

Search Engines and their Role in Retrieval of Digitized Information

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Abstract

This paper presents a review of recent literature related to the retrieval tools used for searching the digitized information on the information Super Highway. Functioning of search engines i.e. methods and techniques for information retrieval are discussed. Emerging areas of web searching along with context of web search are mentioned. The relationship between use of search engines and gender of private university lecturers is looked into. The effects of using search engines on the OPAC users have been explored. The major characteristics, utilization and performance of international and Greek search engines are discussed. Factors that have effect on user evaluation, quality of search results are also presented. An assessment of the performance of three most used search engines is carried out. The performance comparison of major search engines on the basis of locating geographic web services as well as, indexing quality and ranking of XML content objects is made. Demonstration of search engine working in accessing knowledge is outlined by rank correlation analyses impact. The performance comparison of natural language (NL) search engines is accomplished. A technique for comparing search results that are pulled from different sources is described. It is also shown how social search is based on the patterns of web search behavior. In addition, taxonomy of social search and a user-centered social search method is proposed. And the search engine queries that are used to locate topic in an electronic theses and dissertations (ETDs) collection are analyzed. The WAI model is recommended as solution for barriers related to disabled person. The best practices that must be followed by information architects, webmasters, and libraries for effective information retrieval by search engines are also suggested. Recommendations lay importance on organization and classification of content with diversification. Emphasis on designing content oriented websites is made along with, proper use of keyword in content.

Keywords: Search Engines; Digital; Information; Retrieval; Internet; Google.

Introduction

Internet search engines are the most effective and handy retrieval tools to search the information from disparate sources on the worldwide web. Search engines have evolved over time and have become beneficial in learning from research papers, abstracts and citations in any research area. They also help in locating the full text in the library or on the web. Jain and Saraf (2005) have outlined developments of Google search engine since 1999. Their work also

includes features of Google scholar, Google's specific search engine for finding articles and books search on Google. Google search engine is the most popular among all types of users, especially academic users. It is also suggested that librarians ought to play significant role to manage the web resources as well as, assist the users in getting right information.

Definitions of Search Engines

There are many a formal definitions of Search Engines. According to computing Dictionary, "Search engine is a program that allows users to locate specified information from a database or mass of data. Search engines sites are extremely popular on the world wide because they allow users to quickly sift through millions of documents on the internet".

There are many software packages that can be used for development & design of search engine. Many search methodologies can be incorporated into the

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search engine for effective role in retrieval of digitized information. For finding relevant information, every search engine deploys different searching strategies.

The website "Searchtools.com" single-handedly lists more than 170 search tools. From a plethora of search engine software, opting for appropriate search engine software is a bit tough than retrieving relevant information efficiently from websites. Fundamentally, based on these search strategies the three categories of Search engines are:

- Search engines called Crawlers, ants or spiders. These are powered by robots software programs.
- Search engines designed developed and maintained manually. Humans work as editors.
- Search engines Hybrid or mix of the Crawlers and Manual.
- Some authors consider Meta Search Engine as separate from the hybrid category.
- Deep Search Engines/web crawlers/ants/indexes are search engines automatically

Role and Uses of Search Engines in Information Retrieval

Libraries are providing different ICT services such as, e-mail, online retrieval, networking, multimedia and internet so faster access to information can be done (Jadhav, 2011). Out of the online retrieval by using search engines has become quite a pre-dominant one. These search engines deploy various different searching techniques. Michigan Public Health Training Centre proposes that the information searching process i.e. search strategies as the technical methods and practices of identification and significant use of information available on the web. It can be under the four procedures such as:

1. Generation of Index Formulation of optimized Query
2. Fetching up relevant information and
3. Assessment and enhancement

Most search engines display SERPs. For this they employ methods to rank results. SERPs provide the "best" results first out of the millions pages found upon searching. SERPs display methods differ widely as well as, change over time with new techniques. Advertised results are part of SERPs as some search engines like Google are based on clickable advertising revenue.

Relevancy of results is important. Link Analysis and Click-through analysis determine the relevancy of results on SERPs. (*Michigan Public Health Training Centre*) The search engine is the most important tool

for the socio-economic and scientific development. Researchers in every field require delivery of information in timely, effortless and efficient manner for innovations and inventions that are the foundation of growth of that field. To fulfil these informational needs libraries are implementing automated systems and services such as:

- i. Internet library website
- ii. e-bibliographies
- iii. Library portals

Electronic resources are dominating print resource in usage and acquisition. Libraries are implementing modern technologies to provide effective and instant services to users. The development of the internet and search engines has contributed immensely in the documentation compiled by researchers. Advantages of the search engine are:

- i. Search engines provide effective and instant searching of enormous volume of information and display results.
- ii. Have become de- facto method of obtaining information.
- iii. Search engines appear to perform better than other engines.

Librarians and information scientists prefer AltaVista over Dialog. Generally, users can't find specific user required information from internet without search engines. The correspondence between web search engines and library catalogue and Meta search Engines similarity to Union catalogue was mentioned by Lal (2008). Search engines perform several functions for libraries, academicians, researchers and library professional.

Acting as a catalogue to internet resources help in the following:

- i. Subject wise and field wise information retrieval.
- ii. Retrieving information from scholarly literature.
- iii. In locating the informational resources on the information super highway.

Search engines assists team of researchers to share information from many resources on web. The search engine helps in categorization of research works as these search engines deploy following methods:

- I. Search engines generate and store of Meta data for retrieving pertinent information on the internet.
- II. These search engine's thesauri, keywords subject heading contain related phrases of a specific topic the subject.

A Boolean operator for searching and usage of

pattern for storage and retrieval of information helps researchers to view same topic at different abstraction and perceptions.

With reference to the user's needs of the internet age, Shiv (2011) proposed that OPACs need to include the modern features of present search engines to improve their practices. An evaluation and comparative study of the effect of web searching on online public access catalogue (OPAC) users in the 3 Punjab state university libraries underlined the following:

- a. Need for community collaboration of users and librarians with OPAC designers with the goal of a user-friendly OPAC system development.
- b. Web-based resources were found to be heavily used.
- c. Web searching influenced their OPAC searching methods and Users were found to be unaware of internal-search methodology of OPAC and Google.

Measurement and comparison of the performance of major search engines in the discovery of geographic web services was performed by (Francisco et.al. 2011) compared "search engines" performance in terms of finding of geographic web services. He and his team specifically measured the performance of Bing, Google and Yahoo! It concluded with the inference that Yahoo! as the best performer. Other findings suggested the following:

- i. Search engines are a viable option for finding geographic web services.
- ii. This discovery of geographic web services does not need the application of advanced search operators.
- iii. Resource-orientation can be impaired by some progress in the technical aspects of search engines.

The indexing quality and ranking of XML content objects were examined by Farajpahlou and Tabatabai (2011). These XML content objects consisted of Dublin Core and MARC 21 metadata elements. Study was on general search engines such as Google and Yahoo! The Following points are marked in the study:

- Although both the XML-based Dublin Core Metadata Initiative and MARC 21 did not show were indifferent to the information that was accessed.
- But both the metadata elements were indexed by Google only and not by Yahoo! search engine.

Different search engines are compared by Garoufallou (2012) on the utilization, performance

and characteristics of international and Greek search engines as an information retrieval tool. The comparison of search results produced upon searching was done on the below mentioned parameters:

- i. Quality
- ii. Accuracy
- iii. Appearance
- iv. Significance

Librarians favored using international search engines rather than Greek ones and that search results. The factors that results gratified the librarians were identified as:

1. Search results' significance i.e. Precision and hence the quality and value of result.
2. Presentation and the visualization.

Lewandowski (2012) presented views on Web searching, assessment of search engines, context of Web search. His endeavor is useful for researchers working on Web search engines. He emphasized the utility of Web search engines for the process of acquiring knowledge that too from different perspectives.

Effects of using alternative Search Engines and evaluation of search strategies therein, was performed by *Kammerer and Gerjets (2012)*. Demonstrated that alternative search engine interfaces usage has influence on:

1. Web users search.
2. Retrieving high-quality, credible information.

Information Foraging Theory in the field of cognitive science was given by Pirolli (2007). Expounded on this theory in 1999. Later in 2003, the Prominence-Interpretation-Theory was given by foggin his research on communication and persuasion. Layouts of search engine results pages are evaluated in terms of searchers information quality. In addition, credibility evaluation of search results is also reviewed. Techniques of automatic search results categorization based on specific genre categories are also mentioned. It is concluded that the Web users are biased on the ranking of search engines and they do not give weight age to the reliability or relevance of the results and Web pages containing them.

The research was carried out to determine the relation of gender with the familiarity and usage of search engines. Private south Nigerian university lecturers were the subjects during the study. Anyira

(2013) investigated the gender in awareness and use of search engines. This investigation was related to the university library usage by Lecturers in private universities. The t-test results indicated following observations:

- I. The awareness-level of search-engines between male and female lecturers.
- II. Significant differences were observed in the usage of Yahoo and Google search engine.

Implementation of ICT policy that promotes gender impartiality in is advocated. The studies focus on the finding the factors:

- I. Contrasting differences between search engines against meta-search engines were observed which effect overlapping degree of retrieved information from search engines against meta-search engines.
- II. Google usage was 91.93 percent and Yahoo usage came 43.85 percent.
- III. Dogpile and Ixquick came 35.78 percent each.
- IV. A significant relationship existed between the respondent's profession and use of search engines Profession is closely related to the method of learning the search strategies.

The research effort helped in outlining the steps needed for increasing the usefulness of search engines for accessing knowledge. Intensive training of users Gender impartiality must be a key clause in the ICT policy document.

These recommendations can help Indian academics in searching effectively and efficiently. The analysis of the search engine queries used to locate an electronic theses and dissertations (ETDs) collection of the Auburn University was performed by Coates (2014). Findings of the analysis are outlines as follows:

1. Search engine users constituted over two-thirds of visits to the AUETDs collection with most of the local user's queries contained person names, variants for thesis or dissertation, and variants for Auburn University.
2. More than, a third queries were for the AUETDs collection, while the remainder were seeking theses and dissertations from specific Auburn researchers.
3. Most out-of-state user's queries contained title and subject keywords and emerged for seeking specific research studies.

These key results emphasized the importance of certain steps related to the Repository that must be taken:

- i. Repository content must be indexed so that they can be located by search engines such as Google.
- ii. Specificity of their queries indicates that full-text indexing of content will be more helpful to users than metadata indexing alone.

Study has limitations, as query content for the major search engines is no longer available from Google Analytics.

The search engines provide effective and instant searching of enormous volume of information and display results. Search engines perform better than other engines, subject wise and field wise information retrieval and retrieving information from scholarly literature. In locating the informational resources on the information super highway. Delving into workings of Search engine for Information Retrieval shows that search engines generate and store of Meta data for retrieving pertinent information on the internet. These search engine's thesauri, keywords subject heading contain related phrases of a specific topic the subject. There is a need for community collaboration of users and librarians with OPAC designers with the goal of a user-friendly OPAC system development. Web searching influenced their OPAC searching methods and users were found to be unaware of internal-search methodology of OPAC and Google. Metadata elements were indexed by Google search engine but not by Yahoo with both showing no preference towards these markup objects. Intensive training needs for users are advocated. Gender impartiality must be a key clause in the ICT policy document. Full-text indexing of content will be more helpful to users than metadata indexing alone. Repository content must be indexed so that they can be located by search engines such as Google.

Effectiveness of Retrieval Digitized Information through Search Engines

The overlapping degree of retrieved information from search engines against meta-search engines was studied. Six search engines and six public meta-search engines from the "searchenginewatch.com" website were used for the experiment with physics field used as information retrieval domain. This study by *Esmail and Kiaie (2011)* helped arrive at following implications:

- a. "Yahoo" retrieved i.e. 40% of physics documents in search engine category whereas "Curry Guide" retrieved maximum i.e. 77.1% of physics documents in search engine category.
- b. Maximum overlapping degree with various other search engines i.e. 39% was found with "AOL" search engine.

The notion of social search, its taxonomy social search and a user-centered social search method based on the patterns of web search behavior was proposed by MacDonnell and Shiri (2011). Google search system was used for this study. The significance and authenticity of the approach taken is exemplified by the real search topics based use cases. This was achieved by identifying the key trends and latest topics on social search. The results verified the facets of Google social search system such as:

- i. The importance of "collective intelligence" in web search.
- ii. General web searches were more precise when bookmarks, tags and social media platforms were used.

Recommendations related to the improvements in search engines' design, use of browser add ons and implementation of digital libraries was made. This was done so as to help searchers and web designers of social search systems. An assessment of the performance of Ask.com, Bing and Google was done by Sadeghi (2011). Two measures that are introduced by this assessment are:

- Tendency degree presentation of results.
- Coverage degree is the measure for retrieval effectiveness.

Results suggested that Google did better than the others. Bing and Ask.com came second and third in the evaluation results' ranking. The inferences drawn from investigation help users in selection of search engine from various options that are available. In addition, these inferences also help vendors of web search engines to enhance the features and functioning of technology their product and / or service.

The methodical performance comparison of MSN, Google, Yahoo!, Ask, Exalead, and Seek port on navigational queries was made. This study compared the effectiveness of result fetching of the engines on informational queries. The implications of these performance comparison shows:

- i. Effectiveness of Google, Yahoo!, and MSN was around 90 percent.
- ii. Ask and Exalead were worst performers but received good scores.
- iii. Users can be influenced easily in their quality ratings of search engines based on this performance.

Suggestion for careful designing of a search engine is made. So that the designed search engine may compete with the major search engines

on the performance on navigational queries. The results are limited as only German-language interfaces were used and all the queries were only in one language i.e. German. Therefore, the results are only valid for German queries. Influence of web searching on OPAC users, was assessed by Shiv Kumar (2012).

He discovered following aspects related to, influence of web searching on OPAC users:

- i. OPAC and web search engines compete for survival and sustainability.
- ii. There were noteworthy changes in searching patterns of academicians.
- iii. The number of academicians who are using Internet to filter out information is increasing exponentially.
- iv. Influence of search engines on OPAC is prominent.

Recommendations were made for designing user friendly OPAC friendly Computational problems exist in algorithms of search engines. To address these problems Rall (2012) reviewed the concept of truth claim He recommended deeper exploration of search, Melucci (2012) concluded that Rank correlation analyses affected the people's daily life activities related to work. He demonstrated that:

- a. Only approach to arrive at rank correlation was via statistical methods.
- b. Rank on SERP search engine result page is very usual for a search engine.

A model for the application of rank correlation is proposed. Analysis of existing social search engines was performed. Specific features and social aspects of these social search engines were described (Markus and Christain, 2012). An overview and a comparison of the different genres of social search engines are made. Two surveys, first related to the General computer searching behaviors were explored by (Zimmerman, 2012). He suggested the following:

1. Digital natives search habits were of prime concern.
2. It will be a great disservice to digital natives unless they are trained on specific methods to search academic databases.

The performance comparison of Google, Ask, Yahoo!, Live, and AOL revealed following facts:

1. Google performed.
2. Yahoo! is the second best.
3. The other three search engines did not performed satisfactorily compared with Google and Yahoo!

4. Different technology was used by Different web search engines.

These findings can help search companies to improve their services (Deka and Lahker, 2010).

Light on UK discovery tool issues is shed by (Joint, 2010). The value of bibliographic databases was measured. The study found that:

- i. Federated searching has proved valuable but not as valuable as Google Scholar.
- ii. Harvesting search engine can create search engine like Google Scholar.
- iii. Google's success does not make the library discovery tools useless.

Search engines are evaluated by (Palanisamy, 2013) by using a model. This model identified the attributes of a good search engine Implications are useful for searchers. Taheri, Hariri and Fattahi (2014) used 'Data-Island' method to check the indexing and visibility of metadata elements by search engines. The research demonstrated Google and Bing considered these metadata element tags during searching.

- i. Control groups' tag names were not considered by Google and Bing. The control group records were accessible by elements name only.
- ii. Indexing and retrieval of metadata elements through use of their tag names was possible.

Based on these findings the authors made recommendations related to the design of search engines and digital libraries. Performance of Google with Bing and Ask.com was compared. Yahoo! and MSN along with, Ask and Exalead were also compared with other search engines. Comparison suggested the social systems and search engines' designers of developing countries, to develop user friendly search, social, add on tools of browser and OPAC systems. The effectiveness of Google scholar in pulling-out information related to the electronic journal services is not an end to itself. Harvesting search engine can be the option for use in this electronic journal services domain.

Barriers of Using Search Engines in Retrival of Digitezed Information

There are several manners in which the search engines' strengths can be applied to improve user's experiences. User's intentions for using online catalogs are also identified. Despite absence of any real world exhaustive testing of strategies in improving the ranking, many a recommendations are made on improving the ranking functionality of a library catalogue. But system integrators and implementers

will find recommendations for developing better OPACs. Findings do not outline main shortcomings, not addressed in current 2.0 developments of current OPACs in which results are not refined nor do they conform to the relevance expected user. It is proposed that OPAC development should on priority basis approach the search centered on the subject of searching (Lewandowski, 2010).

Application of dual phase methodology was done by *Ilan and Levene (2011)*. An assessment of search results retrieved from different sources was done. This method was tested in by comparison of Google and Bing in terms of different country specific search results of Users evaluated the results of specific number of nine queries. These were designed so they were able to create their own preferred ranking. In addition, users were also able to pick the best ranking from the six engines.

The search results came from Google Israel, Google.com, Google UK, Live Search of Israel, US and UK. Study suggested the following:

- i. Users preferred their local Google interface, this in turn implied Google succeeded in its country specific customization of search results.
- ii. Live Search was much less successful in interface aspect.

Results are limited by the fact that search engines are highly dynamic, thus the findings of the case study have to be viewed cautiously.

Kerkmann and Lewandowski (2012) suggested WAI Methodology for accessibility review of search engines in a comprehensive manner. Outlined in, three-steps namely:

- I. Preliminary review Conformance evaluation User testing

Several measurements of many accessibility aspects and difficulties are made. This is especially true, during accessibility of web search engines for people with disabilities. This also holds true for the elderly or temporarily handicapped people. The study can assist the researches, search engine developers and educators in practice, with reference to the aspects of disability studies. Research is limited as it describes a theoretical concept. It also lacks on the part that the model is not tested so far.

The impact of user's demographic characteristics web searching has been elucidated by Shiv (2012). These characteristics have definite impact on web searching but in some limited activities. Study is particularly done on Google. Following implications have been derived:

- a. There are very visible differences between OPAC

usage patterns and demographic characteristics of user categories and age groups were found.

- b. Also that, variations of significant nature among user age groups for awareness about differences between the inner workings of the OPAC and web search engines was noticed.
- c. A significant relationship was found between male and female users regarding their perception of unsuccessful searches.

Although certain variations among academic majors with regard to perceptions of users after failed searches were also observed. But there were insignificant differences after unsuccessful searches a variety of diversification approaches are available to address diversity within web search. The paper addresses the diversification issue from following two angles:

- i. Notions of diversity are introduced.
- ii. Diversity is discussed with its dimensions.

The diversity is defined as the SERPs result set's coverage of multiple interpretations of a query. Objective of the web search is those diversifications make the ranking so one gets diverse top results. Adapted ranking increases by following range of diversifications:

- I. Similarity measures or diversity scores.
- II. Comprehensive diversity analysis which determines topics and classifies text according to opinions etc.
- III. Combination with image search result diversification.

Organization and classification of content within diversification become increasingly important. By exploiting some of the best practices of information architects and webmasters, libraries can also open their huge data to the search engines and can get listed in the top results to get more visibility as suggested (Vinit, 2012). The study provided ways to reach out to the users by exploiting present day mighty web search engines. Outlined problems related to unfriendliness of library OPACs and the reasons behind these problems. He also identifies several website characteristics with a focus on libraries' application of SEO. Analysis is performed from the following angles:

- I. Impact of external links and the number of indexed web pages by search engines on elevated SERP rankings.
- II. Examined the SEO for improving libraries' digital content search-ability on the web.
- III. Comparing the visibility performance in the

ranking of search engine results by application of Alexa.com, on the collection of data of Canadian libraries.

- IV. Concepts from the Integrated IS&R Research Framework are applied to analyze SEO as an element within the Framework.

Impact of certain characteristics of websites on ranking of libraries' websites by search engines was confirmed by the findings. Following suggestions are made:

- i. Use of sitemaps to expose the bibliographic records to search engines.
- ii. And usage of various different options to create, upload and submit these sitemaps to search engines.

Comparative study of Google, Yahoo and two meta-search engines Met crawler, Dogpile was performed. The bases of comparison are:

1. Precision value of searching potential.
2. Relative recall of searching capabilities.

Kumar, B.T. Sampat and Pavithra (2010) evaluated first 100 results of the 15 queries related to library and information science that were tendered for search engines and meta search engines were compared. Findings suggested the following:

1. Search engines poor performance relative to the Meta search engines in terms of precision.
2. Meta search engines were poorer in performance than search engines on recall parameter comparison.

Hariri (2013) determined that the performance of natural language (NL) search engines. The results were summarized as:

- a. Precision for Google and three NL search engines were similar.
- b. Ask.com retrieved 60 percent of searches better than the other search engines.
- c. Mean value on the searching based on, the top list documents for three NL search engines (20.67) were a little less than Google's (21).

Implications of these results suggested that all NL deployed similar techniques using keywords of the NL queries, which is far from semantic searching and understanding what the user wants in searching with NL queries. The emphasis on content oriented websites is made by Herbert and Mellius (2013). They suggested website design be centered on high quality, well-written content. Even though keyword stuffing is likely to lead to search engine rankings increase, it

could deter human visitors and reduce website value. The study determined how the three biggest search engines interpret keyword stuffing as a negative design element. The study contradicts claims of high keyword densities leading to blacklisting by search engines have been disproved. Study is limited as only the three biggest search engines were considered, and monitoring was done for a set time only. Users preferred their country specific customization of search results. Live Search was much less successful in this aspect. Further, benchmarks and standard data sets for evaluations need to be established to ensure comparability of results from various approaches.

Conclusions

Web-based resources were found to be heavily used and searched. Search engines de-facto method of obtaining digitized information. Federated searching to rival Google Scholar, Google has a significantly higher rate of performance as against other search engines. Yahoo! is the second best. Web searching influenced users OPAC searching methods Google interface was preferred

Recommendations and Suggestions

There are steps needed for increasing the usefulness of search engines for accessing knowledge.

- I. Intensive training is must for effective retrieval of digitized information.
- II. Gender impartiality must be a key clause in the ICT policy document.
- III. Indexing of Digital repository content. Specificity of queries indicates that full-text indexing of content be more helpful to users than metadata indexing alone.
- IV. Designing a user friendly OPAC Additional emphasis on the digital natives' search habits Digital natives must be trained.
- V. Use of sitemaps.
- VI. Usage of various different options to for submitting and creating sitemaps to search engines.
- VII. Website with high quality, well-written contents are recommended. Keyword stuffing deters human visitors and reduces website value.
- VIII. A user-friendly OPAC system development approach is needed.

- IX. Usage of bookmarking systems, social tagging services and social media sites are must.
- X. Presentation and the visualization aspects of search engines must be improved with time.
- XI. Quality, accuracy, appearance and significance of digital information also determine search results thrown by search engines. Hence attention must be given to these aspects.

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