

Design and Implementation of a Website Usability Model

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Abstract

Evaluating the quality of a website helps to assess whether or not the website is meeting its intended purpose for the intended users. Besides, the results of the evaluation can help to understand the parts of the website that need modifications to bring an improvement in the website. Usability is one of the most important quality factors in any quality model for the website.

In this paper a Website Usability Model (WUM) for informational websites from developer perspective was designed and implemented, an extensive study of the literature on existing quality models, essential website success factors and criteria was made to identify necessary quality characteristics, sub-characteristics and criteria. The proposed WUM able to evaluate the usability of academic websites automatically online and makes a suggestion according to the results. It includes four layers browsing layer, parsing layer, evaluation layer and suggestion layer. The experimental results showed that the WUM able to make a decisions such that some websites in general have a good scale of usability, while other websites having defects in the usability be revisited using the WUM suggestions.

Keywords: *Usability, Evaluation method, Quality Model, Website quality characteristics.*

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1. Introduction

Web technologies evolve extremely fast, enabling sophisticated tools to be deployed and complex interactions to take place. The life cycle of a website is also extremely fast, maintenance of a website is performed at a rate that is higher than that of other software products, because of market pressure and lack of distribution barriers. In addition, often the scope of maintenance becomes so wide that a complete redesign takes place. It is clear that as change actions on a website increase rapidly in number and variety, more and more resources need to be deployed to ensure that website quality does not decrease. It is also clear that any tool that can, at least in part, automate evaluation and maintenance processes will help to fill this ever widening gap [1].

The end users activities summarized can be characterized in information seeking, user behavior during information seeking processes is strongly affected by users' culture, language, previous knowledge in the field, and experience in using the web. Also, end user technologies can affect interact with the website where the end user interact through a layer of technology that is not under control by the web designer: browsers, protocols, plug-ins, operating system platforms, interaction devices (screens, speaking devices, pens, reduced telephone keyboards, etc.), network connections[2].

On the other hand, the developers a prominent role is played by actions that include, fixing problems with the website behavior or inserting missing contents, upgrading the site with respect to new technologies, like new browsers' capabilities and improving the site behavior or content. A large fraction of these activities is aimed at detecting system failures, analyzing and identifying faults [2].

The aim of this paper is to design a model to evaluate the usability of website this model is implemented to evaluate an informational and take the academic websites as a case study. The rest of this paper is organized as follow: Section 2 reviews the related work; section 3 reviews the usability in general, while section 4 presents the proposed website usability model. The implementation with the suggestion results for the WUM is presented in Section 5; Section 6 reviews a comparison between the WUM and another models. Finally Section 7 reviews the conclusions.

2. Related work

The phenomenal growth and use of the web during the last decade is providing fertile grounds for research activities. Olsina L., [3] in 2001 proposed a Website Quality Evaluation Method (QEM). The aim of the QEM is to show a hierarchical and descriptive specification framework for characteristics, sub-characteristics and attributes regarding the student's viewpoint. The Web QEM presented in 2002[4], is a methodology that may be useful in systematically assess characteristics, sub characteristics and attributes that influence the product quality in operative as well as early phase of web development project in diverse application domains. MiLE [5] (Milano- LuganoEvaluation Method) presents in 2002 an innovative method for evaluating the quality and usability of hypermedia applications based on a combination of inspection from expert evaluator and empirical testing through panels of end users. Mich [6] in 2003 presents general purpose approach to evaluate a website that provides guidelines for website design and a framework for analysis and evaluation of websites independently of their goals and domains .J.Lencastre and J.Chaves [7] in 2008 try to evaluate the usability of an educational website by using a questionnaire list method about the usability of the website. R. Lopes [8] in 2008present a theoretical model to study the universal usability of the Web and define a set of Universal Usability Metrics (UUM) to be applied into Web portions (example. Websites, clusters) at different abstraction levels. ZihouZhou [9] in 2009, proposing a website quality metrics and methods automatically measures the website interface and reputation quality factors. Tsigereda W., [10] in 2010presenta framework for academic websites from students' perspective, the framework consisting of five high-level quality factors (Content, Usability, Reliability, Efficiency and Functionality).AlexanderR., [11] proposing in 2012an automated usability testing to determine usability problem.

3. Usability

Website usability is the quality of a user's interaction with a website or, in other words, how usable a web site is to the user. Ultimately, users want to be able to easily access a website and determine how to use it within seconds. Usability influences whether many users will return to a

website, how often they will use the website, and how happy they are with their overall experience at the website. Millions of websites in competition for users' time and attention, users can get their expectations for usability from the best of all of these other sites.[12]

The ISO/IEC 25010:2010 defines the usability in general as “*the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*”. In this definition, *effectiveness* means “*the accuracy and completeness with which users achieve specified goals*”, *efficiency* is “*the resources expended in relation to the accuracy and completeness with which users achieve goals*”, and *satisfaction* is described as “*the comfort and acceptability of use*”[13].

The important of Usability are [14]:

- 1) Reduced production costs: Development times and costs can be reduced by avoiding over design.
- 2) Reduced support costs: Systems that are easier to use require less training, less user support and less subsequent maintenance.
- 3) Reduced costs in use: Systems better matched to user needs improve productivity and the quality of actions and decisions. Systems that are easier to use reduce stress and enable workers to handle a wider variety of tasks. An ineffective system may be a major financial liability for the user organization.
- 4) Improved product quality: User-centered design results in products, which have a higher quality of use and are more competitive in a market, which is demanding systems that are easier to use.

3.1 Usability Evaluation Methods

Applying principles for the design of usable applications is not sufficient for ensuring the usability of the final product. Even though accurate design techniques are used, it is still necessary to check the intermediate results, and test the final application for verifying if it actually shows the expected features, and meets the user requirements. The role of evaluation is to help verifying such issues. Usability evaluation method categorized into [15]:

A- User Testing: User testing deals with real behaviors, observed from some representative of real users. It requires that users perform a set of tasks through physical artifacts, being them prototypes or systems, while

the experimenter observes users behaviors and collects empirical data about the way users execute the assigned tasks [15].

B- Inspection Methods: Methods have been proposed when the issue of cost effectiveness started guiding methodological work on usability evaluation. Therefore, many proposals were made for usability evaluation techniques based on the involvement of specialists to supplement or even replace direct user testing. Different methods can be used for inspecting an application. Among them, the most commonly used are *heuristic evaluation*, in which usability specialists judge whether the application properties conform to established usability principles, and *cognitive walkthrough*, which uses detailed procedures for simulating users' problem-solving processes, trying to see if the functions provided by the application are efficient for users, and lead them to the next correct actions [15].

1- Heuristic Evaluation: It is the most informal of inspection methods. It prescribes having a small set of experts analyzing the application against a list of recognized usability principles the heuristics.

2- Cognitive Walkthrough: The users will do in specific situations of use and evaluators go through the interface step by step using a task scenario, and discuss the usability issues as they arise.

C- Web Usage Analysis: A relatively new direction in the evaluation of web applications deals with web usage analysis, performed on the record of user accesses to the application pages, collected in a web server log. After Web applications are deployed, web usage analysis can be employed to analyze how users exploit and browse the information provided by the website [15].

3.2 Evaluate Website Usability

The usability of any website can be evaluated and determined using usability evaluation methods and techniques. Generally, any website should meet the needs of its various stakeholders. Users of informational website are mainly concerned with the following two major questions [16]:

1. Can I find the information I am looking for in my website easily?
2. Can I find the information in timely manner?

The evaluation for the website usability depends on the usability sub-characteristic, According to the Nigel Bevan [17] usability broken down to the sub-characteristic and each sub characteristics has its own criteria includes:

A- Accessibility: it is the ability for a person using any user agent (software or hardware that retrieves and renders web content) to understand and fully interact with a website's content. [18].

B- Hardware and Software: Designers must consider any constraints imposed on them by their users' hardware, software, and speed of connection to the Internet to maximize the effectiveness of the website [19].

C- Page Layout: The quality of web page is strongly affected by its appearance, but it is usually difficult especially for a novice user to design a good looking layout [20].

D- Navigation: it refers to the method used to find and access information effectively and efficiently within a Web site [19].

E- Links: a text or graphics in one page that connect to another page or a different location within a single page [21].

F- Search: Many websites allow users to search for information contained in the website [19].

G- Writing: Website content is a king; websites can contain various features, where writing and preparing content for the website requires a different approach from writing and preparing content for print documents and publications [22].

H- Multimedia: The user can hear or see: music, sounds, videos, flash, and more. Without this integration of web attributes, the quality of website to connect with the customers will ultimately suffer [19].

Website metrics can be *objective* and *subjective* [18]. An *objective metric* is an absolute measure taken on the product or process which is usually based upon an interval or ratio scale such as cost, number of lines of code, productivity, number of errors. *Subjective metrics* represent an estimate of extent or degree in the application of some technique or a classification or qualification of problem or experience which is usually based upon a nominal or ordinal scale such as: the degree of use of a method or technique or the experience of the programmers in the application [18].

4. The Proposed Website Usability Model

Designing a Website Usability Model (WUM) needs a careful study on the key quality factors for websites. According to Nigel Bevan's usability model presented in the previous section, 43 measurable criteria can be

selected to classify the usability effects which can be categorized into eight quality sub-characteristics, including the accessibility, hardware and software, page layout, navigation, links, search, writing, multimedia. Figure (1) shows the structure for the proposed WUM.

The function of the proposed WUM is to calculate the strength of the website's usability and to determine if it's good or bad through assessing sub-characteristics and criteria.

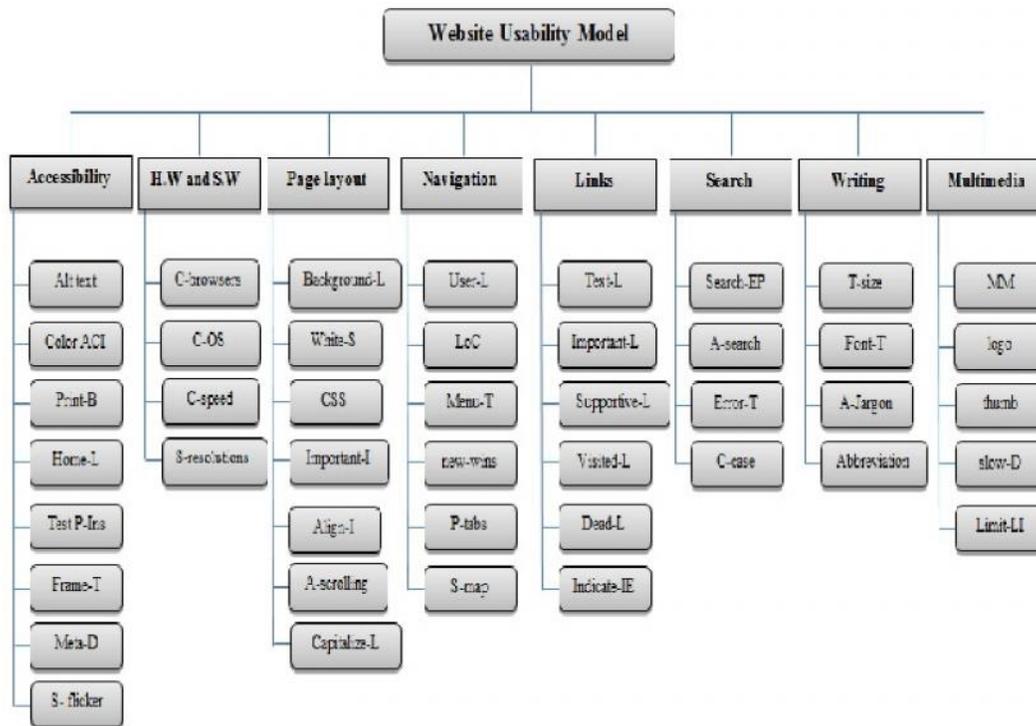


Fig (1) the Proposed Website Usability Model (WUM)

This model was evaluating an informational websites. The main objective of the evaluation of the website usability is to calculate different scores of the usability sub-characteristics for the website, which indicates the results of criteria measurement by using the following aggregation formula:

$$Usa_{\text{website}} = 0.1 * \text{Acc} + 0.05 * \text{H.S} + 0.1 * \text{links} + 0.2 * \text{Nav} + 0.1 * \text{Multi-m} + 0.1 * \text{PL} + 0.2 * \text{Search} + 0.15 * \text{Wr...} \quad (1)$$

Where $Usa_{website}$ means Usability of the website and the sum of the constant weights: (0.1, 0.05, 0.1, 0.2, 0.1, 0.1, 0.2, 0.15) is 1, which are used to normalized the final usability score. The values of these weights have been distributed according to the importance of the proposed usability sub-characteristic for the informational websites to consider the purpose of informational websites where the main goal of websites is to find the right information in minimum time. Each usability sub characteristics of the webpage (Acc, H.S, Links, Nav, Multi-m, PL, Search and Wr) can be formulated as follows:

$$\text{Sub_characteristics}_{\text{webpage}} = \text{criteria}_1 + \text{criteria}_2 + \dots + \text{criteria}_n \dots (2)$$

Such that the total sub-characteristics for the website can be found using the following formula:

$$\text{Sub_characteristics}_{\text{Total}} = \sum \text{sub_characteristics}_{\text{webpage}} / n \dots (3)$$

where n is the total number of webpages in the website.

- The sub-characteristics_{webpage} score is between $0 \leq \text{sub-characteristics} \leq 1$ and the criteria's score is either 0 or 1, 0 refer to the criteria does not exists and 1 refer to the exist criteria.

Two methods are used to evaluate the criteria of the sub-characteristics subjectively and objectively. Usability has twenty nine criteria evaluated objectively and nineteen criteria evaluated subjectively. The sub-characteristics and criteria are:

A- Accessibility (Acc): The idea of accessibility is that everyone has the right to be included in society. Accessibility in the proposed WUM has eight measurable criteria, including:

1). Alternative text for non-text elements (Alt text): This standard helps an individual's to use a using screen reading software and other devices and software. If Alt text used then *objectively* evaluate Alt text = 0, otherwise Alt text = 1.

2). Do Not Use Color Alone to Convey Information (Color ACI): The content (text) has not used the limitation color such red, green and yellow. If unsafe color used then *objectively* evaluate Color ACI = 0, otherwise Color ACI = 1.

- 3). Providing printing options (Print-B): It is usable to provide a link to print the web pages, document, resources, or file. *Objectively* evaluate print-B = 1 if the websites pages provided with printing option, otherwise Print-B = 0.
- 4). Provide home page links (Home-L): It is usable to make a user's to return to the home page to begin a new task or to start a task over again. *Objectively* evaluate Home-L = 1, if the website's pages provide link labeled "Home" otherwise Home-L = 0.
- 5). Testing plug-ins (Test P-Ins): Plug-in is a program that interacts with a web browser to extend the web browser's specific functional supports. *Subjectively* it can be proposed that Test P-Ins = 1 if the websites plug-ins works correctly, otherwise Test P-Ins = 0.
- 6). Providing frame titles (Frame-T): Providing frame titles will allow users with visual impairments to understand the purpose of the frame's content or its function. *Subjectively* evaluate Frame-T = 1 if the page frames provided by title, otherwise Frame-T = 0.
- 7). Meta description (Meta-D): website should have the appropriate META information to be searchable by search engines, and this information must contain "author", "copyright", "keywords" and "date", etc. *Objectively* evaluate Meta-D = 1 if the website pages should have Meta description, otherwise Meta-D = 0.
- 8). Screen flicker (S-flicker): Design web pages that do not cause the screen to flicker with a frequency greater than 2 Hz and lower than 55 Hz , many people with epilepsy are photosensitive, and may have seizures triggered by certain screen flicker frequencies. If it is then *subjectively* evaluate S-flicker = 1, otherwise S-flicker = 0.

B- Hardware and Software (H.S): Hardware and Software in the proposed WUM has four measurable criteria, including:

- 1). Including Common browsers (C-browsers): The web pages of the website should work and accessible to the 95% of all users at least. *Objectively* evaluate C-browsers = 1 if the common browsers work, otherwise C-browsers = 0.
- 2). Common operating systems (C-OS): Each operating system has its own way of rendering web pages and even each version. If the common operating systems work then *objectively* evaluate C-OS = 1, otherwise C-OS = 0.

3). *Connection speed (C-speed)*: If your pages load to slow, a user will probably click to go to another site, without viewing any of your content. *Objectively* find if the page loads during 20 second then. C-speed = 1, otherwise C-speed = 0.

4). *Screen resolutions (S-resolutions)*: Screen resolutions have changed very quickly over the last few years. *Subjectively* find if the resolution is greater than 1024x768, the most common screen high resolution then S-resolutions = 1 otherwise S-resolutions = 0.

C- Page Layout (PL): Page Layout in the proposed WUM has 7 measurable criteria, including:

1). *Background limitation color (Background-L)*: There are several types of color blindness, the most common affecting red and green the web page background has not to use the limitation color such red, green and yellow, if safe color used then *objectively* evaluate C-browsers = 1, otherwise C-browsers = 0.

2). *Use Moderate White Space (White-S)*: Limit the amount of white space (areas without text, graphics, etc.) on pages that are used for scanning and searching. If the page has limit white space then *subjectively* evaluate White-S = 1, otherwise White-S = 0.

3). *Cascading Style Sheets (CSS)*: if the website use the Cascading Style Sheets (CSS), then *objectively* CSS = 1, otherwise CSS = 0.

4). *Place Important Items at Top Center (Important-I)*: Put the most important items, critical content and navigation options at the top center of the web page to facilitate users finding the information. If it is then *subjectively* Important-I = 1, otherwise Important-I = 0.

5). *Align Items (Align-I)*: Alignment makes the page easy to scan. If it is used then *objectively* evaluate Align-I = 1, otherwise Align-I = 0.

6). *Avoid horizontal scroll (A-scrolling)*: the website pages should not use Horizontal scroll because it is a slow way to view an entire screen. If it is not use then *subjectively* evaluate A-scrolling = 1, otherwise A-scrolling = 0.

7). *Capitalize first words in a list (Capitalize-L)*: Capitalize the first letter of the each list items make it easy to scan and distinguish between each item. *Objectively* evaluate Capitalize-L = 1 if it is used, otherwise Capitalize-L = 0.

D- Navigation (Nav): in the proposed WUM six measurable criteria have been introduced, including:

- 1). Feedback on user location (User-L): Feedback provides users with the information they need to understand where they are within the website, and for proceeding to the next activity. If it is then *objectively* evaluate User-L = 1, otherwise, User-L = 0.
- 2). Clickable list of contents (LoC): The website should contain a 'list of contents' with links that take users to the corresponding content, if it is then *objectively* evaluate LoC = 1, otherwise LoC = 0.
- 3). Appropriate menu types (Menu-T): The website should use simple and traditional menu that save user time then *subjectively* evaluate Menu-T = 1, otherwise Menu-T = 0.
- 4). Avoid open new browser windows (new-wins): Navigation should be done using the same web page without opening any new browser windows to save the user from confusion and frustration, if it is then *subjectively* evaluate new-wins = 1, otherwise new-wins = 0.
- 5). Present tabs effectively (P-tabs): The navigation tabs should present in the clear and efficient way to be recognized, if it is then *subjectively* evaluate P-tabs = 1, otherwise P-tabs = 0.
- 6). Use Site Maps (S-map): The Site Map should be included in the website, such that if it is then *objectively* evaluate S-map = 1, otherwise S-map = 0.

E- Links: Links in WUM have six measurable criteria, including:

- 1). Using text for links (Text-L): The text links usually download faster than image links therefore it should be used rather than image links, then if it is used, evaluate *objectively* Text-L = 1, otherwise Text-L = 0.
- 2). Repeat important links (Important-L): The important link should be accessed from more than one link to make it easier to find the information. If the link are repeated then *objectively* evaluate Important-L = 1, otherwise Important-L = 0.
- 3). Supportive links (Supportive-L): Use links to provide definitions and descriptions to clarify technical concepts or jargon, *objectively* evaluate Supportive-L = 1, otherwise Supportive-L = 0.
- 4). Visited link (Visited-L): Link colors help users understand which parts of a Web site they have visited, and to improve the user's speed in finding

information. If it is used then *objectively* evaluate Visited-L = 1, otherwise Visited-L = 0.

5). Dead links (Dead-L): The website pages should not contain any dead links (link that no longer works) that make a user just move on the next site without exist, if the download page not dead then *objectively* evaluate Dead-L = 1, otherwise Dead-L = 0.

6). Indicate Internal and external links (Indicate-IE): The website links should have clear description to indicate to the internal or external links to avoid user's confusion and save website credibility. If it is then *subjectively* evaluate Indicate-IE = 1, otherwise Indicate-IE = 0.

F- Search: Search in the WUM has five measurable criteria, including:

1). provide a Search Option on Each Page (Search-EP): The search option should be available in each page in the website. If it is used then *objectively* evaluate Search-EP = 1, otherwise Search-EP = 0.

2). Advanced search (A-search): Advanced search operators are query words or symbols allow users to find what they are looking for quickly and accurately. if it is used then *subjectively* evaluate A-search = 1, otherwise A-search = 0.

3). Error tolerant search (Error-T): Error tolerant search is a mechanism that facilitate to the users to search inside the website even if they use wrong sentence and save user time. If the website provide this techniques then *subjectively* evaluate Error-T = 1, otherwise Error-T = 0.

4). Upper-and Lowercase Search Equivalent (C-case): The website search option should not be case sensitive when searching; users will generally be indifferent to any distinction between upper and lowercase. If the search option not case sensitive then *subjectively* evaluate C-case = 1, otherwise C-case = 0.

G- Writing (Wr): Writing in WUM has four measurable criteria, including:

1). Text size (T-size): if the text size greater than 12 point then *objectively* evaluate T-size = 1, otherwise T-size = 0.

2). *Font type (Font-T)*: if the website page use familiar font such Times New Roman or Georgia (serif fonts), or Arial, Helvetica, or Verdana (sans serif fonts), then *objectively* evaluate Font type = 1, otherwise Font type = 0.

3). Avoid Jargon (A-Jargon): Jargon is unnecessarily complicated, technical language used to impress, rather than to inform, your audience. Jargon plays a large role in the user's ability to find and understand information. If the website does not contain jargon then *subjectively* evaluate A-Jargon = 1, otherwise A-Jargon = 0.

4). Define Abbreviations (Abbreviations): The website should use abbreviations sparingly and must be defined in a specific format such as Physician Data Query (PDQ), if Abbreviations defined then *objectively* evaluate Abbreviations = 1, otherwise Abbreviations = 0.

H- Multimedia (multi-m): The multimedia in WUM has five measurable criteria, including:

1). Using multimedia (MM): If the multimedia exists in the website then *objectively* evaluate MM = 1, otherwise MM = 0.

2). Include Logos (Logo): The website should use logo in each page in the website to conveys trust and gives the sense, such that if the logo is used then *objectively* evaluate Logo = 1, otherwise Logo = 0.

3). Use thumbnail (thumb):The website should use thumbnails to improve the website performance, if it is used then *objectively* evaluate thumb = 1, otherwise thumb = 0.

4). Ensure images do not slow download (slow-D): The website developer should use techniques to ensure fast page download such as decrease number of image, minimize the number of color used in an image and put height and width pixel dimension tag. If it is then *subjectively* evaluate slow-D = 1, otherwise slow-D = 0.

5). Limit Large Images (Limit-LI):The website should have only single large image in each page, if one large image use in page then *subjectively* evaluate Limit-LI = 1, otherwise Limit-LI = 0.

5. Implementation of WUM

The implementation of the proposed WUM is structured into four layers as shown in figure (2): browsing layer, parsing and preparing layer, evaluation layer and suggestion layer. It is implemented using a Visual Basic.Net software under access database to evaluate the websites usability online with a GUI (Graphical User Interface) illustrated in figure (3).

A- Browsing Layer: Browsing layer is a term used in WUM to mean the mining and extracting the link from the root page. Browsing layer is

considered as important process of data extraction from the whole website to gather specific types of information from the web pages. It is mainly used to extract the whole website Uniform Resource Locator (URLs) and create a copy of all the web pages and its HTML (Hyper Text Markup Language) scripts.

Browsing process is illustrated in figure (4) starts with a list of URLs to visit that retrieved from the root page. The browser visits these URLs; identifies all the hyperlinks in the page and adds them to the list of URLs to be visited. A browser may only want to seek out HTML pages and avoid all other Internet media type such as (pdf, postscript, zip, mp4, mpeg, gif, jpeg, png, tiff, css, quicktime, doc, etc). A browser may examine the URL and only request a resource if the URL ends with certain characters such as .html, .htm, .asp, .aspx, or a slash.

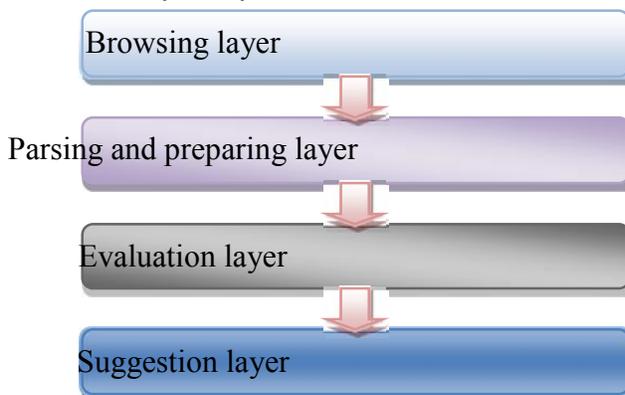


Figure (2) structure of implementing the proposed WUM

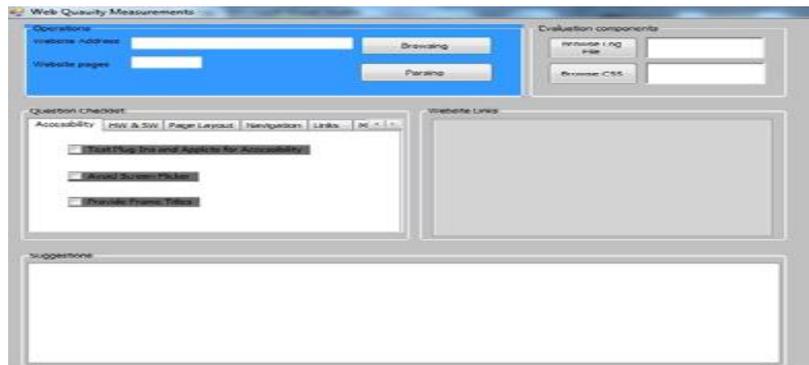


Fig (3) GUI of WUM

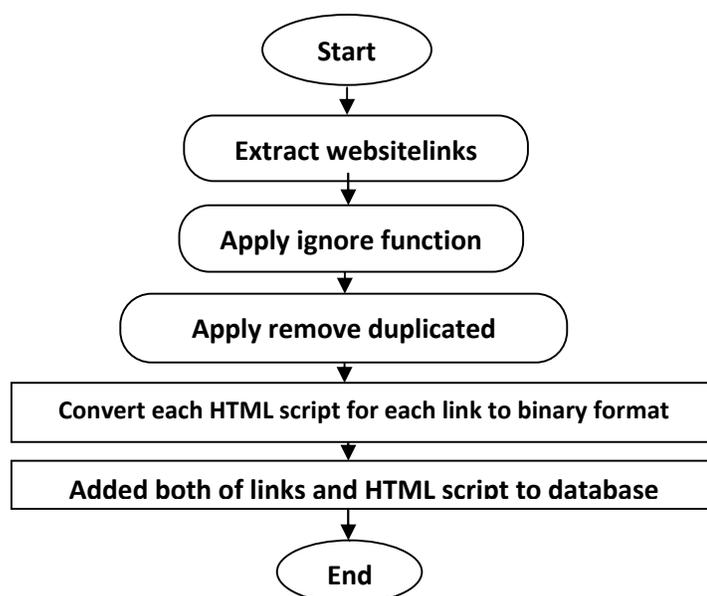


Figure (4) Browsing Process

B- Parsing Layer: Parsing layer or Analysis layer illustrated in figure (5) in the proposed WUMs, simply means extract information from the evaluation component (HTML script, CSS (Cascading Style Sheets), access log file) and make it ready as a variable to evaluate the usability,. Parsing layer provides evaluation support to the next website evaluation layer. The reasons to parsing HTML script, CSS and access log file are:

- The most characteristics of the proposed quality model could depend on it.
- HTML script and CSS is another way allows measuring the website objectively.
- The HTML script and CSS could be enough to represent most of the website usability, reputation aspects and access log file considered to express other aspects that related to the usability and reputation aspects such as number of hits per day, operating system (O.S) and browser compatibility.

This layer parsing the data into two different ways Objectively (Objective Metric): the data in this process pass through multi-operations to analyses the data according to the conditions of the

website evaluation metrics. Some of these operations based on the analysis of the data to extract the attribute such as link attribute in href tag and extract browser type from access log file. The main goal of this process (Objective Metric) is to check the data and extract the results that will be set as Boolean value, true or false (1 or 0) for each criteria then save them in the data base.

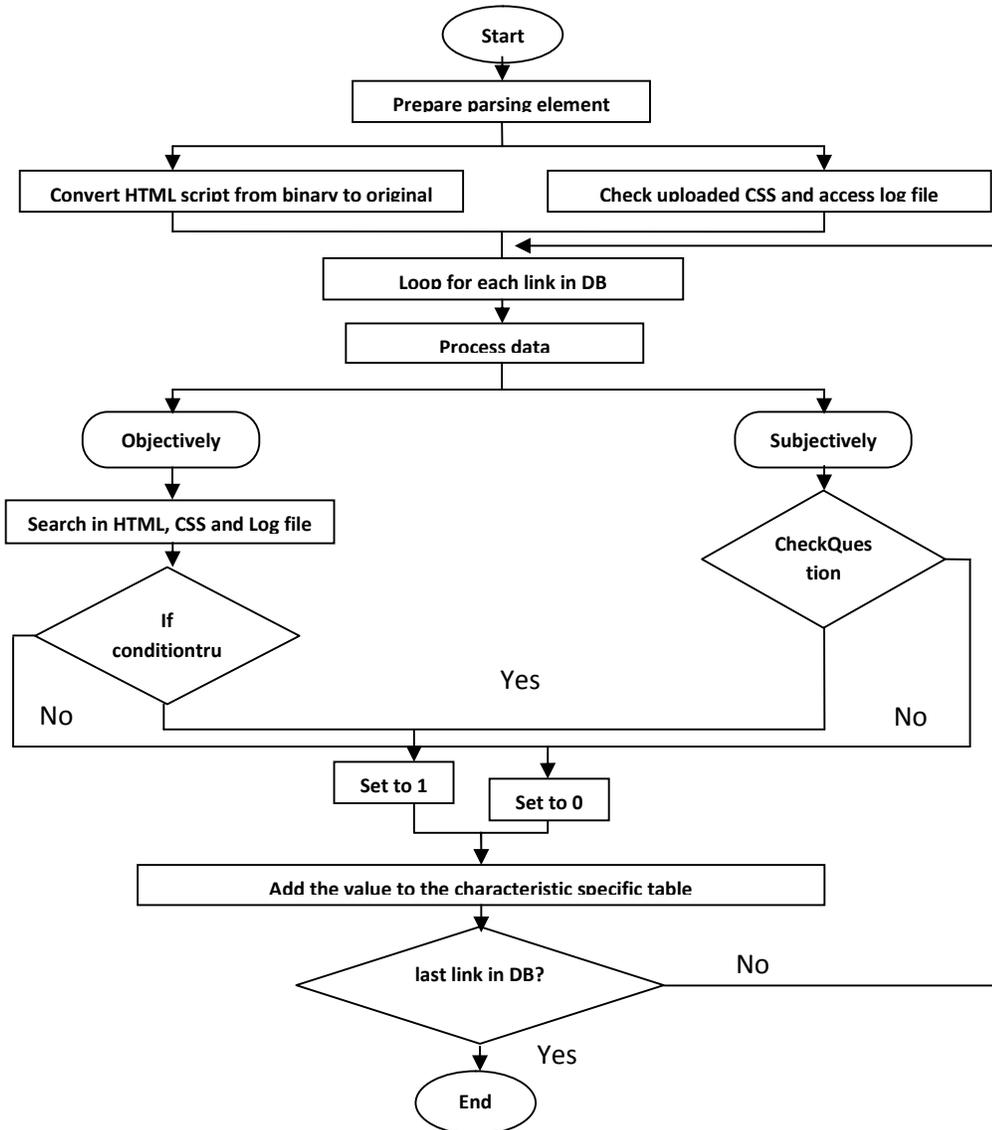


Figure (5 parsing process

Subjectively (Subjective Metric): are a set of checklist questions to include the user in the website evaluation and increase the interaction where each question represents one criterion related to the usability characteristic. The questions are organized into eight groups, each group represent questions related to one of the usability sub-characteristic. Figure (6) illustrates an example for subjective questions from the GUI (Graphical User Interface)

of this model. The user able to answer the questions through check box, the value for the subjective criteria has two basic ranges:

(1) Check = good quality (exists criteria).

(2) Uncheck = bad quality or needs work (not exists criteria).

Table (1) shows a list of the Objective and Subjective criteria.

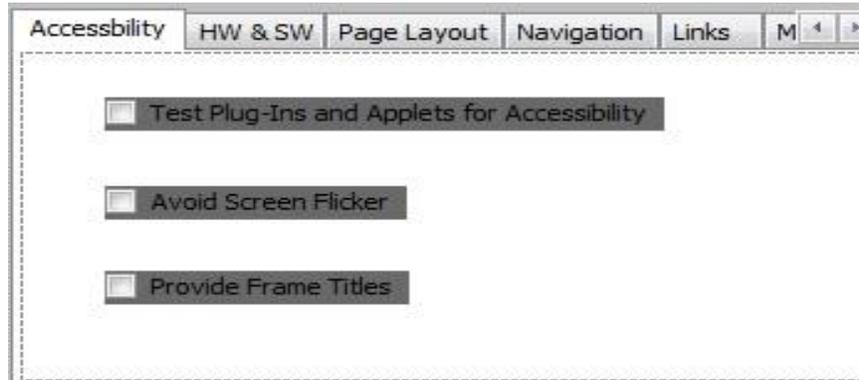


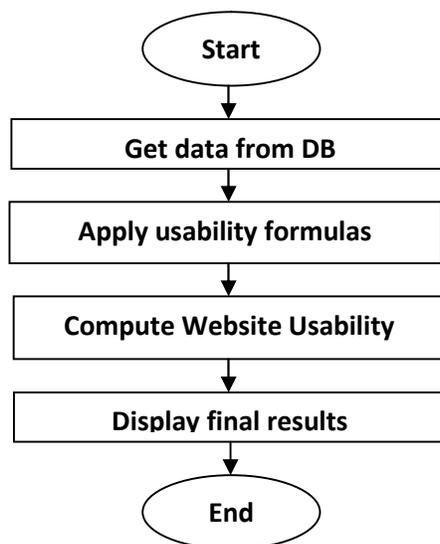
Figure (6) example for subjective questions

C- Evaluation Layer: Evaluation layer is the calculation layer that processes the different values which have been extracted from the parsing layer in order to evaluate the website usability by applying the formulas and calculating the final score for each sub-characteristic. The process of the evaluation layer is illustrated in figure (7).

D- Suggestion Layer: The main objective of this layer which illustrated in figure (8) is to suppose a suggestion to improve website quality by analysis the results that gathered from the evaluation layer. These suggestions depends on the first level of the usability result then if it is not acceptable then check each sub characteristics to find in which criteria the defects can be appears.

Table (1) Objective and Subjective criteria

Objective metric		Subjective metric
Home-L	Supportive-L	Test P-Ins
Alt text	Visited-L	Frame-T
Color ACI	Dead-L	S-flicker
Print-B	Search-EP	S-resolutions
Meta-D	T-size	White-S
C-browsers	Font-T	Important-I
C-OS	Abbreviations	A-scrolling
C-speed	MM	Menu-T
Background-L	Logo	new-wins
CSS	Thumb	P-tabs
Align-I	Supportive-L	Indicate-IE
Capitalize-L	Visited-L	A-search
User-L		Error-T
LoC		C-case
S-map		A-Jargon
Text-L		slow-D
Important-L		Limit-LI

**Figure (7) evaluation layer**

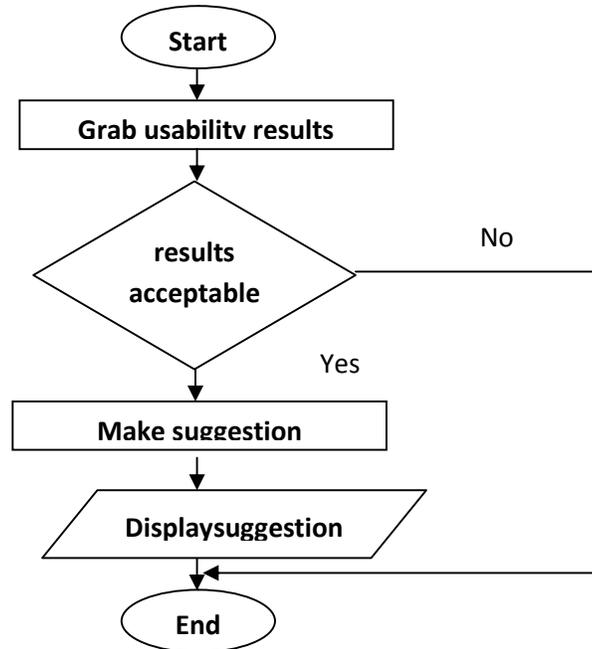


Figure (8) suggestion process

5.1 Usability Decision

The proposed WUM helps the user to make a decision such that he can easily figure out which websites is the good usability and which are not. The decision scales for the website usability can be classified into three different degree levels (High, Average and Low) as shown in table (2). These scales determined according to the range of the experimental results that got it from the normalized weights for the usability sub characteristic.

Table (2) usability Levels for WUM

Level	Scale
 High	0.85~1
 Average	0.61~ 0.84
 Low	0.1 ~ 0.60

5.2 Experimental Results

Ten university websites have been selected as an informational websites to show the implementation of the proposed WUM and to evaluate the usability of them online. Table (3) lists the evaluation scores of the usability's sub-characteristics for these websites. From table (3) it can be seen that the first two websites have a high level of usability. While the usability scales of the rest websites are ranged between average and low usability level, this is because these websites do not use some criteria that considered as important criteria in the proposed WUM which could effects the usability websites scores such as (search and navigation criteria). According to the results for the website usability the proposed WUM will be started to build the suggestion results for the website that does not cope with any reasonable level. The proposed WUM will start to check each sub-characteristic result and pass through criteria to find the defects and build the suggestion for the user to improve the website usability.

Table (3) evaluation scores for ten websites of ten universities

No.	Universities	ACC	H.S	Link	Nav	MM	PL	SCH	Wr	Usability Score	Usability Level
1	Oxford www.ox.ac.uk/	0.1	0.025	0.06	0.2	0.09	0.08	0.2	0.12	0.88	★★★★
2	Northampton www.northampton.ac.uk	0.1	0.025	0.08	0.16	0.07	0.1	0.2	0.12	0.85	★★★★
3	Leeds www.leeds.ac.uk/	0.09	0.025	0.05	0.18	0.8	0.87	0.2	0.12	0.83	★★★☆☆
4	Exeter www.exeter.ac.uk	0.09	0.025	0.05	0.18	0.1	0.09	0.16	0.12	0.82	★★★☆☆
5	York www.york.ac.uk/	0.08	0.025	0.05	0.14	0.09	0.08	0.2	0.12	0.79	★★★☆☆
6	Norwich www.nua.ac.uk/	0.09	0.025	0.05	0.12	0.08	0.1	0	0.12	0.60	★★☆☆*
7	AshBourne www.ashbournecollege.co.uk/	0.09	0.025	0.05	0.2	0.1	0.9	0	0.12	0.60	★★☆☆*

8	Oldham www.uco.oldham.ac.uk/	0.08	0.025	0.05	0.14	0.08	0.09	0	0.12	0.58	
9	Norland www.norland.co.uk/	0.09	0.025	0.05	0.14	0.07	0.1	0	0.12	0.60	
10	BIMM www.bimm.co.uk/	0.08	0.025	0.05	0.16	0.08	0.09	0	0.12	0.60	

The suggestion results for the above low usability websites according to the proposed WUM illustrated below:

1. The suggestion for the *Norwich University* is recommended to:

- provide the website with print page option.
- avoid open the website pages with new window.
- Ensure that important content can be accessed from more than one link; it is recommended to repeat important links.
- provide the website with supportive links to support the website content such (adobe reader, flash, etc.).
- Use color changes to indicate to users when a link has been visited.
- provide the website with advance search option.
- provide the website search with error tolerant search.
- use safe color in the website background.

2. The suggestion for the *Ash Bourne University* is recommended to:

- provide the website with print page option.
- limit the amount of white space (areas without text, graphics, etc.).
- Ensure that important content can be accessed from more than one link; it is recommended to repeat important links.
- provide the website with supportive links to support the website content such (adobe reader, flash, translator, etc.).
- Use color changes to indicate to users when a link has been visited.
- provide the website with search option in each page.

3. The suggestion for the *Oldham University* is recommended to:

- provide the website with print page option.
- improve website Meta tag information.
- use breadcrumbs to provide feedback for user location.
- use sit map for the website.
- Ensure that important content can be accessed from more than one link; it is recommended to repeat important links.
- provide the website with supportive links to support the website content such (adobe reader, flash, translator, etc.).

- use color changes to indicate to users when a link has been visited.
 - provide the website with search option in each page.
 - use the thumbnails in different pages to keep the user as far as possible inside the website , also by using thumbnails, those who do not need or want to see the full image are not slowed down by large image downloads.
4. The suggestion for the *Norland University* is recommended to:
- provide the website with print page option.
 - improve website Meta tag information.
 - use breadcrumbs to provide feedback for user location.
 - use sit map for the website.
 - Ensure that important content can be accessed from more than one link; it is recommended to repeat important links.
 - provide the website with supportive links to support the website content such (adobe reader, flash, translator, etc.).
 - use color changes to indicate to users when a link has been visited (visited link).
 - provide the website with search option in each page.
 - use logo as an image in the top left corner for each page.
5. The suggestion for the *BIMM College* is recommended to:
- provide the website with print page option.
 - provide alt tag with description.
 - use sit map for the website.
 - Ensure that important content can be accessed from more than one link; it is recommended to repeat important links.
 - provide the website with supportive links to support the website content such (adobe reader, flash, translator, etc.).
 - use color changes to indicate to users when a link has been visited.
 - use logo as an image in the top left corner for each page.
 - use the thumbnails in different pages to keep the user as far as possible inside the website , also by using thumbnails, those who do not need or want to see the full image are not slowed down by large image downloads.

6. Comparison

The proposed WUM can be compared with other previous models according to many perceptions where L. Olsina [3] proposed quality characteristics to evaluate the academic website using different methods to collect data and evaluate the quality (manual, observation, automatic), the WUM proposed two methods to evaluate the usability and treat some criteria which evaluated manually and can be evaluated automatically that could give results more accurate than use subjective method.

MiLE [5] use a combination of two methods inspection (i.e. an expert evaluator systematically explore the application) and empirical testing to evaluate the usability of the museum websites and these methods have many disadvantages where the evaluator may not at the same level of knowledge, take time, and also cannot determine the usability defects precisely while the proposed WUM evaluate usability automatically, do not need much time, suppose suggestions to improve usability.

J.Chaves [7] try to evaluate the usability of an educational website by using a questionnaire list method about the usability of the website where the questionnaires may be difficult for some participants, may not provide all the information needed for interpretations, self-report may result in biased or truthful responses, provide a general picture but lack depth; Doesn't provide the "full story" while the proposed WUM use subjective in an easy way and objective methods that make it more precisely in evaluate the website usability.

7. Conclusions

The design and implementation of the proposed WUM present in this paper. This model can be used to evaluate the informational websites as well as help website designers and developers to build websites with high website usability and free of defects. An academic websites as a case study can be evaluated and improved by using two evaluation approaches: subjective method and objective method. Based on the evaluation measures the results from both approaches showed that the websites are reasonably acceptable. It has been pointed out that some parameters of evaluation have satisfied when compared with the acceptable weight values. It should be noted, however, that the results could change at any time by editing on websites usability factors. The proposed WUM supporting repair actions (in addition to identification of usability faults) have the potential to dramatically reduce the time and effort needed to perform maintenance activities. Instead the website developers need to check each page to find defects the model able to evaluate each characteristics and according to the results the developers can conclude what characteristic that need work. The proposed WUM not only can be used as an evaluation model to evaluate websites and allocate usability scores, but also can be help to improving website usability through re-engineering. Also the proposed WUM can be part from any website quality model; the proposed WUM gives more accurate results, need less time, more precisely, in evaluating the usability of websites as compared with another three usability models.

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تصميم وتنفيذ نموذج قابلية الاستخدام للمواقع الالكترونية

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المستخلص

تقييم جودة الموقع الإلكتروني يساعد في تقييم ما اذا كان الموقع الإلكتروني يطابق الغرض المخصص له ولمستخدمين معينين او لا. الى جانب ذلك, فان نتائج التقييم يمكن ان تساعد في تحديد اجزاء الموقع الإلكتروني التي قد تحتاج الى تعديلات لتحقيق بعض التحسينات في الموقع الإلكتروني. قابلية الاستخدام هيه احد اهم عوامل الجودة في اي موديل للجودة للموقع الإلكتروني. في هذا البحث نموذج قابلية الاستخدام للمواقع الالكترونية (WUM) للمواقع المعلوماتية من وجهة نظر المطورين صمم ونفذ, وتم اجراء دراسة مستفيضة على نماذج الجودة الموجودة, العوامل الأساسية لنجاح الموقع الإلكتروني و المعايير لتحديد عناصر الجودة والعناصر الفرعية و المعايير. النموذج المقترح قادر على تقييم قابلية الاستخدام (Usability) للمواقع الأكاديمية اوتوماتيكيا وتقديم المقترحات بالأعتماد على نتائج التقييم. والذي يتضمن اربعة طبقات طبقة التصفح (browsing layer) , طبقة التحليل (parsing layer), طبقة التقييم (evaluation layer), طبقة الاقتراحات (suggestion layer). أظهرت النتائج التجريبية ان نموذج قابلية الاستخدام للمواقع الالكترونية (WUM) قادر على اعطاء قرار حيث ان بعض المواقع وبشكل عام تمتلك قابلية استخدام جيدة , بينما البعض الاخر من المواقع الالكترونية تحتوي على بعض العيوب في قابلية الاستخدام التي يجب اعادة النظر فيها بأستخدام مقترحات نموذج قابلية الاستخدام (WUM).

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**ميرمح في وزارة النفط العراقية