one word, multiword and complex multi word queries.

Thanuskodi (2011) conducted a study on webometrics analysis which calculated and compared the number of web pages, in links, external in links and also the overall and absolute WIF of private engineering colleges in Tamil Nadu. The study covered the active exclusive websites, compared and then ranked these universities according to webometric indicators. The study used AltaVista because of its ability to cover a broader range of the web as opposed to the other commercial search engines. Sampath Kumar and Pavithra (2010) studied the searching capabilities of search engines and meta search engines and found that search engines did not achieve higher precision than the meta search engines. Mohammadesmaeil and Mansoorkiaei (2010), carried out a study entitled: "Comparing search engines and meta search engines in physics Information Retrieval. Results show that in search engines yahoo retrieved the most physics documents and scored the highest rank (40%) and Also AOL had 38.57% overlap with other search engines. In Meta search engines curry guide retrieved the most

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physics documents and scored the highest rank (77.1). Also info had 43.7% overlap with other Meta search engines.

Mohammadesmaeil and Ghaffari (2012), carried out a study entitled: "Precision in General Search Engines for agricultural Information Retrieval: An Experience by an Iranian Librarian in Response Queries. The objective of that research was measure the relevance of documents retrieved from search engines and meta search engines in the field of agriculture. Mohammadesmaeil (2014) carried out a study for assessing the recall, precision and overlap in search engines in the field of nuclear physics information retrieval using google, yahoo, AOL, Alta vista and ASK and found out AOL had highest precision and recall and Yahoo with highest overlap with other search engines. Thanuskodi (2013) worked on the websites of some Institutes, which is of national importance in India. The study showed that only a few websites were up to date and that webometric techniques are in their early phases.

### OBJECTIVES

- \* To find out the extent of overlapping among the search engines.
- \* To analyze the percentage of unique sites in each search engine.
- \* To assess the precision and relative recall of the selected search engines.
- \* To compare the search engines with meta search engines in terms of their overlapping, precision and relative recall in the topic medical tourism in Kerala.

### METHODOLOGY

After reviewing related literature on search engine studies six search tools and five different components on the topic medical tourism in Kerala were selected and the study was conducted from 10 to 30 January 2015. Results for each query from all search engines were collected simultaneously. The first 100 hits from each SERP for each search query were considered as the research population and the research elements are as listed below.

Search engines:- Bing, Google and Lycos.

Meta search engines:- Dogpile, Ixquick and Webcrawler.

Search queries :- Q1. Medical tourism in Kerala, Q2. Ayurveda tourism in Kerala, Q3 Dental tourism in Kerala, Q4. Speciality hospitals in Kerala and Q5. Cost of surgery in Kerala.

### OVERLAPPING OF SEARCH RESULTS

Overlapping of search engines means occurrence of same sites between or among the selected search engines. Number of overlapping sites for each query is calculated separately and the percentage of average overlapping is considered as the extend of overlapping of search engines in the field of Medical Tourism in Kerala. In this study the overlapping results retrieved by search engines are considered as set of results and is represented by intersection ( ) and search engines are represented by their first letter. That is B G means a set of same websites retrieved by Bing and Google. All possible combinations are studied and shown in tables 1-4. Representations in histogram are shown with tables 1 and 3.

### OVERLAPPING BETWEEN TWO SEARCH ENGINES

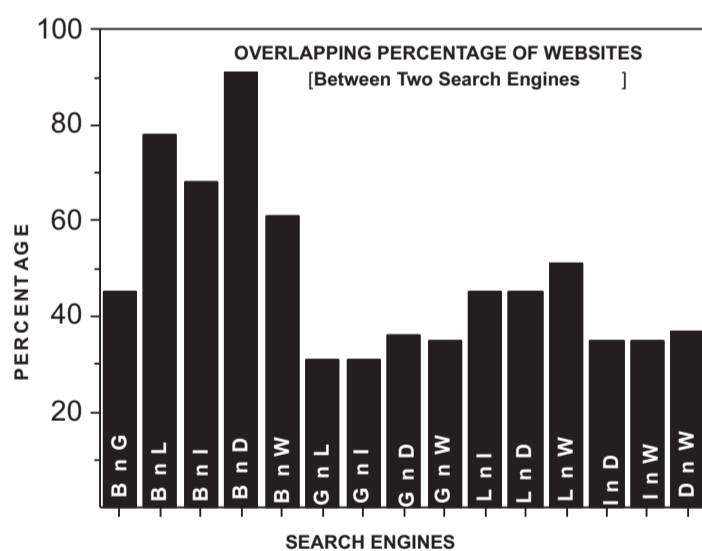
Analysis of the overlap between 2 search engines shows that highest overlapping is between Bing and Dogpile (91%), followed by Bing and Lycos (78%) and Bing and Ixquick (68%). Lowest overlapping (31%) is seen in 2 pairs, between Google and Lycos and Google and Ixquick. On analysis, it is

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found that the average overlapping of Bing is 68.6% with all other search engines and that of lycos is 50%, Dogpile with 48.4%, Webcrawler with 44.3%, Ixquick with 44% and Google with 35.6%. In short the Bing shows the highest, followed by Lycos in second position and Google shows least overlapping with all other search engines and metasearch engines. The results are represented in Table 1 with Figure 1.

**Table 1: Overlapping between two search engines.**

SET	No. of common sites for 5 queries in 500 sites	Percentage of overlap
B n G	225	45
B n L	390	78
B n I	340	68
B n D	455	91
B n W	305	61
G n L	155	31
G n I	155	31
G n D	180	36
G n W	175	35
L n I	225	45
L n D	225	45
L n W	255	51
I n D	175	35
I n W	175	35
D n W	185	37



**Figure 1: Overlapping between two Search Engines**

**Overlapping between three search engines**

On considering overlap between 3 search engines there are 19 possible sets and overlapping ranges from 18-42%. Bing, Lycos and Dogpile shows 42% of same results and least overlapping is between Google, Dogpile and Webcrawler with 18% and all results are shown in Table 2 .

**Table 2: Overlapping between three search engines**

SET	No. of common sites for 5 queries in 500 sites	Percentage of Overlap
B n G n L	135	27
B n G n I	120	24
B n G n D	175	35
B n G n W	120	24
B n L n I	165	33
B n L n D	210	42
B n L n W	185	37
B n I n D	160	32
B n I n W	130	26
B n D n W	170	34
G n L n I	110	22
G n L n D	115	23
G n L n W	105	21
G n I n D	95	19
G n I n W	110	22
G n D n W	90	18
L n I n D	120	24
L n I n W	140	28
I n D n W	95	19

**Overlapping between four search engines**

There are fourteen sets with four search engines and overlapping ranges from 15- 18%. All combinations and their corresponding percentages are shown in Table 3 with Figure 2.

**Table 3: Overlapping between four search engines**

SET	No. of common sites for 5 queries in 500 sites	Percentage of overlap
B n G n L n I	140	28
B n G n L n D	105	21
B n G n L n W	90	18
B n G n I n D	95	19
B n G n I n W	85	17
B n G n D n W	90	18
B n L n I n D	125	25
B n L n I n W	115	23
B n L n D n W	130	26
B n I n D n W	100	20
G n L n I n D	75	15
G n L n I n W	75	15
G n L n D n W	80	16
L n I n D n W	85	17



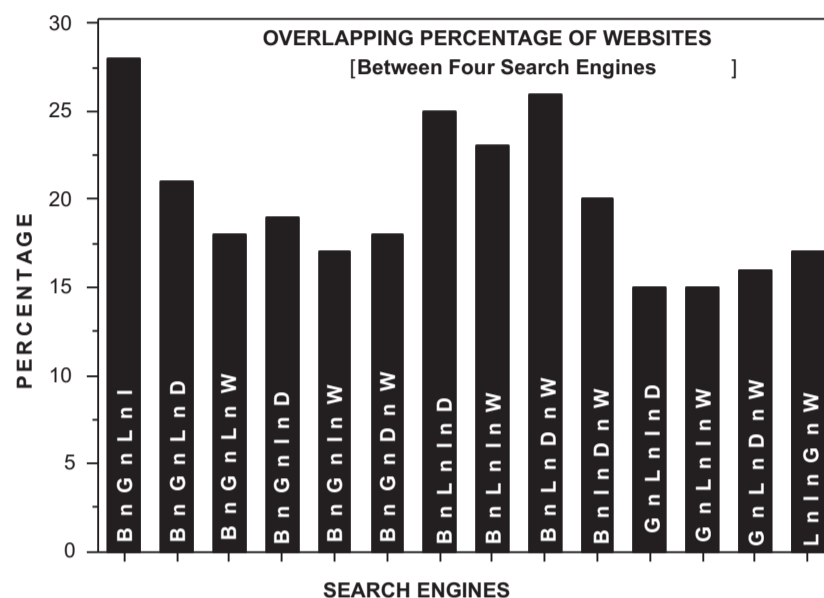


Figure 2: Overlapping between four Search Engines

**Overlapping between fi**

Overlapping among five search engines gives 6 sets of results ranges from 14-15% and shown in Table 4.

**Table 4: Overlapping between five search engines**

SET	No. of common sites for 5 queries in 500 sites	Percentage of overlap
B n G n L n I n D	75	15
B n G n L n I n W	75	15
B n G n L n D n W	70	14
B n G n I n D n W	70	14
B n L n I n D n W	70	14
G n L n I n D n W	70	14

**Overlapping between six search engines**

Analysis of overlapping among all six search engines shows only 13% of common results among them and is represented in the Table 5 below.

**Table 5: Overlapping between six search engines**

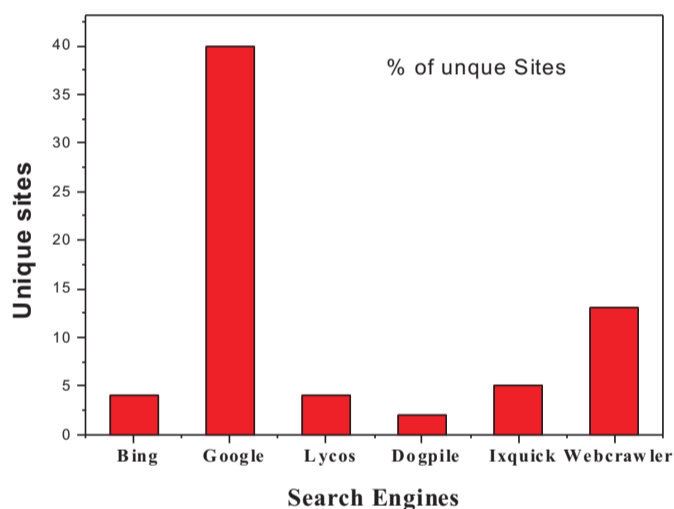
SET	No. of common sites for 5 queries in 500 sites	Percentage of overlap
B n G n L n I n D n W	65	13

**Percentage of unique websites in each search engine**

Analysis of the percentage of unique sites in the selected search engines shows that 40% of the sites retrieved by Google is not shared by any other five search engines followed by Webcrawler with 13%. All others show low percentage of uniqueness as detailed in Table 6 and Figure 3.

**Table 6: Percentage of unique sites**

Search engine	No. of unique sites for 5 queries in 500 sites	Percentage of unique sites
Bing Exactly	20	4
Google Exactly	200	40
Lycos Exactly	20	4
Dogpile Exactly	10	2
Ixquick Exactly	25	5
Webcrawler Exactly	65	13



**Figure 3: Percentage of unique sites in 6 search engines**

In this figure Google stands first with a high margin from the second placed Webcrawler followed by Ixquick and Lycos in third and fourth position respectively and least uniqueness is shown by Bing and Dogpile.

**Precision and Relative Recall of search engines**

Same queries and search engines used for the overlapping studies are considered here for estimating precision and relative recall. Usually SERP contains sites with varied relevance and they can be categorized into more relevant, relevant, less relevant and irrelevant sites. Precision is the fraction of a search output that is relevant for a particular query. Its calculation, hence, requires knowledge of the relevant and non-relevant sites in the evaluated set of documents (Clarke & Willet, 1997). Thus it is possible to calculate absolute precision of search engines which provide an indication of the relevance

of the system and the precision is defined as:

$$Precision = \frac{\text{Sum of the scores of relevant documents retrieved by a search engine}}{\text{Total number of documents evaluated}}$$

To determine the relevance of each site, a four-point scale was used to calculate precision. In this study the relevance of a site is determined by the point of view of a medical tourist as shown below,

\* A site representing all the details related to the medical tourism sector of the Kerala state is given a score of three.

\* A site representing all the details related to a single hospital or treatment is given a score of two.

\* A site representing articles, news, wikipedia, blogs, you-tube, slideshare and links is given a score of one.

\* A site representing irrelevant, repeated occurrence, can't be access etc is given a score of zero.

Precision of search engines

Precision of six search engines are tabulated separately in Tables 7-12. Each table contains precision values corresponding to the results of all five search queries and the mean precision is shown at the end.

**Table 7: Precision of Bing**

Search queris	Total no. of sites	No. of sites evaluated	More Relevant (3)	Relevant (2)	Less Relevant (1)	Irrelevant (0)	Precision
Q1	7310000	100	35	9	52	4	1.75
Q2	1010000	100	38	12	47	3	1.85
Q3	763000	100	30	35	30	5	2.20
Q4	908000	100	25	32	39	4	1.78
Q5	42500000	100	20	26	45	9	1.57
Mean precision							1.83

**Table 8: Precision of Google**

Search queris	Total no. of sites	No. of sites evaluated	More Relevant (3)	Relevant (2)	Less Relevant (1)	Irrelevant (0)	Precision
Q1	656000	100	20	12	64	4	1.48
Q2	691000	100	30	11	53	6	1.65
Q3	401000	100	28	35	32	5	1.86
Q4	302000	100	22	30	42	6	1.68
Q5	484000	100	21	29	42	8	1.63
Mean precision							1.66

**Table 9: precision of Lycos**

Search queris	Total no. of sites	No. of sites evaluated	More Relevant (3)	Relevant (2)	Less Relevant (1)	Irrelevant (0)	Precision
Q1	2830000	100	33	8	47	12	1.62
Q2	790000	100	37	10	48	5	1.79
Q3	307000	100	30	34	32	4	1.90
Q4	674000	100	26	34	34	6	1.80
Q5	71600000	100	21	28	41	10	1.60
Mean precision							1.74

**Table 10: Precision of Dogpile**

Search queris	Total no. of sites	No. of sites evaluated	More Relevant (3)	Relevant (2)	Less Relevant (1)	Irrelevant (0)	Precision
Q1	260	100	36	10	49	5	1.77
Q2	300	100	38	11	47	4	1.77
Q3	260	100	32	33	33	2	1.95
Q4	270	100	24	35	36	5	1.78
Q5	266	100	23	25	41	11	1.60
Mean precision							1.77

**Table11:: Precision of Ixquick**

Search queris	Total no. of sites	No. of sites evaluated	More Relevant (3)	Relevant (2)	Less Relevant (1)	Irrelevant (0)	Precision
Q1	625014	100	33	11	36	20	1.57
Q2	646508	100	35	9	40	15	1.63
Q3	299132	100	32	28	31	9	1.83
Q4	134022	100	24	31	39	6	1.73
Q5	146757	100	21	25	46	8	1.59
Mean precision							1.67

**Table 12: precision of Webcrawler**

Search queris	Total no. of sites	No. of sites evaluated	More Relevant (3)	Relevant (2)	Less Relevant (1)	Irrelevant (0)	Precision
Q1	370	100	30	10	55	5	1.65
Q2	250	100	35	11	49	4	1.78
Q3	200	100	33	33	30	5	1.93
Q4	200	100	22	35	39	7	1.69
Q5	310	100	23	25	44	8	1.61
Mean precision							1.73

Diagrammatic representation of precision values of 6 search engines for 5 queries is plotted in Figure 4 by a line graph below and shows Bing with comparatively high precision and all others are in almost same range. Search engines and metasearch engines show no distinct variations in their

precision values.

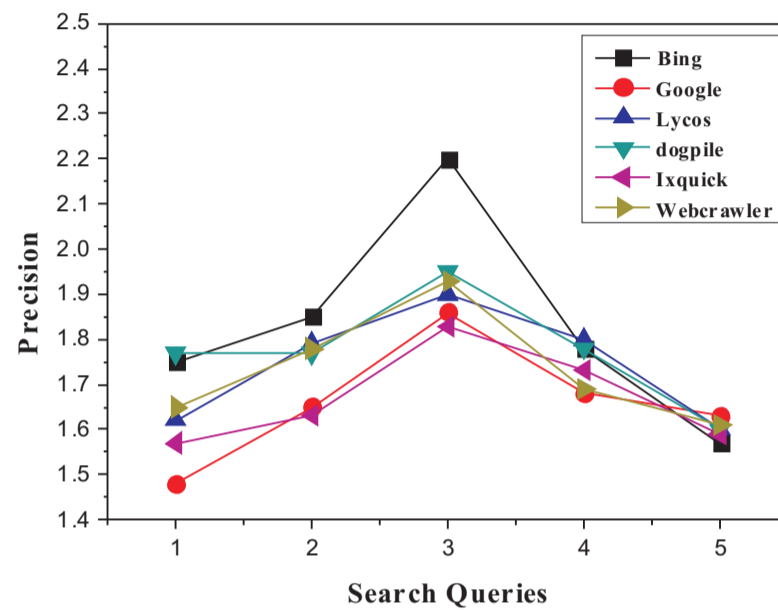


Figure 4: Precision of Search Engines

Figure 5 shows the mean precision values of 6 search engines with Bing in first place, followed by Dogpile in second place. Lycos and Webcrawler are in third and fourth position respectively. Google shows low precision with a slight difference from Ixquick.

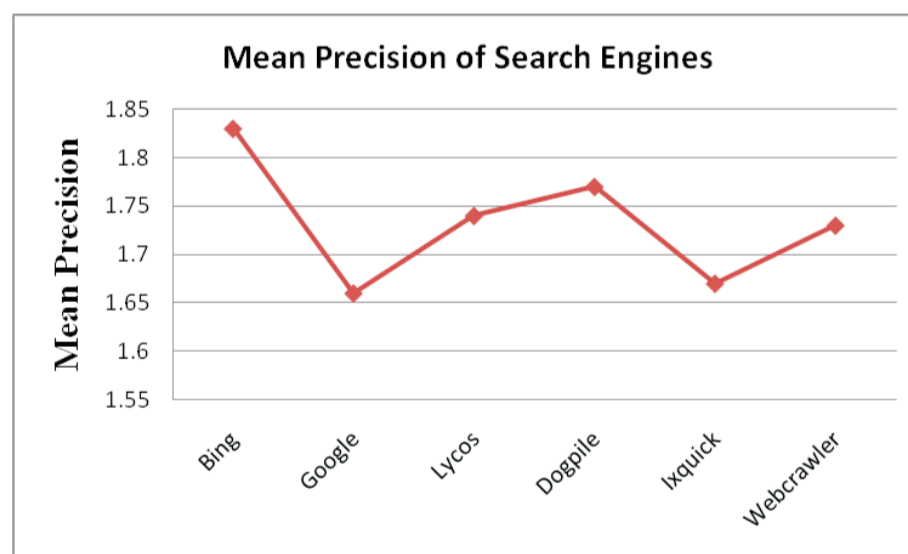


Figure 5: Mean Precision of Search Engines

Analysis of Tables 7-12 revealed that the search engine Bing shows the highest precision 1.83 followed by the metasearch engine Dogpile with precision 1.77. Search engine Lycos and metasearch

**OVERLAPPING, PRECISION AND RELATIVE RECALL OF SEARCH ENGINES: A COMPARATIVE STUDY OF SEARCH...**

engine Webcrawler shows 1.74 and 1.73 respectively, followed by metasearch engine Ixquick with 1.67 and search engine Google shows the least precision 1.66. This study shows that in the case of precision, notable difference is not there between search engines and metasearch engines. Moreover, it is proved from the related studies that precision varies with the structure of queries. Here the in-depth nature of the topic and multi-worded nature of the queries may be the reasons for having the same range of precision for all search engines and metasearch engines. Even though the metasearch engines retrieve less number of results, they attain almost the same precision as that of search engines which retrieve a vast amount of results.

**Relative Recall of search engines**

The recall is the ability of a retrieval system to obtain all or most of the relevant documents in the collection. The relative recall value is thus defined as:

$$\text{Relative Recall} = \frac{\text{Total number of documents retrieved by a search engine}}{\text{Sum of documents retrieved by all six search engines}}$$

The total number of results retrieved by each search engine for a particular query and its relative recall within the bracket in each column, and the mean relative recall of each search engine are represented in Table 13.

**Table 13: shows total no. of sites retrieved for each query with Relative Recall**

Search Queries	Search engines			Meta Search engines		
	Bing	Google	Lycos	Dogpile	Ixquick	Webcrawler
Q1	7310000 (0.64)	656000 (0.05)	2830000 (0.24)	260 (0.00002)	625014 (0.05)	370 (0.00003)
Q2	1010000 (0.32)	691000 (0.22)	790000 (0.25)	300 (0.00009)	646508 (0.20)	250 (0.00007)
Q3	763000 (0.43)	401000 (0.22)	307000 (0.17)	260 (0.0001)	299132 (0.16)	200 (0.00009)
Q4	908000 (0.44)	302000 (0.14)	674000 (0.33)	270 (0.0001)	134022 (0.06)	200 (0.00009)
Q5	4250000 (0.37)	484000 (0.004)	7160000 (0.62)	266 (0.000002)	146757 (0.001)	310 (0.000002)
<b>Mean Relative Recall</b>	<b>(0.44)</b>	<b>(0.12)</b>	<b>(0.32)</b>	<b>(0.00007)</b>	<b>(0.09)</b>	<b>(0.00006)</b>

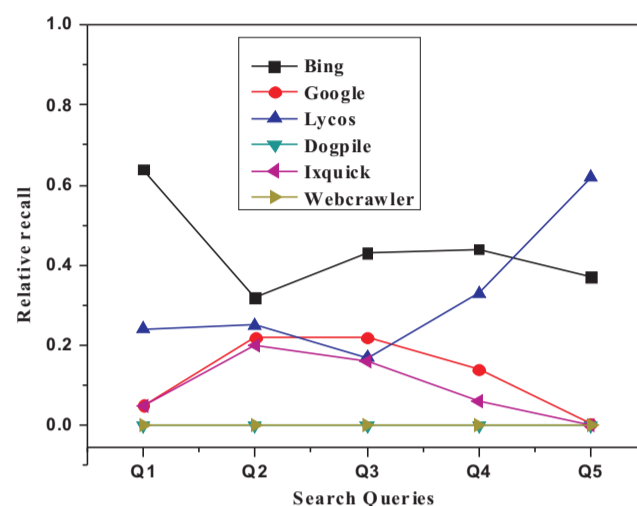


Figure 6: Relative Recall of 6 search engines

Analysis of relative recall values Figure 6 shows that search engine Bing stands first with the mean relative recall 0.44 (44%) followed by Lycos with 0.32 (32%) and Google with 0.12 (12%). Metasearch engines show very low level relative recall. A point to be consider in the case of relative recall is that it is not a constant or permanent value, and it is always related to the other search engines and topics taken for the study. If the metasearch engines are taken separately for a study, they may show high relative recall. It is noted in the figure that Dogpile and Webcrawler are in very low position and plotted together as a single line.

#### FINDINGS

Search engine Bing shows highest average overlapping (68.6%) followed by Lycos (50%), Dogpile (48.4%), Webcrawler (44.3%) and Google shows least overlapping ( 35.6% ) with other five search engines.

Bing stands first in precision and metasearch engine Dogpile stands second followed by Lycos and webcrawler at third and fourth position respectively. Google and Ixquick occupies the last two positions. Precision of search engines and metasearch engines are in the similar range, between 1.83-1.66.

In the case of relative recall also Bing stands first with 44% of total results followed by lycos with 32% and Google with 12%. Relative recall of metasearch engines is found negligible when compared to that of search engines.

Google stands first in the case uniqueness with 40% of unique web sites followed by webcrawler with 13% and Ixquick with 5%. Bing and Lycos show 4% followed by Dodpile with least uniqueness of 2%.

#### CONCLUSION

Today, web searching is a daily behaviour and search engines are the effective tools to access information on any topic. As they retrieve an enormous volume of information, the all results may not be relevant. Even though metasearch engines retrieve less results, the mean precision of them is comparatively equal in this study. Searching capabilities and retrieval effectiveness may differ in

different search engines .This study revealed that Bing is the relevant and relatively efficient search engine in the field of Medical Tourism in Kerala. This findings may not be same for all time due to the dynamic nature of the World Wide Web.

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