Measuring Web Site Usability Quality Complexity Metrics for Navigability

Sandeep Kumar Panda, Santosh Kumar Swain and Rajib Mall

Abstract Now days, Web site design depends on a key feature such as navigability. This paper aims to find the usability, quality of web structure, based on the construction of hierarchical structure of the Web site, digit of strikeouts, and cyclomatic complexity of a Web site roadmap. The PowerMapper tool generates the roadmap for the league Web site. Route matrix is used to check the maximum digit of strikeouts to find the web page and Web site complexity is found by Web site structural cyclomatic complexity. The ease of use of the Web site, such as usability quality is calculated in 10-point scale and using some mathematical formula, the output suggests the improvement of Web site structure.

Keywords Cyclomatic complexity · Navigability · Web site roadmap

1 Introduction

Of late, there has been a proliferation of commercial Web sites due to the increased use of the Internet. There is a phenomenal increase in many organizations those are using the web for trading, marketing, promoting, and transacting products and services to consumers. Apart from firms and organizations, there seems to be a very large growth of the Internet by consumers for various purposes,

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including online shopping and information search. The consumer interest rise in online shopping is affecting the traditional retail sales. The rise in business to consumer electronic commerce has made many organization looks for new ways to understand online shopping behavior to attract and keep the consumers. Till today, the center of focus for web users is usability engineering.

To be successful, Web sites need to have good usability. Usability is an overall measure of how easy the user interface is to use [1–3]. Nielsen [3] stated that if users were unable to find a product, they would not buy it. Measuring the usability, navigation is one of the key attributes. We define how easily the real users find the desired information by linking through the Web site via navigability.

In the construction of Web site roadmap, navigation places an important role because it finds the route to be traversed to get a desired web page. The roadmap of the Web site looks like a tree starting from the home page as origin node. The Web site origin node such as the home page is constructed in a certain way that it should not consist of lots of routes. According to Benjamin Yen, in 2007 maximum digits of links in a route are 20 in a web page and there are only four strikeouts needed to reach a desired page [4]. At the time of designing a roadmap of a Web site, developer must consider these facts.

Section 2 represents a survey of related works. Section 3 describes the three metrics that are a road map of Web site structure, maximum digit of strikeout routes and web structure cyclomatic complexity. Section 4 presents the evaluation output. Section 5 concludes the paper with a critical analysis and interpretation of our work. Finally, we discuss the possible future extensions to our work.

2 Literature Survey

Web usability is the ease of use of a Web site [3]. Navigation is one of the important components of web pages that support the user in finding information and in browsing through the site's content. There is a convenient and obvious way to move between related pages and sections and also easy to return to the home page. The Web site structure relies on the efficiency of usability. The roadmap of the Web site should be in such a way that the user can easily interact Web site without any formal training. A Web site interface is a complex mix of text, links, formatting, graphic elements, and other aspects that affect the 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 roadmap of a Web site appears as a directed graph where every single node serves as a web page and a route serves as a path to that page [7].

3 Procedure

To assess the usability quality of the Web site, the roadmap consists of three phases: construction of hierarchical structure of the web pages of the Web sites, calculation of route dimension metrics and finding the roadmap cyclomatic complexity of the Web site.

3.1 Construction of Hierarchical Structure of Web Site

A simple web software tool that is PowerMapper generates an HTML roadmap from a given uniform resource locator (URL). The search algorithm, breadth first search (BFS) is used to travel the Web site starting from the origin node such as a home page. All the pages are fetched recursively from the Web site. The tool generates Web site roadmap as a hierarchical tree with the origin node as a home page. In filter process, it removes all the multimedia and graphic files, because in Web site roadmap there is no significance of these files. The hierarchical tree structure of the Snapdeal.com commercial Web site is given in Fig. 1.

3.2 Calculation of Route Dimension Metric

A route dimension is needed to score the maximum digit of strikeouts per page. The route dimension of the tree is determined by the summation of all the level

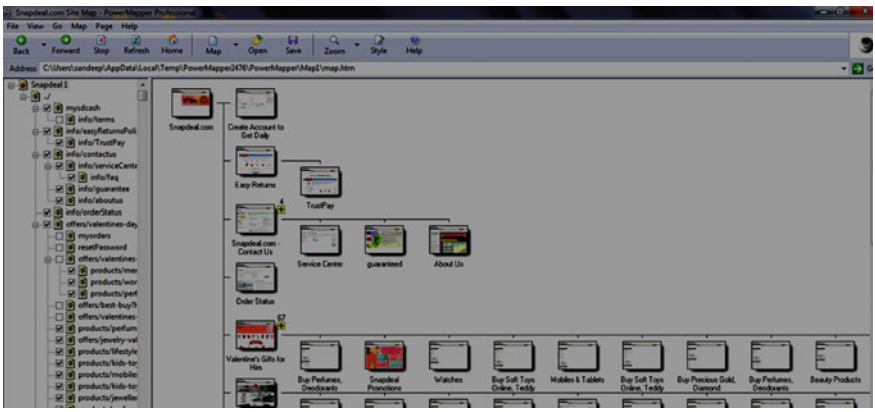

Fig. 1 Snapdeal.com Web site roadmap

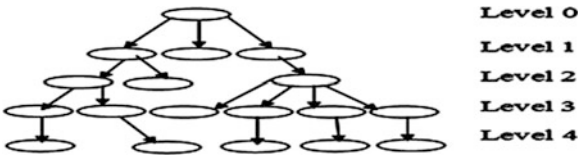

Fig. 2 A tree with four levels

nodes. In formulae 1, the route dimension is calculated as the summation of all level weights with the digit of nodes in each level. The maximum digit of strikeouts is calculated applying formulae 2.

$$\text{Route Dimension} = \sum Lj \cdot Nj \tag{1}$$

where Lj is level digit j, Nj is the digit of nodes at level j.

$$\text{Maximum digit of strikeouts} = \text{route dimension}/m \tag{2}$$

where m is the digit of nodes in the tree. An example tree is shown in Fig. 2.

Route dimension $= 0 \times 1 + 1 \times 3 + 2 \times 3 + 3 \times 6 + 4 \times 5 = 47$

Average digit of strikeouts $= 47/18 = 2.61$

3.3 Roadmap Complexity

In graph theory, the Web site structural cyclomatic complexity is described as follows. The origin node such as the home page is structured as a tree. In constructing a roadmap of a Web site such as a tree, one has to know the height and level of the tree. The origin node contains lots of sub nodes and dead nodes. An origin node structure with the sub nodes of a Web site is shown in Fig. 3.

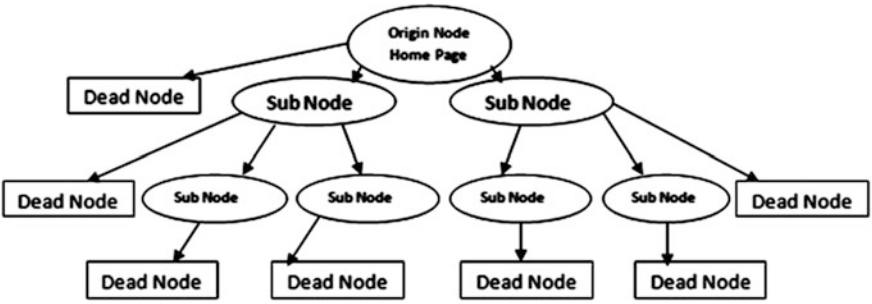

Fig. 3 A tree structure of a Web site

There are too many intermediate links are present in an origin, such as the home page of a Web site. In a roadmap, every single node appears as a web page, again the web pages are routed differently and at the least there is a dead node. In an origin node of a roadmap, at every single level, all sub nodes such as a web page, those do not have further routes ended with a dead node and a sub node those have further routes directs to the node up to the end level. We have evaluated the Web site structural cyclomatic complexity in formulae 3. According to McCab [8] in 1976, the cyclomatic complexity digit does not exceed 10.

$$\text{Web site Structural Cyclomatic Complexity} = (R - N + D + 1)/N \quad (3)$$

R number of node routes
N number of nodes in the roadmap
D number of dead ends in the roadmap

4 Evaluation

The Web sites of more than 10 Indian electronics commerce online shopping Web sites are taken under assessment mode. The PowerMapper web tool fetches URL address of each e-commerce Web site and creates roadmap. The Web site roadmap combines all the web pages and looks like a tree structure at different levels. The maximum digit of strikeouts desired to retrieve a web page is calculated with route dimension metric applying formulae 1 and 2. The Web site structural cyclomatic complexity number is calculated from the Web site roadmap applying formulae 3. The roadmap of every single e-commerce Web site is computed in 10-point scale. Every single e-commerce Web sites are focused on organizational web pages in the roadmap, Web site structural cyclomatic complexity of the Web site and maximum digit of strikeouts from the 10-point scale value. The calculation process for 10-point scale value is given in Tables 1 and 2. The roadmap of the Snapdeal.com commercial Web site is given in the Fig. 3. The navigability value of the Snapdeal.com commercial Web site up to two levels is given in Table 3. The usability quality of 10 e-commerce Web site roadmap assessments are given in Table 4. Table 5 shows the 10 point scale assessment description.

Table 1 The roadmap and cyclomatic complexity calculated from 10-point scale

Sl. no.	Quality parameter	10-point scale value evaluation
1.	Number of links on web page of roadmap tree	If (number of links in the home page = total number of web pages) and (number of links in home page $\leq$20) then $k1 = 10$ else
		If (number of links in a page between 10 and 29) then $k1 = 10$ else
		If (number of links in a page = 9 or 21) then $k1 = 9$ else
		If (number of links in a page = 8 or 22) then $k1 = 8$ else
		If (number of links in a page = 7 or 23) then $k1 = 7$ else
		If (number of links in a page = 6 or 24) then $k1 = 6$ else
		If (number of links in a page = 5 or 25) then $k1 = 5$ else
		If (number of links in a page = 4 or 26) then $k1 = 4$ else
		If (number of links in a page = 3 or 27) then $k1 = 3$ else
		If (number of links in a page = 2 or 28) then $k1 = 2$ else
		If (number of links in a page = 1 or 29) then $k1 = 1$ else $k1 = 0$
2.	Cyclomatic complexity	If (cyclomatic complexity $\leq$1) then $k2 = 10$ else
		If (cyclomatic complexity $\leq$2) then $k2 = 9$ else
		If (cyclomatic complexity $\leq$3) then $k2 = 8$ else
		If (cyclomatic complexity $\leq$4) then $k2 = 7$ else
		If (cyclomatic complexity $\leq$5) then $k2 = 6$ else
		If (cyclomatic complexity $\leq$6) then $k2 = 5$ else
		If (cyclomatic complexity $\leq$7) then $k2 = 4$ else
		If (cyclomatic complexity $\leq$8) then $k2 = 3$ else
		If (cyclomatic complexity $\leq$9) then $k2 = 2$ else
		If (cyclomatic complexity $\leq$10) then $k2 = 1$ else $k2 = 0$
Value = average ($k1$, $k2$)		

Table 2 Maximum digit of strikeouts index calculated from 10-point scale

Sl. no	Quality parameter index	10-point scale value
1.	Average digit of strikeouts per web page	If average digit of strikeouts ≤2.5 then
		Value = value + 0.75 else
		If average digit of strikeouts ≤4 then
		Value = value + 0.5 else
		If average digit of strikeouts ≤5 then
		Value = value + 0.25 else

Table 3 The Snapdeal.com Web site structure quality evaluation

University name: Snapdeal.com			
Route dimension = 1,575			
Average digit of strikeouts = 2.90590			
Level number	Subtree in Web site structure	Number. of web pages in subtree	10-point scale value
1.	1	26	1
2.	1	1	1
	2	4	3
	3	17	4
	4	12	5
	5	6	7
	6	9	8
	7	9	8
	8	3	3
	9	1	1
	10	11	10
	11	1	1
	12	3	3
	13	22	1
	14	20	1
	15	04	4
	16	02	2
	17	08	5
	18	01	1
	19	02	2
3.112903			
Cyclomatic complexity = (R − N + D + 1)/N = (2,064 − 452 + 90 + 1)/452 = 3.365044		10-point scale value = 7	
Route dimension = 1,575		Average digit of strikeouts = 2.90590	
10 point scale value of snapdeal.com structure = 3.112903 + 7 + 0.50 = 10			

Table 4 Usability quality of various e-commerce Web site structure

Sl. no.	University name	$P1$	$P2$	Avg ($P1$, $P2$)	R	10-point scale value	Remarks
1.	Snapdeal.com	3.112903	7	5.056451	0.50	10	Very good
2.	Flipkart.com	4.21875	8	6.109375	0.50	12	Very good
3.	Ebay.com	5.666667	3	4.333333	0.25	8.9	Needs minor changes
4.	Homeshop18.com	2.55	6	4.275	0.25	8.8	Needs minor changes
5.	Quikr.com	4.380952	8	6.190476	0.5	12	Very good
6.	Jabong.com	2.833333	8	5.516667	0.75	11	Very good
7.	Myntra.com	3.058824	9	6.029412	0.75	12	Very good
8.	Futurebazaar.com	2.365854	6	4.182927	0.75	9.1	Good
9.	Naaptol.com	4.346154	5	4.673077	0.75	10	Very good
10.	Yepme.com	3.352941	6	4.676471	0.75	10	Very good

$P1$ = Road map calculation value, $P2$ = cyclomatic complexity value, R = route dimension metrics

Table 5 10-point scale value description

0–4	5–6	7	8	9	10
Very poor	Poor	Needs improvement	Needs minor changes	Good	Very good

5 Conclusion

We investigated three metrics of e-commerce Web site roadmap. Our study shows that a digit of strikeouts, web structure cyclomatic complexity, and navigability are the key dimensions toward Web site measure. The web developer concentrates on these key dimensions to measure the usability quality of the Web site. There are still limitations to the roadmap complexity, such as the structure of each page route, that will also an important issue of navigability. In the future, we have extended our work to find out the major and minor problems such as broken links of navigability on a Web site.

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