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A WEB SITE USABILITY MEASURE USING NAVIGABILITY MAP METRIC

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ABSTRACT

We propose a website navigability map metrics suite. To evaluate a large scale website, use of website navigability map metrics opens up the potential of employing intelligent tools. We propose a set of four metrics associated with navigability rating based upon computing site navigability map complexity. To validate our proposed metrics we have evaluated the Cyclomatic complexity of 10 electronic commerce websites. We have conducted empirical studies to study the effectiveness of our proposed metrics.
Keywords: *Navigability Map Metrics, Cyclomatic Complexity, Intelligent Tool, Electronic Commerce*

1. INTRODUCTION

Over the last decade, there has been a rapid proliferation in the use of internet for buying and selling, advertising and marketing, together with transition obtains towards consumers. There is also a phenomenal increase in the use of the internet in B2B, mcom and other web applications. However, web applications vary a great deal in facilitating user productivity. Users' experience considerable variance in transacting their business while using different websites. An important reason for this situation is that web site design is largely subjective and lack of standardized web site design methodologies. Further, tools and techniques to quantitatively evaluate the effectiveness of web sites is scarce. In this context, We propose a metric to evaluate the effectiveness of a website in facilitating productivity. Our metrics to evaluate websites are based on several factors associated with a web application.

A key factor affecting the productivity of website explorer is usability. Usability is normally a general way of measuring how effortless any one user interface should be used [1,2]. Nielsen [2] stated that if visitors were not able to easily locate an item they are disinclined to use the website for initiating purchase transactions. Calculating the simplicity, such as usability, navigability is regarded as the crucial attributes.

In the structure of the website navigability map, navigation plays a significant function because it determines the path to be traversed to find a desired piece of information in a web page. The navigable map of the site appears as a graph beginning of the home page as header node. The website header node such as the home page is structured in a particular approach that it should not consist of lots of paths. According to Yen et.al. [4] maximum number of links in a path are twenty in a web page and there are only four clicks needed to get to a required page.

In this paper, We are focused on the way of measuring of the usability of websites in connection with navigation. Here, We specify navigability map is the easiest way to find an information by the user to locating a webpage within a website. We propose four metrics for navigability map complexity.

The rest of the paper has been organized as follows. Section 2 represents an investigation of connected works. Section 3 explains the four main metrics with web system complexity. Section 4 presents the experimental results. Section 5 describes the empirical evaluation. Section 6 concludes the paper

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2. LITERATURE SURVEY

According to Furnas [4] there is a convenient and obvious way to move between related pages and also easy to return to the home page. The website structure relies on the efficiency of usability. The navigable map of the website

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should be in such a way that the user can easily interact website without any formal training. A web site interface is a complex mix of text, links, formatting, graphic elements and site's overall quality [5].

An effective web design is one that makes it easier for users to navigate through the different pages on the site [6]. The navigate map of a website appears as a directed graph where every single node serves as a web page and a path serves as a path to that page [7].

Zaphris et.al.[8], stated that in a website of 64 links, the design with 8 links per page and two levels resulted in fastest response time and lowest navigation efforts.

Rodriguez et.al.[9], designed a tool named as ANTS (Automatic Navigability Testing System). The tool was showed the data flow from the remote system to the server easily. It was study the human behavior without observing where the user are located and which navigability map user can follow. Although the tool could be useful for future information retrieval concerning navigability, still the results showed little relationship between user behavior and navigability.

Jin et.al. [10], modelled a web site as <G, O>, where exactly G = (V, E) can be an outlined graphical record symbolizing an internet site; V stands for the number of nodes addressing internet pages; E represents the number of edges among internet pages, and O is the header node symbolizing home page associated with the web site. They suggested number of paths being measure navigability complexity. The large is the number of paths, the more complicated site construction is, the simpler to get an individual in order to explore the system like an ocean, as well as the poorer is the navigability.

3. NMM: OUR PROPOSED NAVIGABILITY MAP METRICS

To assess the usability, quality of the website, we have developed a metric which we have named as NMM.

3.1 Navigability Map Complexity

The pages in a website are linked with each other through hyperlinks. A user accesses the desired information by following the hyperlinks. Since the amount of hyperlink that a user encounters can be larege, the users can get lost in the huge information, making it difficult to navigate. Our navigability map complexity metrics takes this into account.

The simple navigability map has one single page with no paths. The website navigability map complexity can be defined based on graph theoretical results. The header node such as the home page is structured root of a graph. In constructing a navigable map of a website like a graph, the user may know the how many amount of pages and dead end pages are their in a web site.

For a simple web page , we differentiate the digit of indegree paths and the digit of outdegree paths. Indegree is usually the amount of paths to a web page and outdegree is usually the amount of paths from the web page. As an example, the indegree of web page P is 2 and the outdegree of web page P is 4, shown in figure 1.

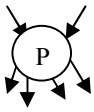

Figure 1: Indegree and Outdegree

Basically, indegree measures the amount of incoming paths and captures how easy it is to achieve a desired page. Lots of indegree signifies it limited to pages that carried out effortless functions recycled during the web site. More indegree paths should not consider as a essential key factor in measure complexity. Where as outdegree measures the amount of outdegree paths. A large outdegree increase the probability of a user getting lost. For this reason outdegree is the key factor in navigation. Based on this observation measuring website navigability map complexity is

$$WNMC_1=\sum_{i=1}^{n} outdegree(i) \quad (1)$$

Out degree(i) = amount of out degree path in a page
n = lots of pages within a web site

In the graph theoretical results it was found that all the directed graph, the summation of indegree paths is equal to outdegree paths, which is equal to the digit of strikeouts. Based on this observation, We can refine expression 3 as

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$WNMC_1=\sum_{i=1}^{n} indegree(i) = digit\ of\ strikeouts$

The intuition behind $WNMC_1$ is that a simple website with less amount of web pages and paths is less complex than a complex website which consists of thousands of paths and pages. However, consideration to the size of website it is needed to know the relative complexity for comparison purposes. Fractioning navigability map complexity by the digit of nodes that is the amount of pages shows a normalized result. The second expression for measuring website navigability map complexity is

$$WNMC_2=WNMC1/_n = \sum_{i=1}^{n} outdegree(i)/n \quad (2)$$

Generally expression 2 represents the navigability map complexity as the average digit of strikeouts per node.

According to Jin et.al. [12], in a web page the numerous individual path in a hyperlinked network is also considered as complexity metrics. On a navigability map every single node represents a web page. The header node associated with a navigability map, each and every individual level, many sub nodes like a web page, those should not have more paths broken along with an inactive node and a sub node those should not have more paths guides toward the node around the finish level. Now we have examined the website navigability map Cyclomatic complexity using the expression 3. According to McCabe [11], the Cyclomatic complexity should not exceed 10.

$$WNMCC_1= (p-n+d+1) \quad (3)$$

p = amount of node paths
n = amount of nodes in the navigability map
d = amount of dead ends in the navigability map
From the numerous individual path in a graph, we can derive the relative complexity as

$$WNMCC_2= (p-n+d+1) /n \quad (4)$$

4. EXPERIMENTAL STUDY

A super easy world-wide-web software program was developed. Typically the program comprises of site download solution which often downlowd all the site. A easy powermapper (www.powermapper.com/download/sort) is needed inorder to produces a powerful HTML navigability map by the uniform resource locator (URL). The breadth first search algorithm is employed to navigate the web site originating in typically the header node which can be generally the home page. Almost all the web pages tend to be retrieved recursively coming from the internet site. The tool creates a website navigability map as a rooted graph with the header node as a home page. This eliminates all of the media and image files. Simply because, in the website navigability map there is absolutely no importance of such files. The tool is designed in such a way that, it calculates all the metrics according to the expressions which is derived in section 3.1 and store the data in the database.

The website of 10 Indian electronics commerce online shopping website were considered in our experiments. To keep anonimity, we have represented these as W_1 to W_{10} respectively. The web site navigability map complexity amount is calculated from the web site navigability map applying expression 1. The relative complexity calculated using expression 2 and website navigability map Cyclomatic complexity and relative complexity calculated using the expression 3 and 4. Table 1 shows the computed metrics for the navigability maps.

For the comparison of complexity we derived the relative complexity $WNMC_2$ and WNMCC2. We can find from the computed metrics that W_2 website score the highest mark where as W_{10} website becomes a more complex structure in navigability map and remaining all websites are similar. Here, $WNMC_1$ and $WNMCC_1$ have the same behavior.

5. EMPIRICAL EVALUATION

We have conducted experiments to study the effectiveness of our proposed metrics on a few comparable web sites. The web sites chosen during the empirical exploration are all business to consumer electronics commerce websites. The electronics commerce websites are geographically located in India. The web sites are named as W_1, W_2 to W_{10}. In the empirical study 100 participants from computer field which are also proficient from the utilization of the web site to obtain the needed information were selected to participate in the empirical study. Of the 100 participants, 50 novice participants those who have less than 3 years

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experience in the computer field and 50 expert participants those who have more than 3 years experience in the computer field are selected. The age limit of those participants varies from 18 to over 50 years.

5.1 Evaluation Procedure

An evaluation procedure was developed to welcome the participants and to provide an introduction to the research. A consent form is designed with a proper format for all the 100 participants present over in this research work. All the participants have assigned a particular task that is purchasing a product in 10 electronic commerce websites.

5.2 Customer Usability Evaluation

A test questionnaire was developed and hard to be filled out by the participants after they had completed the task. The questionnaire was selected based on the list of attributes of navigability collected from IEEE guidelines. The questionnaire includes 8 segments. Every single segment is dealt with a specific aspects of web navigability. Its contain has a amount of assessments for the participants to execute and to provide a quantitative value on the attributes. Segment 1 is concerned with the average time on site, Segment 2 is about the average page views per explore, Segment 3 is concerned with the percentage of time spent exploreing, Segment 4 tests the percentage of strikeout depth explore, Segment 5 is concerned with the amount of backtracking path to get a desired page.

Average time on site is calculated as overall time spent on site for all explores / Explores that is the highest value of this metric might indicate that participants interact extensively with the site.

Average page views per explore is calculated as the amount of page Views / Explores that is the highest value of this metric might indicate that: participants were interested in the site, or the content of the site is interesting, Low value of this metric might indicate that the site is difficult to navigate, or the content of the site is poorly written.

Percentage of time spent exploreing (Percentage of explores in terms of average time participants spent during their explores) derived as percentage of duration exploreing = (Overall Amount of Explores Spending between 0 Seconds and 3 Minutes on the Site/ All Explores) X 100 that is if a site has a relatively high percentage of low time spent exploreing, then this could indicate either: the site is poorly targeted participants or it could be that the site has problems with its information architecture and usability or the site's content are not relevant.

Percentage of medium time spent exploreing = (Overall Amount of Explores Spending between 3 and 10 Minutes / All Explores) X 100.

Percentage of High Time Spent Explores (also known as committed participant share*)* = (Overall Amount of Explores Spending more than 10 Minutes on the Site / All Explores) X 100 that is if a site has a high percentage of high time spent exploreing, this might indicate that participants engage in the activity of the site.

Percentage of Strikeout Depth (Page View) Explores (Percentage of explores in terms of amount of pages participants viewed during their explores) are derived as a Percentage of Low Strikeout Depth Explores = (Overall Amount of Explores of Two Strikeouts or Less/ All Explores) X 100 that is if a site has a high percentage of low strikeout depth explores, this might mean that the site is confusing or uninteresting.

Percentage of Medium Strikeout Depth Explores = (Overall Amount of Explores of 3 Strikeouts to Average page Views Per Explore / All Explores) X 100.

Percentage of High Strikeout Depth Explores (also known as a heavy user share*)* = (Overall Amount of Explores More than Average page Views Per Explore Strikeouts / All Explores) X 100 that is if a site has a high percentage of high strikeout depth explores, this might mean that the site is engaging and interesting or that the site is targeting participants properly and the ease of use of the site.

The particular answers are suggested in Table 2. Tables 2 reveals that right from an objective fuzzy standpoint, W_2 online business increased the best draw relating to navigability, and additionally W_{10} typically the lowest. It complements Table 1 well.

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6. CONCLUSION

We have proposed four metrics that can be used for evaluating the usability and productivity aspects of websites.We measured four metrics of electronics commerce internet site navigability map. Our experiment shows that a web navigability map complexity is key factors that can be used in a internet site measure. The empirical evaluation results suggest that navigability map complexity plays a vital role in the measurement of navigability. There are still limitations to the navigability map complexity, such as taxonomy within the page, layout of paths are the problems of navigability. We plan to extend our work to refine our work to consider productivity (understandability of the text) evaluation of websites.

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Table 1: Summary of Evaluated Map Complexity Metrics

Web site	Pages	WNMC1	WNMC2	WNMCC1	WNMCC2
W1	5744	118423	20.6	112481	19.6
W2	6920	123483	17.9	120122	17.4
W3	3680	86760	23.6	86012	23.4
W4	4710	122948	26.1	122241	26.0
W5	3420	90482	26.5	90002	26.3
W6	6882	134256	19.5	133842	19.4
W7	7938	146734	18.9	146001	18.4
W8	3546	84310	23.8	83922	23.6
W9	5842	107493	18.4	103403	17.7
W10	4608	131789	28.6	128563	27.9

Table 2: Customer Survey Outputs of Navigability

Segment	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
1. Average time on site	00:06:52	00:07:01	00:03:29	00:04:32	00:05:41	00:03:24	00:04:38	00:05:22	00:03:54	00:03:34
2. Average page views per explore	17.11	18.56	13.82	11.09	9.0	8.13	7.49	10.1	11.9	5.62
3. Percentage of time spent exploreing	60.17	57.75	76.76	61.12	63.45	71.52	69.78	66.64	73.82	77.75
4. Percentage of medium time spent exploreing	14.48	21.67	13.23	15.45	14.13	13.98	19.67	18.43	16.52	12.12
5. Percentage of High Time Spent Explores	10.01	18.17	8.53	10.83	12.78	11.76	13.45	15.38	14.87	7.77
6. Percentage of low Strikeout Depth (Page View) Explores (Percentage of explores in terms of amount of pages participants viewed during their explores)	35.38	31.29	41.14	32.63	54.56	52.41	45.23	39.65	33.75	59.20
7. Percentage of Medium Strikeout Depth Explores	42.57	37.97	24.13	25.0	25.34	24.56	25.21	25.44	26.78	22.99
8. Percentage of High Strikeout Depth Explores	26.14	26.66	22.35	23.63	25.13	19.29	18.56	24.13	23.67	17.81