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Abstract

The current state of the World Wide Web demands website designs that engage consumers in order to allow them to consume services or generate leads to maximize revenue. This paper describes a software quality factor to measure the success of websites by analyzing web design structure and not relying only on websites traffic data. It is also documents the requirements and architecture to build a software tool that measures criteria for determining Engagibility. A new set of social criteria to be measured for current website philosophy is also proposed.

1. Introduction

To maintain and to build a professional e-commerce website can be quite expensive, with the prices starting at €10,000 for a professional design by a company with proven records [1]. Losing customers due to the lack of quality of design or lack of communication tools can be minimized with the right software for detecting design issues [2]. It has also been suggested by usability expert Jakob Nielsen, that users tend to choose websites that are easy to use rather than sites with complicated structure and functionality. Nielson's annual report into website habits shows that people are becoming much less patient when they go online [3]. The purpose of this paper is to document the steps involves in developing a software tool to measure design and clarify the current metrics for measuring quality-of-design of a modern website. The resultant software tool could have various applications like analyzing an existing website or benchmarking a website with a competitors. Benchmarking against competitors is a good practice to understand which areas can be improved [4].

The paper may be used by researchers and business owners as reference to calculate the amount of work required to build a website measurement tool. It also can be use as guidelines with key metrics to measure success in website design. Section 2 describes the source for the metrics used to build the software tool. Section 3 explains how to measure the metrics proposed in Section 2 and Section 4 considers a set of new design metrics for modern engaging websites.

2. Design Metrics

Business owners know that a website is a marketing tool that enables sales, brand recognition and better communication with consumers. The current competition between e-commerce websites is very high and website owners require guidelines and tools to have a better understanding of their e-commerce presence. This section presents a quality software model and the metrics extracted from this model. These metrics were used to build a software tool that could help business owners to have a better understanding of the quality of their web presence and to analyze a competitor's website through benchmarking.

Early detection of design problems might reduce the cost of the website and increase visitors' satisfaction yet the current state of the art in software for website analysis does not support the detection of such problems. Software tools like Google Analytics or WebTrends focus on collecting data related to website traffic. Common metrics found in these tools are number of unique visitors, number of page views, average time on site, bounce rate, web traffic sources and other metrics that only inform about how the users use and reach a website. All these reports are interesting and bring information like the most popular page on the site or which are the keywords used on the search engines to arrive to your site. However none of these metrics focuses on detecting design issues. Moreover to extract relevant

information from these types of metrics the website must have been in existence for a period of time. Website use reports are not available during the design and implementation phases. It seems that with website usage metrics it is difficult to detect possible design issues; at the moment there isn't a direct report available. To solve the issue of detecting design problems in a website this paper uses Engagibility a software quality factor to measure quality-of-design with a set of criteria to be measured. Engagibility was one of the five additional quality factors for the World Wide Web [5]. It studies the mechanisms that a website requires to attract repeat visitors [7].

Engagibility is a quality factor that aims to measure the level of engagement that a website design offers to website visitors. It seeks to define how likely consumers are going to return to a website after their first visit. The characteristics of Engagibility are: navigability, interactivity and appeal [7]. One of the most important parts is that it stresses the strategy of "*two-way communication*" between users and websites. This strategy is also supported by Cao, Zhang and Seydel in their paper "B2C e-commerce website quality: an empirical examination" [4].

The two-way communication strategy follows:
1. A website exposes its service or goods to its visitors.
2. The visitor's potential need to communicate with the website or with other visitors.
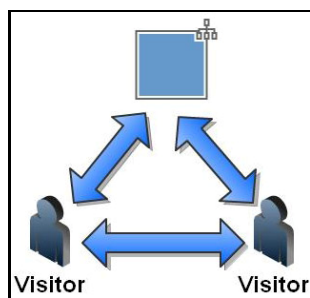
Figure 1 Representation two-ways of communication strategy

Typically, a website visitor might link to an existing website and could write comments about a product or service. A different visitor can read and respond to the previous comments. Meantime, website owners can response to both visitors' comments or improve their product/service according to the consumers feedback. With this strategy it is expected that customers' satisfaction with the website will increase and they might better engage with the website's content and service [4].

The characteristics that define and enable website Engagibility are called enablers [3]. Table 1 list some of these enablers.

Table 1 Enablers of website Engagibility

□ Menu Structure	□ User-defined preference
□ Home	□ Email communication
□ Keyword search	□ Comments forum
□ Hyperlinks	□ Chat room
□ Signposting	□ Questions Bulletin Board
□ Data Retrieval	□ Offer a Unique experience
□ Online E-commerce	□ Evoke emotion

These enablers can be measured through a set of criteria that need to be found and counted [7]. There are approximately 67 different criteria. These criteria are grouped in 10 types of ratio. Table 2 Quality-of-product ratios (source: Dr Fitzpatrick) lists these ratios and show set of relevant criteria for each ratio.

Table 2 Quality-of-product ratios (source: Dr Fitzpatrick)

	Criteria	**Counts**
Common ratio	Size of active website in KB	Semi-Automatic
	Number of active HTML pages in website	Semi-Automatic
	Total scanned Web objects in active website	Manual
Navigation ratio criteria	Number of pages containing site-bound links in website	Manual
	Total occurrences of links to Home	
Surf ratio criteria	Total occurrences of outbound links in website	Manual
	Number of pages containing outbound links	Manual
Activities ratio criteria	Number of core activity components: □ Contact Us, □ survey/feedback form, □ mailing list/discussion forum, □ site search, □ bulletin board, □ chat line, □ newsletter, □ e-mail this page, □ archive retrieval, site □ map.	Manual
Contribution ratio criteria	Number of content contribution activity components: □ Visitor Content Management, □ mailing list/Discussion forum, □ others.	Manual
	Number of fields in site membership Registration Form	Manual
Commerce ratio criteria	Number of fields in first-time buyer's Registration Form	Manual
	Number of Add to Basket offers on Home Page	Manual
Assistive ratio criteria	Number of voice enabled HTML pages in websites	Manual
	Number of text colours on Home Page	Manual
	Number of fonts on Home Page	Manual
Community ratio criteria	Number of community activity components: □ Conferencing, □ intranet, □ mailing, □ chat line, □ newsletter, □ newsgroups, □ diary, □ gaming/quiz, □ survey/feedback form, □ guest book	Manual
Competitive ratio criteria	Number of competitive activity components: □ e-learning, □ Intranet, □ multi-lingual options, □ other sector-specific activity.	Manual

The counts at Table 2 can be counted semi-automatically or manually. This paper describes the process followed to develop a software tool that automatically gathers these criteria counts.

Some of the advantages of developing a software tool for automatic criteria measurement are:

- Reduce cost of testing and building a website.
- A website can be benchmarked against competitors.
- A website could be tested before is launched.
- Reduced need to hire people for testing a website through surveys or interviews.
- Supports collaboration between managers and designers for improved and faster design decisions.

These criteria and the values of their counts are used to measure quality-of-product (design). The website quality is calculated based on a mathematical model that include the values of these criteria. To get more information about the formula the reader is referred to the original paper [7].

Section 3 explains the requirements to build a tool to measure criteria and their counts. It is also explains the steps and decision taken to build the tool use to count the criteria values.

3. Requirements to build a software tool to measure design

Section 2 has defined the typical metrics for measuring website design quality. This section is divided into three subsections. The first 3.1 explain how the software tool measures five different criteria counts. The second 3.2 lists the software requirements and challenges overcome to build the software tool and the third 3.3 briefly explain the required architecture to meet the software requirements.

3.1. How to measure criteria counts

There are 64 different criteria to be measured grouped between 10 different ratios. The software tool focuses on finding the counts for the following: Common, Navigation Ratio, Surf Ratio, Activity Ratio and Assistive Ratio. The reason for choosing this set is that all of these ratios require a different technique to measure the values for their counts. The remaining criteria can be measured in the future using the same or similar techniques.

From the 64 set of criteria that were previously gathered manually or semi-automatically, the new application gathers 32 criteria automatically, an improvement of approx. 50%.

The following sections present the different criteria that were included in the measurement tool and clarify how each count was measured.

3.1.1. Common Criteria

The Common criteria measured were:

- Size of active website
- Number of active HTML pages in website
- Number of levels below Home page
- Number of HTML pages at level 0, level 1, level 2, level 3, level 4 and below level 5
- Total occurrences of horizontal menus in site
- Total occurrences of vertical menus in site
- Total scanned web objects in active site

Size of active website: This was calculated as the sum all existing web pages, the size of images, size of JavaScript and CSS files. The API used was the responsible to determine the size of every object analyzed.

Number of active HTML pages in website: This was the result of counting the total number of "text/html" [17] objects found. The "Text/html" value is found under the MIME type [18], information available on the header of an HTTP request.

HTML pages at every level: The level was determined by analyzing the URL structure. In most URL's the level is determined for the number of "slashes" (/). Given any URL, the software tool counts the number slashes and increments a counter to that level.

To decide the technique to count the *total occurrences of horizontal and vertical menus* in an existing website was a challenge because of the nature in which web pages are developed; the HTML used to build websites' menus differs between websites. Modern website development techniques where studied to find a solution.

Web developers use Cascading Style Sheets (CSS) and Document Object Model (DOM) to give format to web pages content. Using CSS and DOM developers can transverse HTML pages and access specific sections that are wrapped under a unique ID or name. Typical sections identified by a unique ID are: top navigation, header menu, footer menu, breadcrumbs, sidebars or main content. Web Developers are responsible for defining the unique ID's that identifies such sections.

Assuming most modern websites are developed using such techniques, the application was implemented as being able to access the HTML content wrapped within a unique ID.

Using this solution the final software tools follows the logic: the software is launched to start the process of measuring counts then the application requests the user to input the unique IDs that identify the horizontal menu and vertical menu. When the unique IDs are available the software automatically measures the counts within the scope of these two unique IDs.

Total scanned web object in active site was measured counting the total number of unique URL's downloaded. The objects could be HTML pages, JavaScript Files, Images, Sounds files, Word Documents, PDF files and any other web object that belong to the website.

3.1.2. Navigation Ratio Criteria

The Navigation Ratio Criteria measured were:
- Number of site bound links from Home page
- Total occurrences of site bound links in website
- Number of pages containing site bound links
- Total occurrences of site bound links in horizontal menus
- Total occurrences of site bound links in vertical menus
- Total occurrences of links to Home
- Total occurrences of links to Top
- Number of pages supporting site search engine

Site bound links are the links that point to other web pages within the same websites. To identify site bound links the software compares the domain name of a link with the domain currently being analyzed.

Number of site bound links from Home page - the software simple counts the number of links on the home page. The home page is the initial URL introduced by the user.

Total occurrences of site bound links in website, is the sum of all unique site bound links found during the process of analysis.

Number of pages containing site bound links is the sum of all unique pages with site bound links.

Total occurrences of site bound links in horizontal menus and vertical menus. To identify the menus the technique described at section 3.1.1 was applied. The total was the sum of unique site bound links within the identified menus.

Total occurrences of links to Home and Top page were measured analysing the anchor tag from a hyperlink. The anchor tag is the visible part of a hyperlink. The software analyzes the anchor tag looking for the keywords "top" and "home".

Number of pages supporting site search engine, the software identifies the search form looking for all the forms available on a given web page. For each form the keyword "search" was search within the form attributes ID, name and action. When found a total counter was incremented.

3.1.3. Surf Ratio Criteria

The Surf Ratio Criteria to be measured were:
- Number of outbound links from Home Page
- Total occurrences of outbound links in website
- Number of pages containing outbound links
- Total occurrences of outbound links in horizontal menus
- Total occurrences of outbound links in vertical menus

Outbound links are the links that point to other web sites. The software compares the domain name of a link with the domain currently being analyzed; if it is different the link is classified as an outbound link.

Total occurrences of outbound links from Home page, the software counts the number of outbound links from home page. The home page is the initial URL introduced by the user.

Total occurrences of outbound links in website, it is the sum of all unique outbound links found during the process of analysis.

Number of pages containing outbound links, it is the sum of all unique web pages with outbound links.

Total occurrences of outbound links in horizontal menus and vertical menus, As mentioned in the previous section the menus were identified applying the technique described at section 3.1.1. The total was the sum of unique outbound links within the identified menus.

3.1.4. Activity Ratio Criteria

Activity Ratio Criteria has one criteria to be measured:
- Number of core activity components

The core activity components can be: contact us, feedback form, forum, site search, newsletter, email this page, archive retrieval and site map. From interviewing professional web developers and investigating popular websites it was identified that these components were represented in a form of web pages with a common name that was identifiable at URL. For instance contact us could be found on the form of contact-us, contact_us or contactus, sample www.site.com/contacus.php. Knowing that fact, the software search for the components at the URL structure in English language. For the initial software goals searching for the components at the URL was enough. Future versions might consider analysing HTML content to identify the core components.

3.1.5. Assistive Ratio Criteria

The assistive ratio criteria can be grouped in 3 types of components that can be measured with different techniques: Enable Voice, Images and Images with alt tags and Home Page colors.

Enable Voice; there were 3 criteria to be measured:
- Number of voice enabled HTML pages in website
- Number of voice enabled hyperlinks in website
- Number of voice enabled activity components in website

During research a project was found under the World Wide Web consortium, they are working in a feature to enable voice browser activity, http://www.w3.org/Voice/. Currently, this feature has not being embraced by the web community. It wasn't found implemented. Future work will consider investigating the use of this tag further.

Images and alt tag, there were two criteria to be measured:

- Number of embedded images in website
- Number of embedded images in website alt tags

The technique to measure these count was straightforward. During the process of analysis the application re-use an existing java API that allows access to images and alt tag information within a given web page. The API used was HttpUnit, http://httpunit.sourceforge.net/. The software tool just needed to count the information extracted from the API to calculate the number of images and the number of images with alt tags in website.

Home page colors, there are four criteria to be measured on home page:

- Number of background colours
- Number of text colours
- Number of font sizes
- Number of fonts on Home Page

Modern web development techniques were used here as well, as explained in section 3.1.1. Cascading Style Sheet (CSS) technology is the most common and standard method to give colour and shape to a website. CSS can be embedded with the HTML or can be loaded in a separated file. The application checks both possibilities on the home page. When the CSS file is stored in a separate file, this must be downloaded before it can be analyzed. The CSS file and the HTML are parsed and analyzed looking for the correspondent CSS properties. The properties analyzed were four: background, colour, font-size and font-family. The information from the CSS is analyzed using regular expressions.

3.2. Software Requirements to Measure Criteria Count

This section explains the software requirements for implementing the techniques to count the criteria proposed for Engagibility.

When planning to create a software tool that is required for extracting and analyzing information from an existing website there is a core component to be implemented: a web crawler. A web crawler is a program that, given one seed URL, downloads the web pages associated with that URL, extracts any links contained in them, and recursively continues to download the web pages identified by these links [9]. All URL's are stored in a relational database so that they can be used for other components of the application.

In addition to the web crawler, there is second key component: the HTML analyser. This component is responsible for visiting all web pages found by the web crawler and measuring the criteria counts according to the techniques described in section 3.1.

The final component is a report system that allows the software users to store the analysis and access the results anytime. The results are presented in HTML format. Because all results from the analysis are stored in a relational database and the software has been implemented using modules other types of reports could be implemented when required.

Building the web crawler module required an extra effort of research and development. The following section briefly presents the finding during this process.

3.2.1. Web Crawler requirements

The aim of the software tool is to measure the Engagibility criteria counts. For this purpose the web crawler wasn't required to analyse a huge amount of web pages per day like

in the case of search engine applications. The aim was to analyze 10 to 20 websites a day. It didn't require a scalable crawler that was installed across multiples machines.

There were three areas to be researched before planning and developing a web crawler: web crawler architecture, web crawler challenges and web crawler algorithms.

Web crawler architecture followed the typical architecture found in the research papers frontier, history, fetching client and HTML parser [15].

Web crawler challenges: The web crawler didn't have to support complex and demanding crawling features like indexing the web. However, developing a web crawler for measuring design in a single web site (or developing an application to index the web) a web crawler must consider the challenges: URL normalization, multi-threading, hyperlink extraction, detection of duplicate URL's in the frontier, Maintain frontier in a single machine, spider traps, limiting time of an HTTP request, avoiding overloading websites or networks links, and dealing with huge volumes of data. These challenges have been studied and documented in authoritative research papers [9][13][14].

Web crawler algorithm: The application implemented the basic one Best-First Schema web crawler algorithm with a multithreading approach. There are further crawling algorithms (Naïve Best-First Crawler (Multi-threaded crawler model), Shark Search and Focused Crawler [15].) but all are variations of the Best-First schema. The difference is in the heuristics used to choose unvisited URL's.

3.3. Software Architecture

To have a better understanding of the measurement software tool developed, this section presents the schema that represents its architecture.

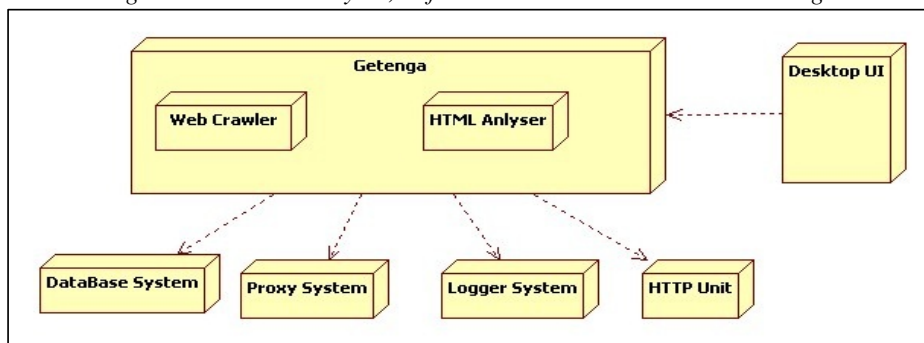*Figure 2 Criteria Analyser, Software Architecture to measure design*

Figure 4 shows the software architecture to measure quality of the design. The components are:

- Getenga: This is the main component. It was developed as independent API module so that it can be used for external modules like "Desktop UI". Getenga is composed of the two sub components:
  - o Web Crawler: Subsystem responsible for finding a collection of unique URLs in an existing website.
  - o HTML analyser: Subsystem responsible for measuring the counts and calculating ratios. It is implemented with all the techniques described in section 3.1.
- Data Base System: Subsystem responsible for saving the information produced for the Web Crawler subsystem and HTML Analyser.
- Proxy: External Subsystem software responsible for caching the pages visited for the web crawler. Its purpose is to speed up the HTML analyser. Sample external proxy: squid-cache proxy.
- Logger System: System responsible for logging all system operations into a log file.

- HTTP Unit: Subsystem responsible for establishing connection with remote servers.
- Desktop UI: Module responsible for presenting a graphical user interface to support easy and friendly user interaction with the tool.

4. Modern Criteria Counts: Social Counts

Initial Engagibility criteria counts were defined 9 years ago [5]. Now in 2010 the current state of the web offers a range of tools to enable Engagibility as never before. These tools allow visitors to review and rate services, communicate with other visitors through social networks, forums or configure products according with their preference to enhance on-line shopping.

These tools belong to the generation of web called, Web 2.0. This concept began with a brainstorming conference between O'Reilly and MediaLive International. It was used to identify a set of common characteristics for companies that had survived the collapsed of dot-com between 1998 and 2001 [16].

Since then these new capabilities have been a business revolution on web applications, websites and social networking. They have changed the manner in which website visitors communicate with website owners and other visitors. These set of tools [10] are the candidates to be the new enablers for Engagibility.

Table 3 New social media Engagibility enablers

- Social Networking
   o Facebook Like button
   o Facebook Connect
   o Tweet this Button
   o Share content button
- Thumbs up/down
- Blogs
- Wikis
- Ratings
	- Blog Comments
	- Product reviews
	- Feeds Subscription (RSS)
	- Social Bookmarks
	- Personalized Newsletters
	- Videos
	- Poad Casts
	- Mobile apps
	- APIs

Table 3 presents some of the newly identified social media Engagibility Enablers. For instance "thumbs up/down" is a voting system which will allow visitors to vote positive or negative for products or services on a website. Over time a product or service might gain more positive votes than negative, in this case new visitors might trust your products or service rapidly an engage with your website. These information is not only beneficial for the end user, it also benefits the website owners, they could find out the proportion of satisfied and unsatisfied customers with their products and service.

5. Conclusions

This paper supports an alternative approach to understanding the success of a website by measuring the quality of a website design rather the traditional metrics of traffic use. Engagibiliy was the quality factor chosen to measure design. It proposed the "two-ways communication strategy" where a website exposes its service or goods to its visitors and the visitor's potential need to communicate with the website or with other visitor.

The Engagibility quality factor proposed a set of enablers to be measured. A list of these enablers was presented. These enablers are measured through a defined set of criteria by establishing counts for those criteria. To measure the counts a set of techniques were described.

In order to automatically measure the criteria, a software tool was developed. The software tool focused on establishing the counts for the following: Common criteria, Navigation Ratio, Surf Ratio, Activity Ratio and Assistive Ratio. The techniques implemented to measure the counts for each ratio are explained. A brief introduction of the three-software architecture was described: Web Crawler, HTML analyser and Report System.

The final section of the paper proposes a preliminary set of new Engagibility enablers for which design metrics can be defined. These are dictated by modern social media considerations. "Thumbs up/down" and "Facebook Connect" are two examples of these new enablers.

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