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Search Engines for User Centric Information Retrieval and Scholarly Communication

J. Vivekavardhan

Digital Information Management, Department of Library and Information Science, University College of Arts and Social Sciences, Osmania University, Hyderabad, A.P., India

Guest-Editor-in-Chief: **Dr. V.J. Suseela,** Dy Librarian, Head, Circulation & IT Services, IGM Library, Univ. of Hyderabad, India

Guest-Editor-in-Chief: **Dr. V. Uma,** Dy Librarian, Head Periodicals (Print & Electronic), IGM Library, Univ. of Hyderabad, India

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Abstract Search Engine (SE) is a software system that is designed to search for information on the World Wide Web. Search Engine helps users to find rapidly relevant information. Search Engines were established based on the traditional database and information retrieval methods and also many other algorithms have been added them to improve their search. The Interconnection of world through the use of Internet and Search Engines has changed the profession of Librarianship. The paper describes the Search Engine Architecture, Working Process, Information Retrieval Features, Scholarly Communication and different types of search engines and their usefulness in the field of Science, Arts, Social Sciences, Engineering, Medical, Legal other aspects. Search engines such as, Scirus, Infomine, Refseek, TechXtra, PubMed, Catalaw, Google, Bing, and Yahoo, are presented with their usefulness and the disciplines in which they are used. Search Engines are very important for retrieving information and scholarly communication in achieving academic excellence as per the changing needs of users in Higher Education. Search engines create an environment whereby scholars and researchers can easily share, publish their research findings and be able to locate and also retrieve the required information. Thus, the paper explains the usefulness of SEs to the wider academic community that prepares academicians to face challenges in Higher Education.
Keywords *Search Engines; Internet; Information Retrieval; World Wide Web*

1. Introduction

Searching for information on the World Wide Web (WWW) is much the same way that we look for information in a library, using an on-line catalog system. The difference and the advantage of WWW is that one can get information from all over the world, instead of from a single library collection. WWW allows people to share the information (data) from the largest database, globally. WWW plays a vital role in the day to day lives as it contains and constantly adds information in huge quantities through various sources that lay tremendous impact on the dissemination and retrieval of information by scholars, information scientists and even by non-professionals in the society. Internet has become the largest and important network which connects billions of people all around the world. World Wide Web has been growing rapidly and attracting the librarians to access the web. The term 'scholarly' is referred in academic domain, especially in higher education, in the context of 'scholarly communication' to describe how research is communicated among peers and evaluated.

Search Engines are used as a quick and direct reference to get any type of information all over the world from World Wide Web. Librarian's catalogue was the ultimate approach of users in searching information for their research before the web search engines took over. Search Engines have changed the way to find information as per the patron's needs, research requirements and connecting the library and resources with users and also beyond. Behind almost all online destinations whether it is a social network, or mobile phone or an online newspaper, individual blogs, or a database containing peer reviewed articles/chapters/data or bibliographic database, there is a search engine. There are many Search Engines available today, but retrieving relevant and meaningful information is very difficult. Perfect Search Engine is something that 'understands exactly what you mean and gives you back exactly what you want'. Ever since the web based information and internet came into existence, the web search engines also have been getting prominence and evolving from time to time adding more and more search options, facilities, connections as well as results display features as per the advancements taking place in processing the information and dissemination to users. Initial search engines are primitive and they had rudimentary general search options. According to the search / research requirements of users and their search behaviour, the trend of developing the search engines from general search options to advanced search features came into existence. In this process various types of search engines are emerged to provide approach to reach different types, forms of information /sources covering almost all disciplines.

A. Statement of the Problem

The present study on 'Search engines for information retrieval and scholarly communication' has been undertaken to answer what is search engine, how search engine works, different types of search engines and their usefulness. Since any individual or researcher simply cannot exactly retrieve the required information or document among billions of pages/documents available on the web, they need the help of search engines to zoom in to a small number of pages worth looking it.

B. Objectives of the Study

The main objective of this study is to explore the working process of Search Engines in Scholarly Communication. The other objectives of the study are –

- To explore the genesis of search engines technology
- To find out the architecture and working process of search engines
- To find out the search features of select search engines
- To find out the usefulness of various types of search engines

C. Significance of the Study

There are many search engines (SEs) available today, but retrieving relevant and meaningful information is yet difficult. SEs, are the most important tools in locating the information, so it is essential to know how to use them effectively. There is no 'perfect place' or 'all in one' search engine to search entire internet, because different search engines, will give different results. In this context, it is felt essential to study the useful features of search engines and their impact on libraries and library users.

D. Methodology

The study is based on an extensive review of literature available in documents, print journals, and online journals on internet, to investigate about the search engines technology its working process to retrieve information from the databases.

E. Limitations of the Study

Search Engines are available globally but the present study is confined to the search engines trends and technologies, working process of search-engines, search features of the search engines, usage of the select fifty (50) Search Engines. The definitions of significant terms are given below.

- **Search Engines:** A Search Engine is a program that searches documents on the Internet with specified keywords or characters and returns with a list of the websites, web documents, wherever the keywords are matched.
- **User Centered Design:** User Centered Design is a frame work of Processes in which the needs, wants and limitations of end users of a product, service or process are given extensive attention at each stage of the design process.
- **Internet:** It is a global network connecting millions of computers, networks.
- **Information Retrieval**: It is an activity of obtaining information against an information need from a source or multiple sources. It is a process of searching, and retrieving information from large amount of stored data.
- **World Wide Web**: It is a system of interlinked hypertext documents on the Internet, which can be accessed through a browser.
- **Scholarly Communication:** It is the process of publishing and sharing the research information, it involves creation, exchange and dissemination of information through search engines.

2. Review of Related Literature

Web search is now a major interdisciplinary area of study; studies on Web Search Engine crawling and retrieving have evolved as an important area of Web research since the mid-1990s. Researchers from different fields have proposed frame works for Search Engines research, taking different perspectives into account.

Bar-Ilan (2004) reveals that Information Science is divided into the two main sections. They are (1) Understanding the Web's structure and processes, and (2) understanding users' needs and behavior. Sufyan (2005) study dealt with web search quality and reveals that the quality of search depends on the search algorithm, indexing techniques used by the different Search Engines. It also revealed that the algorithm differs from Search Engine to Search Engine considerably. Hargittai (2007) stresses that research dealing with Search Engines' impact on society is largely missing, despite their central role in how people access information. However, little social science work has focused on the non-technical dimensions of Search Engine tools, the practices of the users who rely on them. Machill, Beiler and Zenker (2008) find "five topic fields considered to be central to future Search Engine research from an interdisciplinary perspective". These are 1) Search Engine policy and regulation, (2) Search Engine

economics, (3) Search Engines and journalism, (4) Search Engine technology and quality, and (5) user behavior and competence. Ginsberg et al. (2009) research on Search Engines from technical developments to studies on Search Engine quality, from investigations on the social impact of Search Engines approaches to using data from Search Engines to analytic approaches. Zimmer (2010) states that the areas deserve particular attention are: Search Engine bias, Search Engines as gatekeepers of information, values and ethics of Search Engines, framing the legal constrains and obligations. Purcell and others (2012) state that on the usage of web Search Engines from 2002 to 2012 by Americans shows a dramatic increase in the usage from 52% to 73%, the rate of increase is 21% and 91% of Americans find information when they use Search Engines. 73% of users find that Search Engines are accurate and trustworthy; overall view of Search Engine performance is very positive. Ding and Marchionini, (2013) finds that majority of students are unable to search web with efficiency, authors concluded that information literacy education is vital to teach students comprehensive web searching competency, which includes knowledge and techniques for both academic and daily-life search tasks. Egri and Bayrak (2014) states that 93% of internet traffic is managed by Search Engines, hence, exploring the potential of Search Engines is crucial, it shows the critical role of Search Engines on routing users to the right websites. The main focus was to measure the significance of time, speed, reduced bounce rate, page views, and page layout in keeping the user on the site.

3. Search Engine Architecture

Search engine gathers the contents of all web pages (using a program called crawler or spider); organize the contents of the pages in a way that allows efficient retrieval (indexing). It takes the query and determines which page matches the query and shows the results finally (ranking and displaying of results). The development of search engines enabling their complex operations according to the basic as well as the specific requirements of users is possible with a strategic application of user centered design process.

A. User Centered Design Process

User-Centered Design (UCD) is a process to design search engines software, web sites and products around the people who will use them. User-centered search engine design ensures that search engines are useful and usable.

Figure 1: *User Centered Design Process*
(Source: http://www.danygraig.com)

User centered design processes focus on typical users through the planning, analysis, design, implementation, deployment and development of a product. User centered design (UCD) process steps mainly are - know the users; analyze user tasks and goals, establish usability requirements; prototype on design ideas; usability test the concepts and repeat the process for user needs. User-centered search engine design brings the users need into consideration from the beginning of the search engine development. Efficient information retrieval, navigability and good typography, scholarly communication all contribute towards user-centered design. The search engine architecture model is presented below
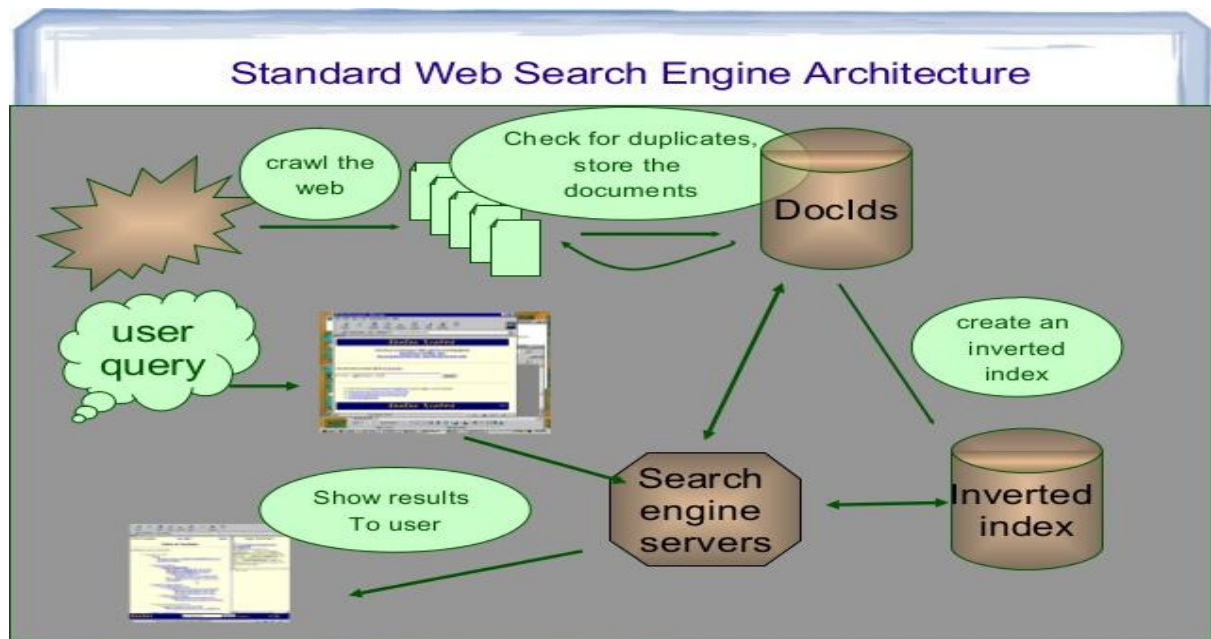

Figure 2: *Standard web Search Engine Architecture*
(Source: www.google.co.in/search?q=web+search+engine+architecture)

4. Working Process of Search Engines

Search Engines allow the user to enter keywords that are run against a database. Based on combination of criteria, Search Engine retrieves WWW documents from the database that match the keywords entered by the searcher. Search Engine works on the four main principles:

- Web crawling,
- Indexing web pages,
- Ranking the results, and
- Search and display the results.

For searching process, Search Engines, simultaneously adopts "Best match searching" as the default mode of operation with "Boolean Searching" as an alternative and advanced retrieval options. A single Search Engine cannot cover every available web resource, but may contain references to millions of resources and thus results may vary from one Search Engine to another.

5. Search Engines - Search Features

The important search features of search engines and the usefulness in search process is mentioned in the following table with examples.

Table 1: Search Features of Search Engines

Sl. No.	Search Feature	Description of Search Features	Example
e1	AND (+ plus sign)	Inclusion of Search Term.	Library AND Digital Library
2	OR	Result that contain at least one of the keyword.	Library OR Digital Library
3	NOT (- sign)	Result that contain one keyword but exclude the other keyword.	Library NOT Digital Library
4	Nesting ( ) Parentheses	Nesting utilizes parentheses to clarify relationships between search terms.	Using (India OR United States) AND Digital libraries
5	Proximity Searching	Proximity search is to search for two or more words that occur within a specified number of words (or fewer) of each other in the database.	Big Data Application retrieves records containing the three words immediately adjacent to one another and in the same order.
6	Phrase Search	Phrase Searching ensures that will retrieve search terms next to each other in the order user typed.	library science, "library science"
7	* Truncation.	Truncation expands a search term to include all forms of a root word,	patent* retrieves patent, patents, patented, etc.
9	File Format Search	Users can limit their search to any specific file format.	MicrosoftWord (.doc), (.pdf), (.xls), (.ppt), (.txt)
10	Site/Domain	Limit to domain search	.com / .gov / .edu / .org
11	Spelling Check	Mistake in spelling then system asks 'did you mean this'.	LibrayScince Did you mean Library Science
12	Similar terms.	Use the "~" symbol to return similar terms.	~plane, also searches for aircraft, flight, jet, etc.

6. Search Engines/Databases – Usefulness

The search engines, their usefulness and the discipline in which they are employed are given in the following table.

Table 2: Search Engines Usefulness

Sl. No.	Search Engines (SEs)	Usefulness/Description
1	AOL Search	It is useful in Communication Mass Media, and digital distribution of content.
2	Academia.edu	It is a platform for academics to share research papers.
3	Awesome Library	It is an online library Search Engine to find full-text of books, journals, kid-safe sites, business information.
4	Bing	It is now known as "Bing" Search Engine of Microsoft.
5	BPubs	It is a Business Publications Search Engine, useful to access business and trade publications.
6	Bielefeld Academic Search Engine- (BASE)	It is one of the world's most voluminous search engines, especially academic open access web resources.
7	CataLaw	It is Law Search Engine that organizes "all indexes of law and government into a uniform, universal and unique meta index."
8	CiteSeer	It is useful to access Scientific Research Digital Library by using the CiteSeerX website.

9	Clusty	Clusty Search Engine organizes numerous search results into several meaningful categories called clusters.
10	Congoo	Congoo Search Engine is for current events and news searches; Congoo connects to the latest in technology, industry, business, world news, finance, politics, Internet trends and more.
11	Deeper Web	It allows navigating through search results. The technique involved is tag cloud technique.
12	Dogpile	Dogpile find is the best of all the major Search Engines like Google, Yahoo!, and Bing, with categories including Web, Images, Video, and even White Pages. It filters for duplicates and then presents the results to the user.
13	DuckDuckGo	DuckDuckGo has some slick features, like 'zero click' information.
14	Ethnologue	Ethnologue searches the world's known living languages. It can find more than 28,000 citations in the Ethnologue's language.
15	Excite	Excite is a collection of Internet sites and services and offers online service for a variety of content.
16	Google	Google's mission statement is 'to organize the world's information. Google is fast, relevant and the largest single catalogue of web pages available today. Google uses the page rank algorithm for displaying the pages. The main features of Google are images, maps news, geographic directions, photos etc. Google Indexes 8 Billion pages.
17	Google Books	Google Books can search through online in the field like literature, science, fiction, biology etc.
18	Google Scholar	Google Scholar searches wide array of scholarly literature, including journals, books, theses, universities, and academic publishers, etc.
19	HotBot	HotBot searches the Internet for user documents stored on a hard drive.
20	Harvester42	Harvester42 distributes queries over 30 major Search Engines in parallel and presents a large result page with the individual Search Engine results.
21	Internet Public Library	It searches the collections by subject, checks out the reading room when user visits this online public library.
22	INFOMINE	INFOMINE is a virtual library of Internet resources relevant to faculty, students and research staff at the university level.
23	Intute	Intute is a British Search Engine, specialized to search in science and technology, arts, humanities, social sciences, health and life sciences etc.
24	ISEEk Education	iSEEK is an excellent targeted search engine, designed especially for students and teachers.
25	Inspec	Inspec was made for scientists and engineers by the Institution of Engineering and Technology. Users will find nearly 13 million abstracts and research literature, primarily in the fields of physics and engineering.
26	JustCite	JustCite is an online legal research platform that helps users to find leading cases and establish the current status of the law.
27	Libdex	Libdex is a directory of library across the world as well as an extensive collection of books. Libdex searches the indexes about 18,000 different libraries.
28	Librarians' Internet Index	Librarians' Internet Index is a 17,000 plus websites evaluated and chosen by librarians in many subject categories. Search with keyword like business, government, media, health, computers, or the arts and humanities.
29	Library of Congress	Library of Congress new Search Engine Congress.gov is in beta form and will eventually replace the THOMAS legislative search system. It narrows search results by year, by subject, by House or Senate or other factors.
30	Lycos	Lycos is more of a content hub than a Search Engine destination Lycos Slogan is 'Simplify your Digital Life'. Lycos Entertainment is '*Gamesville', 'Lycos Television' and 'Lycos Video'.*
31	Mamma	Mamma is "the mother of all Search Engines," Meta search tool for web, news, image, video etc.
32	MetaCrawler	Meta Crawler was a Meta Search Engine that blended the top web search

		results from Google, Yahoo!, Bing Ask.com, About.com, and other popular Search Engines. Meta Crawler also provided users the option to search for images, video, news, yellow pages and white pages.
33	MsFreckles	MsFreckles.com provides an easy way to make professional searches for the ordinary internet user. It also offers translation of a text, calculator, super filter, blog search and more.
34	One Page Multi Search	It searches the Meta Search Engines & Search Engines at once. Alta Vista, AOL, Entire Web, Gigablast, Hot Bot, Lycos, Scrub, Yahoo!, Google, Dogpile, Ask Jeeves, and a many more.
35	OmniMedicalSearch.com	OmniMedicalSearch.com collects information from many of the top medical professional sites such as PubMed, NIH, and Merck; this Search Engine provides information from peer level sources. Partnered with Healthline.com and Google Custom Search, the results offered are from a full Search Engine. They also offer a "reference desk of hard-to-find medical resources."
36	OAIster	OAIster finds millions of digital resources from thousands of contributors, especially open access resources.
37	Picsearch	It is a photo Search Engine and has more than 2 billion images in its directory.
38	PubMed	It is a Health Sciences Search Engine. PubMed is for medical students and researchers. It can find journal articles, citations, clinical information etc.
39	RefDesk	RefDesk is known as the "fact checker for the Internet." It can search MSN, Google, Yahoo! Wikipedia, as well as various dictionaries and periodicals.
40	RefSeek	RefSeek is an ad-free Search Engine delivers academic results from more than 1 billion indexed documents, web pages, books, journals, newspapers, and more.
41	Songza	Songza is a music Search Engine, "lets you listen to any song or band." User can also search the featured list or top played list.
42	Scirus	Scirus is a free science-specific Search Engine from Elsevier, covering science-related journal articles, preprints, patents and websites in all areas of science. Scirus searches over 450 million science-specific web pages.
43	SweetSearch	SweetSearch helps students find outstanding information faster. It indexes 35,000 of the most relevant websites.
44	Savvy Search	Savvy Search accesses around a dozen different Search Engines return the results. It offers search forms in over 25 languages.
45	TechXtra	TechXtra is for mainly engineering students. Resource Discovery Tool for Engineering, Mathematics, and Computing.
46	The Open Library	The Open Library is a World's classic literature at user fingertips. Over 1,000,000 free ebook titles available. Here, librarians discover "one web page for every book."
47	WorldCat	WorldCat find items from 10,000 libraries worldwide. WorldCat helps patrons and librarians "find items in libraries near you." Search for books, DVDs, CDs and articles.
48	Yahoo	Yahoo finds information on Mail Search, Cricket, Finance, News, Astrology, Games, Lifestyle, Movies, Celebrity, Answers, Screen, Shopping, Flicker, Mobile, Movies, Messenger, My Yahoo, Transliteration, Travel, Weather etc.
49	Yovisto	Yovisto is a video search engine specialized on educational video content.
50	Yippy	Yippy (formerly 'Clusty') is a Deep Web Search Engine that searches other Search Engines. Deep web pages are usually harder to locate by conventional search.

7. Librarian and User Centric Design

Traditional librarians manage their holdings using catalogs that contain information about every collection library owns. The role of a librarian is continually evolving to meet the information needs of academicians, technical experts, researchers and needs of the society. A paradigm shift in librarianship is taking place since the 20th century with the advent of new information technologies and their applications to make the library services more and more user centric. A modern librarian deals with the information in different forms like physical books, electronic resources, magazines, newspapers, audio, video recordings, maps, manuscripts, archives, photographs, bibliographic databases, web-based and digital resources. World Wide Web has created a revolution in the accessibility of information to the user. Internet and the web search engines are the principal building blocks that are used in the development of several sources of information/documents/data i.e., databases, institutional repositories and digital or virtual libraries.

Resource discovery system helps the librarians in locating, retrieving and presenting information of relevance to their patrons. The new role of librarian in designing libraries to suit the user requirements is becoming a challenging task. Librarians began serving the library patrons as consortia manager, consultant, content manager, facilitator, guide, teacher, information intermediary, knowledge manager, researcher, web designer, etc. to transform libraries more user centric and to satisfy their information /research needs and demands. The Resource discovery tools and technologies - like search engines, meta search engines, web directories, subject gateways, search and retrieval protocols, metadata harvesters, federated search, Internet, metadata schemes like, Dublin Core, Text Encoding Initiative (TEI), Metadata Encoding and Transmission Standard (METS), Metadata Object Description Schema (MODS), Encoded Archival and Description (EAD), etc. play significant role in discovery and transfer of information to the library patrons.

Trained librarian is a powerful search engine. Google search engine brings back lakhs of answers to a single query, but a librarian can get the right one, in a strategic manner. The 21st century librarian when acquires and adopts the latest technologies, and current research trends will become not only well versed with information search and retrieval but will educate library users by conducting information literacy. With the ever increase flood of information, the librarian is transforming as a navigator of information. For this, librarian needs excellent planning, designing techniques, managerial strategies, and analytical skills, to design and deliver the information to suit the user needs.

8. Conclusion

The Human society has experienced unprecedented explosion of information with the advent of digital technologies. The millions of users search World Wide Web for information every day. The web Search Engines are developed with wonderful search features. Though the web search engines are developed with various search features currently there is no search engine that will be able to cover the entire World Wide Web or Internet. Searching across several search engines is more advantageous than searching through a single one. With the exponential growth of information, everyday millions of pages are being added, updated, and deleted to www. The modern day librarian is expected to develop adequate knowledge, competency and skills and be well versed on information search and retrieval tools. User centered search engine works effectively when user query better understands by the system, retrieves exact results as per users request, increases users satisfaction, loyalty, adoption and it also reduces development cost, support services cost and maintenance costs of search engines.

The future trend in Search Engines technology is very dynamic one, Google Glass and Flying Drones are the emerging players in search engines technology. The dynamics of a web search engines will be a great challenge to any designer of search engine. The spoken queries need to be translated into text queries using a speech recognition system, natural language processing and automatic translation of the

queries before matching them to documents for retrieval. The developers of search engines and designers look for the latest technological advancements, innovative ideas and also taking the new demands from users into consideration for redesigning search engines accordingly to meet the information needs ever arising and to face challenges in higher education.

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About Author

Vivekavardhan J. (Dr.)

Asst. Professor, Department of Library and Information Science, Osmania University (OU), Hyderabad.

Qualifications: M.Tech., M.Sc., M.L.I.Sc, M.Ed, UGC-SLET in LIS (1997) and Ph.D in LIS from Osmania University on 'A study of Web Search Engines with Particular Reference to Information Retrieval Features'

Experience: Counselor at B.R. Ambedkar Open University, Hyderabad. Member Board of Studies in OU.

Publications: Above 30 articles to conferences' volumes and journals. Authored a book on UGC-NET/SLET and also the state government science text books.

Professional Associations: Life member of IATLIS, APLA, ALSD and TSLA.

Professional Visits: Recently visited Thailand to present a seminar paper at Mahasarkham University.

Vivekavardhan J. (Dr.)