An Overview of the Web Search Satisfaction

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Abstract

Search is one of the most challenging and interesting problems in information retrieval system. Many studies have been published related to this problem. To date, web searcher is facing with information overload phenomena. Information overload is a situation where too much information, therefore user need to filter the useful information from the abundance of information published on the web. Due to these phenomena, user satisfaction towards the search result has also decrease. This paper investigates the factors that affect user search satisfaction. Initially, user knowledge has been found as the main contributing factor. The overview of user knowledge and other factors is discussed in this paper.

1. Introduction

Search is one of the most challenging and interesting problems in information retrieval system. Many experts claim that continued research into its mysteries will provide the commercial and academic benefits to mimic human intelligence [1]. Typically there are two main groups of search system that is online directory and search engine ([2], [3] [4]). Online directory such as Yahoo! depends on human for it listing and search engines such as HotBot create their listing automatically [5].

To date, many documents, web pages, images and etc have been published online. Many of these have been indexed by the search system. The abundance, of these materials cause information overload. [6] highlighted that the unpredicted rapid explosion in the volume and variety of sources in the Internet has brought many problems, typically, too much of a good thing, useless information and inaccurate information. Too much of a good thing overload users to filter the best out of the best, while useless information is the one that can not be trusted, vague and suspicious content. In 1998, the World Wide Web (WWW) was estimated contains about 800 millions index able pages, encompassing about 6 terabytes of text and on about 3 million servers [7]. When searching, user can be overwhelmed by thousands of results by a search engine, few of which are valuable [8]. Information overload put users at stress and causes difficulty in searching and filtering the unwanted information.

Therefore, Due to these phenomena, user satisfaction towards the search result has also decrease. The remains of this paper will discuss on an overview of search satisfaction and the factors that contribute to the search satisfaction.

2. An Overview of Search Satisfaction

Search satisfaction is one of the indicators in order to determine the user achievement of his information need [9] Information need is the information required by user to solve or fulfill certain tasks. A number of factors have been identified to contribute to the satisfaction or search success, typically, experience ([10]; [11]; [12]; [13], domain knowledge ([14]; [10]), gender ([15]; [16]; [17], and cognitive process ([10]).

Initially, these factors are the pre-determinant for query selection and manipulation. As in the search system, query plays an important role to ensure the search satisfaction, understanding and knowing how to formulate the query will benefit best the user. Previous research has also proved that query-based search system is more popular compared to other search systems ([12]; [18]).

Experience for example significantly affects users' attitudes towards search engines [12]. It provides a heuristic strategy to identify and formulate the suitable query for a given task. As highlighted by [11], experienced individuals are more likely to search for alternative sources for information and be less reliant on the domain. The increase of experience in information search will also guide user to select strategies that lead to more successful results [13]. Earlier study by [19] suggested that subject knowledge became a factor for search satisfaction only after searchers have had a certain amount of search experience.

Previous studies defined search satisfaction based on different views. One view defines search satisfaction based on the performance and times spent in search system. [20] indicate that search

performance (correctness or accuracy, time) and the searcher's attitudes (confidence and satisfaction) influence the overall search satisfaction. [21] defines search satisfaction is when user found a target topic within 30 minutes. [21] justification on the search satisfaction does not consider other factors such as computer specification and operating software, network traffic, and search system response time. These factors can affect the searching speed such that low processor capacity might increase the time taken by the computer to process the signal at the computer level. Network traffic during the peak time will reduce the transmission speed as many user access the network at the same time will increase the load of the network. In addition, concurrent queries made by searchers around the world will reduce the search system response time, thus increase the waiting time.

Another view defines search satisfaction based on user interaction with the search results. [22] define that user is considered satisfied with the search when they pick up the results, the time he spends at these documents and whether or not he prints, saves, bookmarks, e-mails to someone or copies-and-pastes a portion of that document. In addition, more time spent by users in glancing through the document, the more importance that information to those users [23]. [24] view search satisfaction as a constructive effect which lead to the correct inference. Other researchers define search satisfaction based on the judgment of the relevance of the search result.

Typically, search system such as Google organizes the search result based on the relevancy score. [25] define search satisfaction by the number of clearly topically relevant references in the top twenty items retrieved. On the other hand, [26] defined search satisfaction as finding a website that contained the precise information defined in the search task. In a study by [27], children were judged to be successful if they found any relevant information pertaining to their topics. Satisfaction can also be defined as a subjective state of satisfaction with all aspects of the purchase decision after the decision has been made [28].

Different views of the search satisfaction are influence by how someone evaluate and judge the search result. As this study is concern, the search result is generated by the search system's processor based on the query entered.

3. User Knowledge and Search Satisfaction

Knowledge can be defined as knowledge of objects (factual knowledge), knowledge of events (experiential knowledge), knowledge of performance (process knowledge) and meta knowledge [50]. Earlier study by [29], the knowledge can be divided into two components; mechanical aspect of searching and conceptual aspects of searching. Mechanical aspect of searching refer to the syntax for entering search terms and conceptual aspect of searching refer to the thinking processes and problem solving behavior involved in online searching. Later, [30] suggests three layers of knowledge; conceptual knowledge (to convert an information need into a searchable query), semantic knowledge (to construct a query for a given system) and technical knowledge (to enter queries as specific search statement).

Hence, in this study, user knowledge is divided into two that is knowledge in the domain and knowledge on how to use the search system (or knowledge on the search system). Utilizing both types of knowledge will contribute to search success [31]. Knowledge on the domain is a depth understanding of the domain including the search topic. It can be described as knowledge of facts, concepts, and their relationship in a specific domain [32]. Research has shown that the more familiar user to the topic, the more efficient their searching [33]. Knowledge on the domain also influences the query formulation and reformulation which apply as the search tactics ([34]; [35]). The search tactics change over time as the students' domain knowledge changed.

Knowledge of the search system is the knowledge on how to use the search system including the facilities and the strategies supported by the search system. Researchers believe that the usefulness of the search results and search productivity depends on the searcher's ability to understand the system ([29]; [36]; [37]) and use the technology effectively [38]. Advance facilities such as assisted tool which are typically available at commercial search engine have been found to have a significant effect on the performance, satisfaction and confidence [20]. In it absence, Boolean operators was also found to be an effective means for improving user performance. Knowing how to use boolean to formulate query is a great advantage for web users [39]. Therefore, it is no doubt that Boolean has been recorded as the most frequently used facility to support searching [18].

[37] has conducted a study on student's searching behavior. Their study reveal that the system knowledge is crucial as one of the students' feedbacks yield that training on how to use the system is one of the constraints for web searching. The searching behavior of the users illustrates that they would have greatly benefited from easy and immediate access to knowledge tools and those that support navigation.

High domain knowledge enables users to search effectively, and provides a richer set of concepts and terms for query formulation [32], thus initiate a successful search ([38]; [10]). Research has found that having technical searching skills alone is not adequate to search success [40]. Conceptual and semantic knowledge related to the query is required to articulate a good query ([41]; [40]).

4. User Search Behavior and Search Satisfaction

PageRank is an algorithm to determine a document relevancy based on hyperlink in and out from the document [42]. *PageRank* has successfully sort the search results based on the relevancy of the documents or information without human evaluation of the content [43]. Thus, provide unbiased results to search queries. In contrast, [44], point out that incorporating user search behavior in web search system will significantly improve the web search ranking.

[23] classifies the queries into two corresponding categories; broad queries and narrow queries. Broad queries come from a novice and may contain very few terms such as "election", "giraffe" and "tropical forest". Narrow queries on the other hand, are expected from experts and may contain multiple qualifying terms for example "concept based relevance feedback for information retrieval", "parallel sorting neural network", and etc.

Based on the pattern of searching, the search behavior can be divided into three category; top down, bottom up and mix strategy [10]. [10] also stress that the use of these strategies is associated with the kind of search task, especially with how the information was structured in the web, and with the user experience with web searching. How the information was structured in the web is related to the depth and breadth of web search system design.

[45] characterized search behavior at the individual level in terms of depth of search, dynamic of search and activity of search. On the other perspective, [46] define information search behavior on the web into two activities; inter-site and intra-site search. Inter-site search is a search to other web pages, while intra-site search is a search within a site. [46] highlight that web searcher typically cycles both activities as they are searching and move through the information environment of the web. [46] then defined both activities respectively as measures of the breadth of the search and the depth of the search. In this study the measurement of the behavior is based on the depth and breadth of query manipulation.

Both concepts breadth and depth of search are not new in the field of consumer behavior and computer science. As illustrated by [46], in consumer behavior these concepts are similar to the way a consumer moving through a shopping complex to find what he/she desired. While in computer science these concepts are formulated as search algorithms that search a problem space to find the specific solution [47]. Even though, these two fields viewed breadth and depth of search differently, the nature, aim and the final outcome of both activities are similar i.e. browsing the potential node (web pages, links, sub-tree, etc.) to get the solution at minimum cost (reduce search time).

In this study breadth and depth strategy is focus on how users manipulate the query. Breadth query strategy is conceptualized as when users tend to use the same level of queries which will be divided into three types of search strategies; keyword search, wide search definition and general knowledge [26]. The depth of search query is conceptualized as a focus on the topic of search. The strategies involves are complex search, computer convention and Boolean search [26]. [48] in their study on online customer search behavior define search depth as the number of unique retailer web sites within a product category visited during a search session.

The natural tendency of individuals to search broadly or narrowly may have an impact on their success or satisfaction in searching for information on the web to solve user problems [49]. [49] used breadth and depth measurement to the way individuals use hypertext.

5. Conclusion

Previous studies have shown that user knowledge typically topic understanding and search system understanding to have a significant effect on the search satisfaction. This knowledge also influenced user search behavior. User search behavior is the action undertaken by search user, particularly in manipulating the query. The user behavior on this part is crucial as the query use will determine the result. As such, general query used will return millions of general results, whereas specific query will return less result but more focus to the search topic. The active user will take the advantage of the facilities offered by the search system to manipulate and narrow the search in order to get the best result. One of the strategies that have not been widely studied in the domain of search system is the breadth and depth of query manipulation. Breadth and depth behavior of manipulating the query will affect the search performance, thus affect the search satisfaction.

6. References

[1] Battelle, J. *The Search: How Google and Its Rivals Rewrote the Rules of Business and Transformed Our Culture*.Penguin: New York, 2005

[2] Jenkins, C., Jackson, M., Burden, P., & Wallis, J. "Searching the World Wide Web: An Evaluation of Available Tools and Methodologies". *Information and Software Technology, 39*, 1998, pp: 985-994.

[3] Day, J. "The Quest for Information: A Guide to Searching in the Internet". *Journal of Contemporary Dental Practice*, *Nov: (2)4*, 2001, pp: 33-43.

[4] Sullivan, D. "Major Search Engines and Directories". *Search Engine Watch.* Retrieved from http://searchenginewatch.com on April 24, 2008.

[5] Green, D. "The Evolution of Web Searching". *Online Information Review, 24(2)*, 2000, pp: 124-137.

[6] Cooke, A. *A Guide to Finding Quality Information on the Internet (2ⁿᵈ).* Facet Publishing: London, 2001

[7] Lawrence, & Giles, C. L. "Accessibility of Information on the Web". *Intelligence, 11,* 2000, pp: 32-39.

[8] Glover, E. J., Lawrence, S., Gordon, M. D., Birmingham, W. P., and Giles, C. L. "Web Search-Your Way", *Communications of the ACM, 44(12),* 2001, pp: 97-102.

[9] Zoe, L.R., & DiMartino, D. "Cultural Diversity and End User Searching: An Analysis by Gender and Language Background". *Research Strategies*, *17*, 2000, pp: 291-305.

[10] Navarro-Prieto, R., Scaife, M., & Rogers, Y. "Cognitive Strategies in Web Searching". *In Proceedings of the 5ᵗʰ Conference on Human Factors and the Web*, 1999, pp: 43-56.

[11] Ward, M. R., & Lee, M. J. "Internet Shopping, Consumer Search and Product Branding". *Journal of Product and Brand Management . 9(1)*, 1999, pp: 6-20.

[12] Liaw, S. S. & Huang, H. M. « Information Retrieval from the World Wide Web: A User-Focused Approach Based on Individual Experience with Search Engines". *Computers in Human Behaviour, 22,* 2006, pp: 501-517.

[13] Aula, A., & Nordhausen, K. "Modelling Successful Performance in Web Searching". *Journal of the American Society for Information Science and Technology, 57*, 2006, pp. 1678-1693.

[14] Hirsh, S.G. "The Effect of Domain Knowledge on Elementary School Children's Search Behaviour on an IR System: The Science Library Catalogue". *Proceedings of Conference on Companion on Human Factors in Computing Systems, Denver, Colorado, US,* 1995, pp: 55-56.

[15] Steinerova, J. & Susol, J. "Users' Information Behaviour - A Gender Perspective". *Information Research, 12(3),* 2007, Retrieved form http://informationr.net/ir/12-3/paper320.html on July 5, 2007.

[16] Large, A., Beheshti, J. & Rahman, T. "Gender Differences in Collaborative Web Searching Behaviour: An Elementary School Study". *Information Processing and Management, 38,* 2002, pp: 427-443.

[17] Lorigo, L., Pan, B., Hembrooke, H., Joachims, T., Granka, L., & Gay, G. "The Influence of Task and Gender on Search and Evaluation Behavior using Google", *Information Processing and Management, 42,* 2006, pp: 1123-1131.

[18] Ali, N. "The use of Electronic Resources at IIT Delhi Library: A Study of Search Behaviours". *The Electronic Library, 23(6),* 2005, pp: 691-700.

[19]Yee, I. "Research on Web search Behavior". *Library & Information Science Research, 23*, 2001, pp: 167-185.

[20] Topi, H., & Lucas, W. "Searching the Web: Operator Assistance Required". *Information Processing & Management, 41*, 2005, pp: 383-403.

[21] Tabatabai, & Shore, B.M. "How Experts and Novices Search the Web". *Library & Information Science Research, 27*, 2005, pp: 222-248.

[22] Beg, M.M.S. "A Subjective Measure of Web Search Quality". *An International Journal of Information Science, 169*, 2005, pp: 365-381.

[23] Beg, M.M.S., & Ahmad, N. "Web Search Enhancement by Mining User Actions". *Journal of Information Science, 177*, 2007, pp: 5203-5218.

[24] Newell, B.R., Rakow, T., Weston, N.J., & Shanks, D.R. "Search Strategies in Decision Making: The Success of "Success"". *Journal of Behavioral Decision Making, 17*, 2004, pp: 117-137.

[25] Sihvonen, A., & Vakkari, P. "Subject Knowledge, Thesaurus Assisted Query Expansion and Search Success". *Journal of the American Society for Information Science, 55(11)*, 2004, pp: 963-969.

[26] Nachmias, R., & Gilad, A. "Needle in a Hyper stack: Searching Information on the World Wide Web". *Journal of Research on Technology in Education, 34(4)*, 2002, pp: 475-486.

[27] Bilal, D. "Children's Use of the Yahooligans! Web Search Engine III. Cognitive and Physical Behavior on Fully Self generated Search Tasks" *Journal of the American Society for Information Science and Technology, 53(3)*, 2002, pp: 1170-1183.

[28] Botelho, D. "Price Discount and Satisfaction: A Model of Consumer Information Search" *Revista de Economia eAdministracao – IBMEC, 3(1)*, Janeiro-Marco, 2004.

[29] Borgman, C.L. "The Study of User Behaviour on Information Retrieval Systems" SIGCUE, Spring/Summer, 1987.

[30] Borgman, C.L. "Why Are Online Catalogs Still Hard to Use*?" Journal of the American Society For Information Science*, 47,1996, pp: 493-503.

[31] Holscher, C., & Strube, G. "Web Search Behavior of Internet Experts and Newbies" *Computer Networks, 33*, 2000, pp: 337-346.

[32] Sutcliffe, A., & Ennis, M. "Towards a Cognitive Theory of Information Retrieval". *Interacting with Computers, 10*, 1998, pp: 321-351.

[33] Kelly, D., & Cool, C. "The Effects of Topic Familiarity on Information Search Behavior" *Proceedings of the 2nd ACM/IEEE-CS joint conference on Digital libraries*, 2002, pp: 74 - 75

[34] Hong, W., Thong, J.Y. L., Wong, W., & Tam, K. "Determinants of User Acceptance of Digital Libraries: An Empirical Examination of Individual Differences and System Characteristics", *Journal of Management Information Systems, 18(3)*, 2002, pp: 97-124.

[35] Wildemuth, B.M. "The Effects of Domain Knowledge on Search Tactic Formulation" *Journal of the American Society for Information Science and Technology, 55(3)*, 2004, pp: 246-258.

[36] Hildreth, C.R. "The Use and Understanding of Keyword Searching in a University Online Catalog" *Information Technology and Libraries, 16(2)*, 1997, pp: 52-63.

[37] Fidel, R., Davies, R.K., Douglass, M.H., Holder, J.K., Hopkins, C.J., Kushner, E.J., Miyagishima, B.K., & Toney, C.D. "A Visit to the Information Mall: Web Searching Behaviour of High School Students". *Journal of the American Society for Information Science, 50(1)*, 1999, pp: 24-37.

[38] Lucas, W. & Topi, H. "Training for Web Search: Will It Get You in Shape?" *Journal of the American Society for Information Science and Technology, 55(13)*, 2004, pp: 1183-1198.

[39] Chau, M., Fang, X., & Yang, C.C. "Web Searching in Chinese: A Study of a Search Engine in Hong Kong". *Journal of the American Society for Information Science and Technology, 58(7)*, 2007ˌpp: 1044-1054.

[40] Sridhar, M, S. "Subject Searching in the OPAC of a Special Library: Problems and Issues." *OCLC Systems & Services: International Digital Library Perspectives, 20(4)*, 2004, pp: 183-191.

[41] Large, A., Tedd, L. A., & Hartley, R. J. *Information Seeking in the Online Age: Principles and Practice*. Munchen: Saur, 2001

[42] Brin, S., & Page, L. "The Anatomy of a Large Scale Hyper Textual Web Search Engine", *WWW7 / Computer Networks 30(1-7)*, 1998, pp: 107-117.

[43] Austin, D. "How Google Finds Your Needle in the Web's Haystack" *Feature Column: Monthly Essays on Mathematical Topics*. Available online at http://www.ams.org/featurecolumn/archive/pagerank.html, retrieved on October 21, 2007.

[44] Agichtein, E., Brill, E., & Dumais, S. "Improving Web Search Ranking by Incorporating User Behavior Information", *Proceedings of the 29th annual international ACM SIGIR conference on Research and development in information retrieval*, 2006, pp; 19-26.

[45] Johnson, E.J., Moe, W.W., Fader, P.S., Bellman, S., & Lohse, G.L. "On the Depth and Dynamics of Online Search Behavior", *Management Science, 50(3)*, 2004ˌpp: 299-308.

[46] Hodkinson, C. & Kiel, G. "Understanding Web Information Search Behaviour: A Exploratory Model", *Journal of End User Computing, 15(4)*, 2003, pp. 27-48.

[47]Korf, R. E. "Artificial Intelligence Search Algorithms (Chapter 36)", In *Handbook of Algorithms and Theory of Computation.* CRC Press, 1996

[48] Zhang, J.J., Fang, X., & Sheng, O.R.L. "Online Customer Search Depth: Theories and New Findings", *Journal of Management Information Systems, 23(3)*, 2007, pp: 71-95.

[49] Hodkinson, C., Kiel, G., & McColl-Kennedy, J.R. "Consumer Web Search Behaviour: Diagrammatic Illustration of Wayfinding on the Web". *International Journal Human Computer Studies, 52*, 2000, pp: 805-830.

[50] Connell, T.H. "Subject Searching in Online Catalogs: Meta Knowledge Used by Experienced Searchers". *Journal of American Society for Information Science, 46(7)*, 1995, pp: 506-518.