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PROTOTYPICAL WEBSITE QUALITY MEASUREMENT USING T-SCORE STATISTICS MODEL

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Abstract *Websites are used extensively in our daily life to transform information between many users. Transformed information will convey in several forms, styles, languages which includes text, images, sound and video intended to exchange, make agree, sell, and present a viewpoint. In this work, outlined about domain of academic sites with more characteristics and attributes in order to analyze the quality requirement tree and a way to identify them. These fundamentals are used in a numerical methodology for assessment, comparison, and ranking processes. The proposed methodology can be a useful approach to assess the quality in different phases of a Web product life cycle. This work makes an attempt to propose a framework for measuring quality attributes of web-based application systems. Web-based quality properties are referred to as non-functional properties of web applications such as performance, maintainability, security, usability, portability.*

Keywords: **Computer science, Principle Component Analysis, ANOVA, T-Score, Quality Measure.**

1. Introduction

Websites are rising at a fastspeed both in terms of the growing acceptability of Web sites, and in terms of the difficulty of such artifacts. However, a large amount of defined product process model that control the effective development, and evaluation process model that support the Web-site quality assessment and improvement are not being accompanied by that sites development. Consequently, a systematic and disciplined utilization of models, engineering methods, and techniques for the assessment, understanding, and improvement of this type of software is taken as a mandatory constraint. The primary goal for Web-site quantitative evaluation is to understand the extent group of quality characteristics, that is necessary to a choose set of needs in a specific user view.

Web site domains like museums, academic sites, electronic commerce, etc., are becoming increasingly difficult method. Hence, an integral quantitative performance process related all relevant quality characteristics are also a complex problem. The diverse nature of web applications makes it difficult to measure by using existing quality measurement models. Web applications often use large numbers of reusable components which make traditional measurement models less relevant. Estimating web sites quality needs appropriate evaluation criteria. Lot of existing criteria are not simple and easy to calculate and require methods such as heuristic calculation, or/and empirical usability tests. This work aims at defining a quality model and a set of characteristics that is used to measure in an automated fashion, relating internal and external quality factors. As number of existing tools can achieve some analysis, the common architecture will be based upon a conceptual model of the site/page, and the tools will givethe output to a Quality Data Base, which is the basis for subsequent actions.

The rest of this paper is organized as follows. Section II summarizes the concepts and related works. Section III details the analysis of the collected results, which contains a Principal Component Analysis, ANOVA-based analysis and T-Score to evaluate the quality dependency on the application domainand Section IV discusses the experiments and the achieved results. Finally, Section V presents the conclusions of the work.

2. Literature Survey

With the proliferation of the Internet and World Wide Web applications, users are increasingly interfacing and interacting with web-based applications. Aladwani and Prashant (2002) report on the development of an instrument that captures key characteristics of web site quality from the user's perspective. Principal component analysis (PCA) is a multivariate technique was organized by Abdi and Lynne (2010) analyzes a data table in which observations are described by several inter-correlated quantitative dependent variables. Shlens Jonathon (2014) focuses on building a solid intuition for how and why principal component analysis works. This manuscript crystallizes this knowledge by deriving simple intuitions and the mathematics behind PCA. Electron paramagnetic resonance imaging (EPRI) provides a noninvasive, quantitative imaging modality to investigate static pO2 in vivo presented by Redler et al (2014).

Schrimpsher and Letha (2014) proposed two measures of knowledge content and performance. Mean average recall (MAR) with respect to the original ontology compares the data returned from a series of queries related to a particular concept of interest. Sarstedt and Erik (2014) introduced the hypothesis testing which allows for the determination of statistical significance. The main objectives are the logic of hypothesis testing and common types of t-tests, one-way and two-way ANOVA. Gu Chong (2014) provides efficient ANOVA decompositions are constructed into models on product domains, and modeling and inferential tools are provided for tasks such as interval estimates, the testing of negligible model terms, the handling of correlated data, etc.

Covariance decomposition of output variance is used in this paper to take account of interactions between non-orthogonal components in anchored ANOVA method. Furthermore, Tang et al (2014) emphasized covariance decomposition can be generalized in a straightforward way to decompose high order moments. An anchored ANOVA method is proposed by Tang et al (2014) to decompose statistical moments. Compared to standard ANOVA with mutually orthogonal components, anchored ANOVA, with arbitrary anchor point, loses orthogonality if employing the same measure.

Analytical Methods Committee (2014) suggested a Robust ANOVA is a useful tool, which gives a more representative estimate of the separate variances than classical ANOVA when outlying results are encountered. Lin and Jay (2011) presented a systematic, comprehensive and up-to-date review of perceptual visual quality metrics (PVQMs) to predict picture quality according to human perception. Several frequently used computational modules (building blocks of PVQMs) are also discussed.

Ranking algorithms are assessed with respect to some utility measure that reflects the likelihood of satisfying an information need. Pedersen (2013) discussed how this data can be used to derive Web Search quality metrics that have very different properties than traditional offline metrics. In order to obtain valid correlation between analytical model and user scores, assessment based on networking perspectives and human perception is required. Nguyen et al (2012) have utilized the orthogonal arrays using the Taguchi approach performs the experiment to characterize the application as well as network performance metrics in QoE assessment model for web-based systems.

Many existing retrieval approaches do not take into account the content quality of the retrieved documents, although link-based measures such as Page Rank are commonly used as a form of document prior. Bendersky et al (2011) presented the quality-biased ranking method that promotes documents containing high-quality content, and penalizes low-quality documents. The quality of the document content can be determined by its readability, layout and ease-of-navigation, among other factors. These quality degradations could adversely affect users' quality of experience (QoE). The standard method for comparing an individual's test score with a normative sample involves converting the score to a z score and evaluating it using a table of the area under the normal curve by Crawford et al (1998).

3. Quality Model

The assessment of website quality remains a challenging area of research in the website propagation. Customer satisfaction is based on the quality and also with the level of achievement of user expectation when interfacing a website. As performed in this work, quality captures perceptual aspects, probable to be involved in website interaction. Such focus on quality maps to customer satisfaction assessment to the appearance of website quality as an aggregate composite that brings together formal metrics and perceptual user traits.

The major procedure steps that evaluators should follow by applying the web-site, namely:

- Choosing a site or a set of competitive sites to perform or compare
- Identifying goals and the user point of view
- Defining the Web-site quality characteristics and attributes condition tree
- Defining criterion operations for each attribute, and using attribute measurement
- Aggregating elementary preference to achieve the global Web-site quality preference
- Analyzing, assessing, and comparing partial and global outcomes.

The main task of this work is to illustrate the methodology, used for the quantitative evaluation and comparison of sites in the operational phase. It is going to use characteristics for website quality. So our quality model will include the six well-known quality characteristics: Efficiency, Functionality, Maintainability, Portability, Reliability, Usability, Accessibility and Navigation.

This performance is used to produce an automatic classification model for sites quality, then require each quality attribute to be given in terms of automatically collectable quality metrics. The characteristics are used to organize the resulting web quality model, those characteristics are as follows:

Efficiency (E) - includes aspects related to load times and size;
Functionality (F) - includes navigation, identity, forms and other aspects related to the functionality offered by the site;
Maintainability (M) - includes aspects related to the number of items to maintain (e.g. scripts, styles used, tables);
Portability (P) - includes aspects related to page layout, use of html standards, etc.
Reliability (R) - includes aspects related to the validation and links status;
Usability (U) - includes aspects related to accessibility, multimedia and textual contents;
Accessibility (A) - A high quality web site has versions for non PC users as well. It is important that mobile and tablet users can access the web site without any usability issues.
Navigation (N) - Navigation system and links allow incorporating various design elements into the website.

Table I: Web Site Quality Metrics

E	efficiency_css_sizecss	size per page
E	efficiency_homepage_load_time	homepage load time
E	efficiency_img_size [7]	image size
E	efficiency_javascript_size [7]	script size per page
E	efficiency_page_load_time [10]	page load time
E	efficiency_page_size	page size
F	forms_form_info_request [11],[12]	presence of contacts/info form
F	forms_labels	number of label tags
F	identity_author [10]	average presence of author
F	identity_logo [10]	average presence of logo
F	identity_sitename_title [12]	presence of site name in title
N	navigation_bar [7]	presence of navigation bar
N	navigation_breadcrumbs [7]	presence of breadcrumbs (path metric)
N	navigation_quality_of_links [10]	presence of page title in link
M	maintenance_num_scripts	script files number per page
M	maintenance_num_stylescss	files number per

		page
M	maintenance_num_tables [13]	tables number per page
P	pagelayout_device_specific [7]	presence of specific css to devices
P	pagelayout_html_standards	use of html notation in formatting
P	pagelayout_num_divs [7]	number of divs
P	pagelayout_num_frames [13]	number of frames
P	pagelayout_num_tables [7]	number of tables
P	pagelayout_num_tables_inside_tables	presence of tables inside tables
R	links_average_num_words [13]	average of number of words in links
R	links_links_title [11]	links with title attribute
R	links_num_broken_links[11], [7]	number of broken links
R	links_num_extern_broken_links [7]	number of broken links to another sites
R	links_num_extern_links [7]	number of links to another sites
R	links_num_image_links [13]	number of links with images
R	links_num_intern_broken_links [7]	number of broken links in the same site
R	links_num_intern_links [7]	number of inter links
R	links_num_links [11], [7]	number of links
R	links_num_non_implemented_links[11]	number of non-implemented links
R	links_page_without_links [13]	pages without links in the site
R	validation_errors [7]	html errors

		per page
R	validation_warnings	html warnings per page
A	accessibility_img_alt [7]	presence of alt attribute in images
A	accessibility_img_title [13]	presence of title attribute in images
A	accessibility_validate_access [7],[10],[14]	accessibility issues per page
U	multimedia_num_img [7]	image number per page
U	text_font_size_average_em	average of font size in em (percentage) in css
U	text_font_size_average_px	average font size in css in pixels
U	text_font_size_max_em	maximum font size in em (percentage) in css
U	text_font_size_max_px	max font size in pixels
U	U text_font_size_min_em	minimum fonts size in em (percentage) in css
U	text_font_size_min_px	min font size in pixels
U	text_heading_len [7]	average heading length
U	text_heading_reverse_order [7]	number of headings in reverse order
U	text_italic_text	number of italic text bigger than 20 chars
U	text_num_diferent_colors	number of different text colors in css
U	text_num_diferent_fonts [7]	number of different text fonts in css
U	text_num_sentences_in_paragraph [7]	number of sentences per paragraph

U	text_num_subheading_heading [7]	number of sub headings per heading
U	text_num_syllables_in_word [7]	number of syllables per word
U	text_num_words_in_sentence [7]	number of words per sentence
U	text_num_words_meta_keywords	number of words in metatag keywords
U	text_paragraph_max_size [7]	maximum size of paragraph
U	text_paragraph_size [7]	paragraph size
U	text_subheading_len [7]	sun heading length
U	text_total_newlines [7]	total number of newlines
U	text_total_sentences [7]	total sentences
U	text_total_syllables [7]	total syllables
U	text_total_words [7]	total words
U	text_uppercase_text	number of uppercase sentences

4. Data Analysis

The main purpose of this research is to evaluate and compare the quality of Internet sites. The comparison of the portals and the respective factors will take place by applying the following analysis.

4.1.1 Principal Components Analysis

One of the multivariate analysis method and mostly used method in large multidimensional datasets is Principal Component Analysis (PCA). This PCA procedure entails a mathematical calculation which converts into small uncorrelated variables from number of possible correlated variables. First Principal component will accounts in the data variability as much as possible and the succeeding components will accounts component in the data for remaining variability.

The number of multivariate data set can be reduced by using PCA and maintains possible variation that is, present in the data set. This reduction is achieved by taking p variables X1, X2,..., Xp and finding the combinations of these to produce principal components (PCs) PC1, PC2,..., PCp, that are uncorrelated.

4.1.2 ANOVA

The techniques used to perform the assumptions are simple correlated Analysis of Variance (ANOVA), multiple comparisons in ANOVA. Unlike other inference procedures, ANOVA will make the result fully dependable because which has some underlying assumptions which should be in place. They include:

(i) Subjects are chosen via a simple random sample.
(ii) Response variable is distributed within each group/population.
(iii) Population standard deviation is the same for all groups while the population has different form from one group to another.

Assumption 1:

H_0: The means are equal, agro = eco = guest,

H_1: The means are not equal, $agro \neq eco \neq guest$.

Assumption 2:

If differences exist among the mean values of the three Internet sites, then between which sites are these detected?

Simple correlated ANOVA examines the first assumption; the method of multiple comparisons in ANOVA was used to examine the second assumptionalthough remaining assumptions were subject to the t-test. Simple correlated ANOVA examines whether two (or more) value groups differ significantly with regard to the distribution of their mean values. It also assumes that the values of the two groups originate from the same sample of people and that the correlation coefficients are high. The reason that correlated ANOVA was selected on top of uncorrelated is that the data come from the same sample. Yet this method can detect the general tendency and not the points in which differences exist.

For this reason, the multiple comparisons method in ANOVA was applied, with which an attempt was made to detect the statistically significant differences among the mean values of Internet sites. This technique is used when the examined means are two, and it detects which specific pairs of distribution means differ significantly in the variance analysis.

4.1.3 T-SCORE

The t-test is used to examine the differences in mean values of the factors that determine Internet quality. These factors, as mentioned, are usability, functionality, reliability, maintainability etc. However, apart from the evaluation of the portals, the factors that compose the quality of each portal are also assessed and compared. The overall evaluation of the Internet sites examined is performed with statistical tools, based on the scale used in the research questionnaire. To assess and compare the individual quality factors, other inductive-statistical tool t-test was used.

In practice, the research was conducted towards two directions: a part of the sample was approached through personal interviews. Participants came in voluntarily, while exploring the examined Internet sites, they voluntarily answered the questionnaires handed to them in hard copy. The remaining participants were approached via electronic mail, after asking if they would be willing to accept the electronic message. The cover letter itself contained clear information and instructions on the purpose and way to complete the questionnaire. All questionnaires were answered in a unanimous manner.

5. Experimental Results

Experimental result is performed by parametric of PCA, ANOVA tests and T-Score. As it can be seen there, only three metrics have statistical evidence of normality. The T-Score test significance is shown from **Table 2 to Table 9**. As it can be seen there, only three metrics have statistical evidence of normality. For the latter we have used the parametric ANOVA test and for all the others we have used the equivalent non-parametric one, the T-score test, whose corresponding statistics are represented in **Table 2** through **Table 9**. In the same table, the last column (named "Conclusion") shows the label "EFFECT" on those cases where the ANOVA test allowed detecting a statistically significant difference on the variance between the groups. As such, the metrics marked with the "EFFECT" should be considered as possible candidates for a domain-specific website quality model, while the remaining ones are candidates for a domain-independent model.

Table 2: Efficiency Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
efficiency_css_sizecss	0.000		35.102	EFFECT
efficiency_homepage_load_time	0.000		5.907	NOTEFFECT
efficiency_img_size [7]	0.000		27.075	EFFECT
efficiency_javascript_size [7]	0.000		26.012	EFFECT
efficiency_page_load_time [10]	0.000		0.085	NOTEFFECT
efficiency_page_size	0.083			EFFECT

Table 3: Functionality Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
forms_form_info_request [11],[12]	0.000		9.015	EFFECT
forms_labels	0.000		11.021	EFFECT
identity_author [10]	0.000		1.997	NOTEFFECT
identity_logo [10]	0.000		0.401	NOTEFFECT
identity_sitename_title [12]	0.000		1.256	NOTEFFECT

Table 4: Navigation Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
navigation_bar [7]	0.000		0.229	NOTEFFECT
navigation_breadcrumbs [7]	0.000		3.257	NOTEFFECT
navigation_quality_of_links [10]	0.000		2.658	NOTEFFECT

Table 5: Maintainability Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
maintenanc_num_scripts	0.005		11.298	EFFECT
maintenanc_num_stylecss	0.000		9.198	EFFECT
maintenance_num_tables [13]	0.000		4.445	NOTEFFECT

Table 6: Portability Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
pagelayout_device_specific [7]	0.000		4.905	NOTEFFECT
pagelayout_html_standards	0.000		8.998	EFFECT
pagelayout_num_divs [7]	0.003		29.298	EFFECT
pagelayout_num_frames [13]	0.000		3.024	NOTEFFECT
pagelayout_num_tables [7]	0.000		4.892	NOTEFFECT
pagelayout_num_tables_inside_tables	0.000		6.024	NOTEFFECT

Table 7: Reliability Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
links_average_num_words	0.000		3.705	NOTEFFECT
links_links_title	0.000		12.021	EFFECT
links_num_broken_link	0.000		1.089	NOTEFFECT
links_num_extern_broken_links	0.000		0.110	NOTEFFECT

links_num_extern_links	0.000		49.997	EFFECT
links_num_image_links	0.000		28.054	EFFECT
links_num_intern_broken_links	0.000		1.502	NOTEFFECT
links_num_intern_links	0.059	15.801		EFFECT
links_num_links	0.027		35.102	EFFECT
links_num_non_implemented_links	0.000		1.699	NOTEFFECT
links_page_without_links	0.000		12.025	EFFECT
validation errors	0.000		1.102	NOTEFFECT
validation warnings	0.000		2.998	NOTEFFECT

Table 8: Accessibility Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
accessibility_img_alt [7]	0.000		2.001	NOTEFFECT
accessibility_img_title [13]	0.000		1.998	NOTEFFECT
accessibility_validate_access [7],[10],[14]	0.060	5.012		EFFECT

Table 9: Usability Metrics Vs Application Domain

Website quality metric	PCA	ANOVA	T-score	Conclusion
multimedia_num_img [7]	0.005		11.798	EFFECT
text_font_size_average_em	0.000		1.225	NOTEFFECT
text_font_size_average_px	0.000		4.539	NOTEFFECT
text_font_size_max_em	0.000		2.002	NOTEFFECT
text_font_size_max_px	0.000		5.032	NOTEFFECT
U text_font_size_min_em	0.000		0.875	NOTEFFECT
text_font_size_min_px	0.000		4.026	NOTEFFECT
text_heading_len [7]	0.000		7.021	EFFECT
text_heading_reverse_order [7]	0.000		21.201	EFFECT
text_italic_text	0.000		8.012	EFFECT
text_num_diferent_colors	0.000		55.012	EFFECT
text_num_diferent_fo	0.000		32.578	EFFECT
text_num_sentences_in_paragra	0.000		2.045	NOTEFFECT
text_num_subheading_head	0.000		15.025	EFFECT
text_num_syllables_in_w	0.000		5.032	NOTEFFECT
text_num_words_in_sente	0.045		3.082	NOTEFFECT
text_num_words_meta_desc	0.000		15.024	EFFECT
text_num_words_meta_key	0.000		4.978	NOTEFFECT
text_paragraph_max_s	0.004		7.214	EFFECT

text_paragraph_s	0.020		0.702	NOTEFFECT
text_subheading_	0.000		15.874	EFFECT
text_total_newli	0.000		0.198	NOTEFFECT
text_total_senten	0.002		8.825	EFFECT
text_total_syllab	0.001		4.987	NOTEFFECT
text_total_wo	0.000		6.124	NOTEFFECT
text_upperca	0.000		3.014	NOTEFFECT

5. Conclusion

In this work, website quality measurement criteria are defined which help in relating external and internal quality then presented to a framework for measuring the quality of web-based systems. The performance is based on a website user point of view and has been designed in a form of possible automation of the evaluation process. Attention is given to the identification of criteria which is objectively evaluated and measured. The framework is presented by no means a final conclusion on how web-based systems can be measured, but it provided a framework which can be extended by its users, and believe that this is a step to more effective measurements of web quality. The results that emerged from the use of the PCA, ANOVA and t-test statistical tools included statistical significant differences among the examined means. For the future, it suggests creation of an open knowledge base of web-based software's quality factors, criteria, and metrics. Software professionals can then make use of already defined model that suits them or find the closest model and modify it according to their needs.

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