

Analyzing the usage of website evaluation methods – an actor based approach

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Abstract— In recent era, websites are the ultimate media for getting information, advertisement of organizations, shopping, entertainment, education, as well as social contacts. But a website must possess a high quality to provide success to organizers as well as to satisfy the users. The academicians proposed a lot of website evaluation models which has been designed by taking a variety of approaches and methods. To evaluate the website, one needs knowledge about the diversity in website evaluation approaches and methods to be followed. This paper highlights the ethics involved in the application of prominent website evaluation methods by conducting an in-depth study of reputed research papers from large databases such as IEEE, Springer, ACM and Taylor & Francis publications. Website methods have been classified on the basis of actors involved in the evaluation. Analysis of the usage of these methods in previous website evaluation studies has been accomplished which concludes that the majority of evaluation studies relied upon user based evaluation methods. It is recommended that there should be more orientation towards the automated evaluation methods as it is free from human biasing and can be exercised when the website just completed the design phase to predict the quality of the website. Due to summarization of major website evaluation methods, the paper has massive value for academicians as well as industry readership in the discipline of website evaluation.

Keywords—Website evaluation, Evaluation methods, Website quality, Website assessment

I. INTRODUCTION

Quality is an elusive measure. Quality can be seen as the abstract relationship between attributes of an entity [118]. While the term is ambiguous and obviously misunderstood, there are many perspectives and approaches to define and measure quality. According to Kan [119], a quality software must provide conformance to requirements and meet user needs. The first factor defines the quality of software as its capability to work according to outlined specifications which are defined prior to its design by designers and developers. Second factor deals with the capability of software to meet users' intended goals and expectations. ISO 9126: 1991 defines quality in terms of facts which meet the users stated and implied needs. ISO 13407:1999 express quality measurement as multidisciplinary task which entails knowledge of various disciplines such as ergonomics, behavioural and psychological studies, sociological measurement and working techniques. ISO 9241-11:1998 and ISO/IEC 25010:2011 incorporates one more factor i.e. usability into quality system and redefine quality 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."

Websites are the artefacts having distinguished features from traditional software. Like broad definition of quality, website quality is basically an undefined concept. Certain researchers put an effort to explain the quality of a website and method to evaluate it in a descriptive way but some lack to define the key characteristics whereas others the scale to measure them [66, 67, 77]. Certain academicians have divided the quality into different perspectives and measure each perspective separately [28] whereas various researchers have considered quality from different point of views and eliminate the gaps between them [65]. Lilburne *et al.* [57] have proposed two perspectives to measure website quality i.e. website developers and end-users.

Malhotra and Sharma [62] have evaluated website structural aspects by using HTML parser and fuzzy algorithms. Mich [65] has proposed a lot of methods to be used to evaluate the various quality types and gaps between them. But no method has been adopted as universal method for evaluation. Even a single method is insufficient to predict the quality of website so they have been used in combination towards the

accomplishment of mission. Previous evaluation studies have been headed towards the assessment of user satisfaction and hence approached user-based evaluation methods. There exists a deficient in of studies which evaluate the websites from organisational point of view which must be conquered as it is the ultimate reason for initiation and enhancement of the website. One must requires an in-depth knowledge of website evaluation methods and approaches to assess and identify the shortcomings of the website thoroughly. This study endeavours for in-depth review of website evaluation methods and approaches. An effort has been taken to classify the website evaluation methods according to the person who evaluate the site by applying the method. The usage of various methods have been also analysed by accessing the reputed research papers from previous studies. Finally, it is concluded that user-based evaluation methods are used maximally as the ultimate aim for enhancement of website is the user satisfaction.

After introduction, background study has been organised to discuss previous classification of methods in the next section. The research methodology along with classification of website evaluation methods has been talked about in succeeding section. Usage analyses for the various methods and discussions have been embodied in subsequent section. The last section has epitomized the conclusion and future scope.

II. RELATED WORK

Websites can be evaluated by using several methods. These methods have been categorized by various authors in distinct ways. Nielson and Mack [75] categorized these methods into two sub-categories viz – automatic versus empirical, and formal versus informal where automatic methods involve software, empirical methods involve real users, formal methods integrate models only, and informal methods includes rules, evaluators' skills, knowledge as well as experience.

Gray and Salzman [34] proposed two aspects of evaluation methods such as analytic and empirical. Techniques like heuristic evaluation and cognitive walkthrough are categorised as analytic aspect whereas empirical aspect involves user testing methods. Certain researchers count the number of features provided by website [45] whereas several access the structural components or weblog data using automated tool [6, 53].

Some academicians rely on user to evaluate certain quality aspects using questionnaire or interview techniques [17] whereas a few researchers use automated software along with statistical and mathematical models [23, 59]. However, Law *et al.* [55] have broadly classified the methods used for evaluation of websites into five categories as counting, automation, user judgment, numerical computation and combined. Counting involves the examination of the number of features such as search engine, sitemap, number of

images, number of hyperlinks, multimedia elements etc. and provided to user by website by comparing them with a planned checklist. Automation encompass the techniques to analyse the website by measuring quantitative features with the help of web log data such as pageviews, clicks and bounce rates with the help of automated software. This category can also parse the HTML code to trace down the presence of certain features such as search engine, sitemap, number of images, number of hyperlinks, multimedia elements etc. User judgement is implemented by collecting the qualitative data such as perceived usefulness, accessibility, aesthetics, multimedia, operability, interoperability, information content, navigability etc. through questionnaires, interviews and then measures their satisfaction levels on Likert scale. Numerical Computation uses mathematical models and computational techniques like linear programming models and fuzzy AHP, fuzzy ANP techniques for evaluation. Combined methods utilizes two or more approaches at once like automation and counting (HTML parsers & web miners); user judgement and automation (for quantitative metrics use automated tools whereas for weighing and transforming them into qualitative aspects, experts adopted MCDM techniques) to measure both quantitative and qualitative metrics.

Kaur and Gupta [49] have suggested that website evaluation should be successfully implemented by identifying the persons involved in website assessment at different points in the development and implementation of website but one must know the various methods that a person should follow for assessment of website. As different persons have different roles in website development project, they cannot use the same methods for evaluation of website. Mich [65] has also proposed the different persons involved and the methods that can be adopted to evaluate the quality gaps for a website. So, this paper makes an effort to classify the evaluation methods based on actor involved in website assessment. A brief explanation of each method is provided. Finally, previous studies are assessed in order to determine the usage percentage of a particular method.

III. METHODOLOGY

A systematic methodology has been followed for determination of various methods used in previous studies for website evaluation. This systematic methodology engaged various activities to be performed in sequential manner. The main activities performed for this research includes determination of previous studies for website evaluation from reputed databases like IEEE, Springer Link (SL), ACM Digital Library (ACM), Wiley Online Library (WOL), Emerald (EM), and Taylor and Francis (TF), selection of articles after assessing quality criteria, categorize the articles according to the assessors involved in the evaluation, determination of methods under each category,

calculate their percentage usage and analyze the results. The methodology has been depicted in Figure 1.

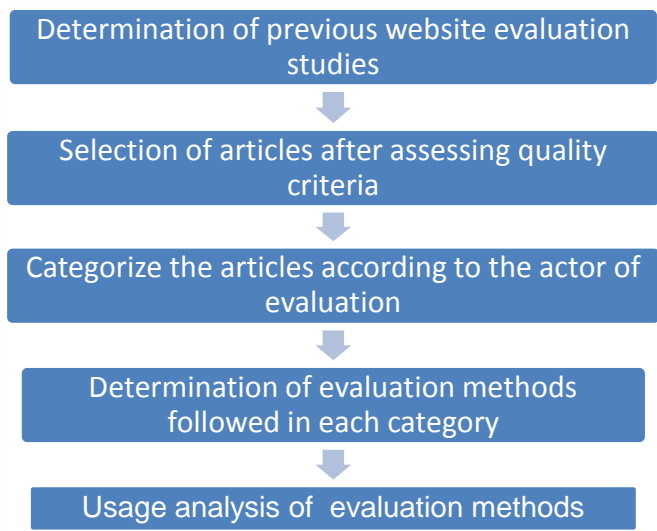


Figure 1 Methodology for Research Process

Research Problem: The existence of a lot of diversity in website evaluation methods in previous literature becomes a riddle for website developers, owners as well as users to assess the quality of website successfully. Keeping in mind, this work put an effort to highlight and classify the website evaluation methods based on assessors involved in the website evaluation study. It provides new challenges for practitioners who are working in this discipline by providing the usage analysis of these methods. It also provides the root for developing the new methods and approaches for website evaluation. The major research questions focussed in this study are:

- Determination of different website evaluation methods and their actors which are in trends in last fifteen years
- Analysis of the usage of these methods

In order to determine the prominent evaluation methods, the activities performed have been summarized in the following sub-sections.

Determination of Website Evaluation Studies: The major keywords used for searching the studies in the discipline comprises 'Frameworks for website evaluation', 'Models for website evaluation', 'Website measurement', 'Website assessment' and so forth. These keywords have been also applied for search for the studies in specific domain such as in e-government studies key words can be 'Frameworks for e-government website evaluation', 'Models for e-government website evaluation', 'e-government website measurement', and 'e-government website assessment'. These keywords

have been applied in academic databases such as IEEE, Springer Link (SL), ACM Digital Library (ACM), Wiley Online Library (WOL), Emerald (EM), and Taylor and Francis (TF) as well as Science Direct (SD) (<http://www.sciencedirect.com>) and Google Scholar (GS) (<http://scholar.google.com>) to attain the research papers in the discipline of website evaluation.

Selection of articles after assessing quality criteria: After conducting the search on academic databases, *one hundred and forty three* research studies have been accumulated in the discipline of website evaluation for last fifteen years (2001–2016). The next step involves the study of abstract and introduction to look for their relevance with the mission of research. *One hundred and twelve* articles have been retrieved after removal of the irrelevant and duplicate articles. After conducting the study of conclusion, *one hundred and two* articles have been taken for in-depth study through iterative group discussions and at the end *ninety one* articles have been finalised for the research purpose of this paper. The quality criteria which have been taken for selection of articles involves explanation of the aims and scope of study, relevance of the research methodology adopted with aims of study, quality and quantity of data collected and analyzed for providing results, explanation of the findings of the research, and finally, value of the research.

Categorization of articles according to the actor involved in website evaluation: After conducting the in-depth study of selected articles, it has been concluded that the three types of actors are involved in the projects of website evaluations i.e. experts, users and software. So, methods can be classified as experts based evaluation methods, users based evaluation methods, automated software based methods. In order to determine the evaluation methods the selected research studies are segmented into five groups as depicted in Figure 2.

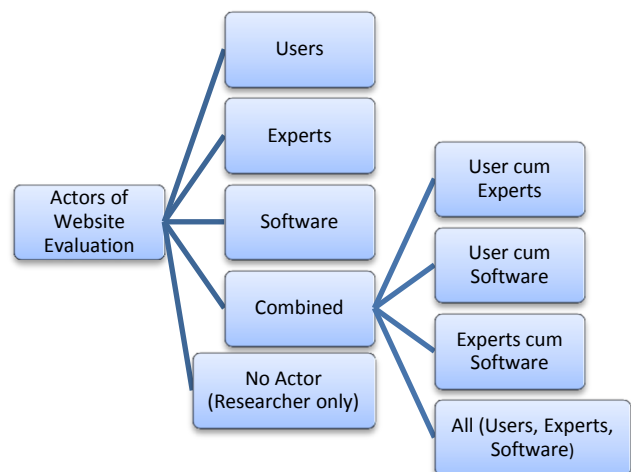


Figure 2 Categorization of website evaluation studies (Actor – based)
Table 1 Expert based evaluation studies

Author	Domain of study	Methods used
Bauer <i>et al.</i> [14]	E-Banking websites	Expert interviews
Vaughan [106]	Search engine websites	Direct Observation, Statistical evaluation
Achour and Bensedrine [1]	E-Banking websites	Direct observation of different facilities which are provided by bank site to compute net score
Garcia <i>et al.</i> [33]	E-Government evaluation	Heuristics evaluation
Miranda [69]	E-Banking websites	Direct observation of different facilities which are provided by bank site, Experts interviews
Gabriel [32]	E-Commerce websites	Hypothesis testing
Alhelalat <i>et al.</i> [3]	Hotel Websites	Hypothesis analysis, Cause and effect study
Weir [109]	E-Banking websites	Sample data analysis using questionnaires
Tsai <i>et al.</i> [105]	Airline Reservation websites	Expert questionnaires
Sivaji <i>et al.</i> [95]	E-Government websites	Heuristics evaluation
Chu and Kim [24]	Social websites	Hypothesis evaluation using survey
Kincl <i>et al.</i> [52]	All websites	Hypothesis evaluation
Afonso <i>et al.</i> [2]	Academic websites	Heuristic evaluation by a case study
Torrente <i>et al.</i> [104]	All websites	Heuristic evaluation
Elkhani <i>et al.</i> [29]	Airline Reservation websites	Hypotheses analysis
Bastida and Huan [13]	Tourism websites	Heuristic evaluation of certain parameters
Chmielarz and Zborowski [23]	E-Banking websites	Direct observation and inspection
Lorca <i>et al.</i> [59]	E-Banking websites	Hypothesis analysis

The expert based studies have been depicted in Table 1, user based evaluation studies have been depicted in Table 2 whereas software based studies have been depicted in Table 3. Some studies have used more than one actor which have been presented in Table 4 whereas table 5 has been organised with those studies which did not involve any actor and researcher has total responsibility for evaluation of website.

Determination of website evaluation methods: These are the methods used to assess certain metrics or criteria for website. These methods have been categorized by various authors in distinct ways. Based on the actors involved, website evaluation methods have been categorised into three classes in this study. The actor can be evaluator (expert), user of website, or some automated software.

a. Evaluator-based evaluation methods: These are the methods where metrics or criteria are evaluated by experts, web developers, or website owners without involvement of end users of website. These methods are also categorized as inspection methods as evaluators inspect or examine the website deeply to assess its certain aspects [75].

Table 2 User based evaluation studies

Author	Domain of study	Methods used
Gullikson <i>et al.</i> [37]	Academic websites	Survey questionnaires
Chung and Paynter [25]	E-Banking websites	Survey using direct observation and questionnaire
Huang <i>et al.</i> [44]	Academic websites	Questionnaires
Lu and Lu [60]	Tourism websites	Survey with questionnaires
Shchiglik and Barnes [93]	Airline Reservation websites	Online Survey
Barnes and Vidgen [11]	E-Government websites	Survey data analysis using questionnaires from two focus groups
Mavromoustakos and Andreou [64]	All websites	Questionnaires
Buyukozan <i>et al.</i> [120]	Academic websites	Questionnaires
Mich and Franch [68]	Tourism websites	Survey with questionnaires
Tate <i>et al.</i> [103]	Academic websites	Survey questionnaires
Stefani and Xenos [100]	E-Commerce websites	User judgement
Sun and Lin [101]	E-Commerce websites	Survey questionnaires
Hu [43]	Airline Reservation websites	User judgement
Verdegem and Verleye [108]	E-Government websites	Focus group interviews
Chiou <i>et al.</i> [21]	All websites	Questionnaires
Moreno <i>et al.</i> [71]	Medical websites	Focus group technique
Joo <i>et al.</i> [47]	Academic websites	Questionnaires
Rocha [87]	All websites	Questionnaires
Alomari <i>et al.</i> [4]	E-Government websites	Survey with users
Orehovacki <i>et al.</i> [78]	E-Commerce websites	Retrospective thinking aloud method, Online questionnaires
Pranić <i>et al.</i> [85]	Hotel websites	Sampling with questionnaires
Effendi and Alfina [28]	Airline Reservation websites	Survey using direct observation and questionnaires
Santos [87]	Academic websites	Questionnaires
Suwawi <i>et al.</i> [102]	Academic websites	Data sampling with questionnaires

Table 3 Software based evaluation studies

Author	Domain of study	Methods used
Olsina and Rossi [77]	All websites	WebQEM tool, Linear additive scoring method, Templates to extract information regarding measurable indicators
Zhu [117]	All websites	Web mining, OLAP
Perez-Lopez [82]	Medical websites	Search engines to determine relevant sites and number of links for site popularity, A systematic assessment tool

Jati and Dominic [46]	E-Government websites	Web Diagnostic tools
Alsmadi <i>et al.</i> [6]	All websites	Web crawler, HTML parser
Malhotra and Sharma [62]	All websites	MATLAB, A Web Metrics Analyzer tool (devin JAVA)
Schafer and Kummer [92]	E-Commerce websites	Click stream, Data mining

Chinthakayala <i>et al.</i> [20]	Social websites	Analytical study as well as user case study	Experts and Users
Asmaran [7]	Search engine websites	Sample data of 40 search queries, an automated tool Pingdom	Experts and Software

The evaluators can inspect them by using various methods, however some well-known methods used in literature includes:

Table 4 Evaluation studies which used more than one actor

Author	Domain of study	Methods used	Actors involved
Barnes and Vidgen [10]	E-Commerce websites	WebQual 4.0, Online questionnaire	Experts and Users
Howitt <i>et al.</i> [42]	Medical websites	STaRNet Website Assessment Tool (SWAT), Questionnaires	Users and Software
Mich <i>et al.</i> [67]	All websites	Questionnaires and interviews of domain experts along with online tools e.g. http://www.usableweb.com , http://www.htmlhelp.com/tools , http://www.merc-int.com , http://www.watchfire.com , http://www.cast.org .	Experts and Software
Wenham and Zaphiris [110]	E-Banking websites	Task analysis, interviews, cognitive walkthroughs and feature inspection.	Experts and Users
Vaughan and Thelwall [107]	Search engine website	Direct Observation, and Crawler	Experts and software
Can <i>et al.</i> [16]	Search engine website	Automation, User Judgement and Statistical analysis	All
Parasuraman <i>et al.</i> [80]	E-Commerce websites	Online survey questionnaires, Reliability and validity tests, Confirmatory factor analysis, Regression analysis	Experts and Users
Martins and Morse [63]	Medical websites	Search engines, and Score systems	Experts and Software
Zafiroopoulos and Vrana [114]	Hotel websites	Hierarchical cluster analysis, Interviews and questionnaires from managers and clients	Experts and Users
Henriksson <i>et al.</i> [39]	E-Government websites	Questionnaires designed at various levels of government and data is collected in spreadsheets for automatic evaluation	Users and Software
Chiou <i>et al.</i> [22]	Tourism websites	Interview of vice managers, Online-questionnaires, Case-study	Experts and Users
Lin and Lu [58]	Social websites	Hypotheses evaluation via online questionnaire, structure equation modelling, clustering analysis tools	All
Sadeghi [89]	Search engine websites	Automation, User Judgement, and Statistical analysis	All
Cebi [18]	All websites	Questionnaires	Experts and Users
Mich [65]	All websites	Delphi Inspections, Comparative evaluation, Experiment tests, Questionnaires, Interviews	All
Kaur and Dani [48]	E-Banking websites	Hypotheses evaluation for research, Crawler for data collection and link analysis	Experts and Software
Ellahi and Bokhari [30]	Social websites	Hypotheses testing by questionnaire	Experts and Users

Table 5 Researcher based evaluation studies

Author	Domain of study	Methods used
Yoo and Donthu [113]	E-commerce websites	Exploratory factor analysis with data sampling
Morrison <i>et al.</i> [72]	Tourism websites	Literature Survey
Corigliano and Baggio [27]	Tourism websites	Confidence levels evaluation with small samples
Chiemeke <i>et al.</i> [19]	E-Banking websites	Sample data analysis
Baloglu and Pekcan [9]	Hotel websites	Content analysis
Barnes and Vidgen [12]	E-Government websites	Survey data analysis, and ANOVA
Petricek <i>et al.</i> [83]	E-Government websites	Graph theory
Lu <i>et al.</i> [61]	Tourism websites	Literature Survey
Yen <i>et al.</i> [112]	All websites	Requirement Analysis, Mapping between layers is illustrated via a case study
Grimsley and Meehan [36]	E-Government websites	Empirical evaluation of public value framework
Bauernfeind and Mitsche [15]	Tourism websites	Data envelopment analysis
Keenan. Shiri [51]	Social websites	Exploratory study of literature
Qi <i>et al.</i> [86]	E-Commerce websites	Literature Survey
Law <i>et al.</i> [55]	Tourism websites	Literature Survey
Hasan, Abuelrub [38]	E-Commerce websites	Literature Survey
Ali and Beg [5]	Search engine websites	Extensive literature review
Ip <i>et al.</i> [45]	Tourism websites	Literature survey
Greene <i>et al.</i> [35]	Social websites	Survey conduction by downloading the recent wall posts and discussion topics from 15 largest Facebook groups
Silius <i>et al.</i> [94]	Social websites	Web-based evaluation tool (WESQU), Survey conduction
Papadomichelaki and Mentzas [79]	E-Government websites	Online Surveys
Neiger <i>et al.</i> [73]	Tourism websites	Exploratory study of literature
Korda and Itani [53]	Tourism websites	Exploratory study of literature as well as Content analysis
Zhao and Cheng [116]	E-Commerce websites	Analytical Hierarchy Process

Heuristic evaluation: This method is preferred where one wants to examine and improve the usability of an interface before deploying it to end-user. The main objective of this method is oriented towards identification of usability problems in the user interface design by involving evaluators specifically [76]. The evaluators review the website's interface and judge its compliance with recognized usability principles. This method assist to obtain early feedback during development of website but it needs trained usability experts who have knowledge and expertise to apply the heuristics effectively.

Pluralistic walkthrough: This method directs a group to evaluate a user interface by 'walking through' the steps of a task scenario, designed by the evaluators [40]. The group involves representative users, website developers along with usability experts. A number of screens have been organized to represent the scenario, which further represents a single path through the interface [91]. Four aspects must be given intention while conducting pluralistic walkthrough [40].

- The group must involve all participants viz - representative users, website developers as well as usability experts but they all play the role of users
- The interface screens should be organized in the same order for display in which they would be displayed in a web or computer interface
- All participants must examine the each screen and write down the actions, they would like to select for performing the task along with details of feedback
- Each screen would be discussed by group members and the representative users are those who speak first.

The main merit of this approach is the direct feedback obtained from users and discussion with experts by concentrating on user's tasks. But the limitation lies in fact by assigning the same task to experts as well as general users who have to work at same speed. It is also difficult to design and investigate all scenarios as it needs a lot of time and expertise.

Cognitive walkthrough: The main aim of this method is to examine learn-ability of a user interface through exploration [84, 111]. Due to its effectiveness, the method is highly implemented for evaluation of web-based applications [40]. Like above method, a team of evaluators has been organised which includes website developers, designers, and programmers. They are assigned to perform some specific tasks and a reasonable response has been invited by let them answering of two questions at each step of the task [96].

- Will the user know what to do at this step and if he/she has done the right thing?
- Will the user know that he/she has done the right thing and is making progress towards his/her goal?

Guideline reviews: This method is performed like heuristic evaluation but difference lies in the fact heuristics are very small in number as compared to design guidelines [34].

Inspection of comprehensive guidelines will take a long time, so, this method is less preferred than others.

Consistency inspections: The method is used to verify the consistency in the design of web pages of site. The main issues which are examined by experts on each webpage of site involves layout, terminology and colour [56] as inconsistency leads to reduction in performance as well as satisfaction of user.

Standards inspection: In this inspection method, expert checks the user interface against a formally defined standard such as ISO 9241 provides guidelines for usability testing formally. To implement this technique, expert must have knowledge of formal standards. Moreover, correct interpretation of these standards is another requisite.

b. User-Based Evaluation Methods: These are the methods which can be implemented with association of users of the interface. The major objective is to predict the user's performance and satisfaction while operating the interface. The chief method of this category is user testing whereas others are supplementary techniques based on it. The main aim of this method to collect the direct information about users while they are using the interface and analysing it in order to determine the troubles they face with the interface (Nielsen and Mack, 1994). Besides questionnaires and interviews, a set of certain other techniques have been also proposed by various academicians.

Capturing user performance: In this technique, the user's actions are recorded and analysed while user interacts with user interface. An automated tool, Camtasia designed by TechSmith Company has been successfully used by Goodwin [31] to record user's actions, movements along with their voices when users interact with computer screen using microphone. Camtasia records the data in files having Audio Video Interleaved (AVI) format which can be replayed to re-examine the users' actions and analyse them with the aim of user testing. This technique is an unbiased evaluation technique, however, it requires a high expertise who can accurately interpret the users' actions to find shortcomings in interface.

Think-Aloud method: Unlike the capturing *user performance* technique, this technique is performed with active participation of users. In this technique, users have to verbalise their thoughts while working on the interface. So, observers have to record their thoughts with some equipment in order to find the misconceptions in the interface. This technique directly provides the users' views for interpretation but users can feel absurd and unnatural while working with an observer and recording equipment [41].

Constructive interaction (co-discovery learning): This technique is a minor alteration of *think-aloud* method as it involves two or more users at the same time interacting with interface rather than single one. Holzinger [41] observed that people can talk and explain their views better when working

on same problem at the same time. But the main limitation is the requirement of large number of users.

Retrospective testing (Post-task walkthroughs): In this technique, users are participated two times. User's actions are recorded one time when he interacts with interface while his additional comprehensive views are collected by playing the recordings. The experimenter can stop the recordings and then replay them many times to ask the users for more information [74]. An in depth analysis can be performed using this technique but it has limitation of time constraint. Orehovacki *et al.* [78] have used this technique successfully to compare the commercial sites qualitatively.

Questionnaires and interviews: These techniques are highly preferred for conducting the sample survey on user interfaces. Evaluator has so many choices for preparing the questionnaires such as open or closed, scaled or un-scaled, as well as conducting interviews i.e. unstructured, semi-structured or structured. The main aim of these techniques is to accumulate data related to users' preferences, satisfaction levels for a user interface and interpret it with some statistical or numerical computation methods like multiple regression analysis, structural equation modelling, confirmatory factor analysis, reliability and validity tests etc. These techniques are basically considered as indirect evaluation methods as they are not providing the directly information when user actually work on the interface instead they provide users' opinions, attitudes and preferences related data which can vary from one sample survey to another sample survey. Moreover, these techniques are very time consuming and can provide incomplete and biased information.

Focus groups: This technique requires groups of users with each group focussed on collecting in-depth information (needs, judgements and feelings) on some specific issues related to the site. The candidates of each group which are mainly comprised of six to nine users are worked on same specific task to verify different functions and features of the interface with the help of moderator who identify inadequacies like problematic and undesirable functions in the website [74]. Like questionnaires and interviews, this technique cannot predict user's actual interactions with an interface [74]. However, focus group can be carried out online by eliminating distance and travel costs and by allowing the users from different geographical locations to participate.

All these techniques are user based, so one can perform very well experimentation by setting the hypothesis to predict the users' reaction by altering some aspects of website.

c. Software-Based Evaluation Methods: Several software tools have been designed to measure the website usage related data from sever log files. Some researchers have also designed the tools to extract various measures from code of website in order to predict the value of various quality aspects. The main aim of these methods is to evaluate the

quality of the website without involvement of users or experts. These methods are mostly adopted by website developers to predict the quality of website both before and after deployment so that they can enhance the features of website in coding. They can be categorised broadly in two categories.

Parsing tools: These are tools which parse the HTML code of website in order to determine certain web measures which can be analysed to predict the quality of website. These measures can be examined for some specific set of guidelines or can be used to compute the quality index value for a website. According to Lazar [56], these tools accomplish the purpose of the expert review/inspection methods. Mich *et al.* [67] have used various tools to partially automate the evaluation of website attributes. They have used website watchers and validators (Watchfire's Linkbot i.e. <http://www.watchfire.com>), Mercury Interactive's Astra SiteManager (<http://www.merc-int.com>) and Bobby (Center for Applied Special Technology, <http://www.cast.org>) and some more tools from <http://www.usableweb.com> as well as <http://www.htmlhelp.com/tools> for the purpose of site map construction, acquiring information on site file types and links, retrieving date and time of last updation performed on the website and so on. In addition, a website crawler has been also used for determination of overall time required for crawling the website in order to study the effect of the size of different components on performance of website.

Web mining and Web Analytics Tools: These methods involve various techniques and algorithms which are used to extract and present useful patterns of data from large web data (web pages, server logs) in order to serve the needs of web-based applications. Web mining has been broadly categorized as web content mining, web structure mining, and web usage mining [115]. Web content mining discovers the patterns from contents of web documents by coping with structured data such as lists and tables and even images, video and audio contents. Web structure mining mainly deals with navigation features of website by presenting the structure of website in the form of graph, in which nodes represent the web pages whereas edges represent the hyperlinks or connectivity between web pages. When patterns are extracted and analysed to present the information from server logs in order to provide vision on user activities, the process is termed as web usage mining. This is the process which is mainly opted for studying the quality of website [115]. However, Bakariya and Thakur [8] have used web usage mining to process the web logs and to calculate the page access frequency. The main web analytics tool which has been used for this purpose includes Web Personalizer [70], Web utilization miner (WUM), Mining internet data for associative sequences (MiDAS) [97], WebSIFT, SpeedTracer, WebLogMiner, Shahabi [98]. However, the main web usage data sources for implementation of web analytics tools includes server log, proxy log, client-based page tagging,

server plug-ins, web beacons approach, hybrid method and network based approach.

- **Server based log file and log analysers:** The web servers create and maintain server log files to record the activities performed on the server. The various website statistics are stored in several types of server log files but website usability related information gets stored in access logs. Each entry in this file corresponds to one request (hit). If a page which is requested by the user contains two images, three entries have been recorded in the log file. But information stored in these files is very difficult to understand and interpret as these are in raw form. So, log analysers (web statistics software) or some web mining tools are needed to extract and present the useful information from these files in easy-to-read form. Moreover, log files become large at very fast pace and servers delete them periodically whereas the information stored by log analyser gets retained in the database even if its respective log file gets deleted. The main information which an access log consists of elements like the IP address of the computer making the request (i.e. the visitor), the identity of the computer making the request, the login ID of the visitor if exists, the date and time of the hit, the request method, the location and name of the requested file, the HTTP status code e.g. file sent successfully i.e. code '200', file not found i.e. code '404', etc), the size of the requested file, the web page which referred the hit (e.g. a web page containing a hyperlink which the visitor clicked to get here). Some typical web log analysers include Analog (www.analog.cx), AWStats (awstats.sourceforge.net), Google Analytics (www.google.com/analytics), Webalizer (www.mrunix.net/webalizer) and VisitorVille (www.visitorville.com). These tools provide the summarized information of the most important stats such as visits, hits, bandwidth usage, referrers etc. and provide facilities to view the information for different time periods i.e. daily, monthly or yearly. The main merits of this method of data collection includes ownership of data by the web servers, no need of additional hardware or software for collection of data, collection of HTTP status for a request, and acquiring as well as storing the data related to visits from robots and spiders [50, 81]. However, proxy servers and browsers can fulfil the second and further subsequent requests for a webpage within a specific period of time such as a single session. The process of page caching leads to absence of entry in server log for second and subsequent page requests. So, server log will provide inaccurate data. Another limitation of this method is providing inaccuracy in identifying unique visits as single IP address corresponds to many users when requests are made through proxy servers. Assignment of dynamic IP addresses by Internet Service Providers (ISPs) also leads to inflation in the number of unique visitors as one user will be counted multiple times [50, 81].

- **Client-Based approach:** As server log files have limitations for providing accurate unique visitor data, the

academicians proposed page-tagging techniques as a new source for collection of web analytics data. These techniques collect data from page view when the pages land on the visitor's browser by executing the JavaScript code which is attached with the web pages. The tagged code mostly acquires the information regarding viewed page and visitor's session and sends it to the web analytics vendor's servers. These are the outsource vendors which maintains the web data centres to provide the desired web statistics online for further processing and reporting [50, 81]. A well-known tool of this category is Google Analytics which effect the web analytic's industry a lot. This method of data collection overcomes the limitation of log files for providing inaccurate data as it is collected from users' browsers directly. This method is not influenced by proxy servers as well as non-human user agents i.e. search engines, indexing spiders and crawlers as they do not execute the JavaScript page tags [50, 81]. This method also does not need log analysers to process large log files and hence, process and report the data in real time without any delay [81]. The major limitation of this method is dependence on JavaScript code as well as cookies which are under the control of users. No data will be available from that users who disable these technologies in their browsers [50, 81]. Another limitation includes the inability to provide all types of data like error pages or redirecting pages [50, 81]. The data is insecure as data is collected and provided by outside vendors. Vendors may delete the historical data periodically to make the room for new data. Also, there is no standard format in which data gets stored, so, it varies from one vendor to another [50, 81].

Other uncommon data sources for web analytics: Several *server plug-ins* can be integrated with the web server through a native API which helps in monitoring and collecting the data related to events that take place on the server. However, *application plug-ins* can be used to monitor the events of an application like making a data entry of the forms on a web page [90]. Another approach, *web beacons approach* is related with page-tagging approach. Rather than embedding JavaScript code, the transparent images are inserted into a web page to gather web statistics. Kaushik [50] has observed that when these type of web pages are landed on user's browser, a call to request the image from a third-party server gets executed which also sends the data about the web page. When image is received by user's browser, it does not contain the code for image only but also contain code that can read cookies as well as acquire the visitor's data like the IP address, the time when page was viewed etc. in order to take the advantages of web server log file as well as client side page tagging, a new approach has been used which is formed by hybridization of two approaches [81]. It provides a powerful and accurate way of attaining the data from visitor's web browser while at same time provides security and ownership of data at the server side [26]. A network based approach is also used to collect the web analytics data with

the help of packet sniffers. Packet sniffers can be in form of software which captures packets of data flowing across a computer network or it can be hardware that is linked to a data centre for capturing its all traffic and passing it to the web server [50, 81]. Some studies have also opted the SEO techniques to increase the popularity of websites [54, 99]. All the above approaches are actually data gathering techniques for website assessment. They provide some quantitative or qualitative figures which are later processed by MCDM approaches to compute index value of quality and its types. These figures also provide guidelines to enhance the quality of website.

IV. RESULTS AND DISCUSSION

This section discusses the usage of various website evaluation methods in the previous studies. This involves an actor based approach.

Usage of Evaluator Based Evaluation Methods: Inspection method is preferred by Yen *et al.* [112] along with graph theory while designing an analytical framework for modelling, evaluation and enhancement of website. Torrente *et al.* [104] have proposed the website usability evaluation model by designing eighty three heuristics to be evaluated from experts. Qi *et al.* [86] as well as Hasan and Abuelrub [38] have employed counting of features of website method by experts to propose conceptual model for evaluation of E-Commerce sites. Several studies in the domain of e-banking site evaluation have relied upon evaluator based methods as Wenham and Zaphiris [110] have used task analysis, interviews, cognitive walkthroughs and feature inspection whereas Achour and Bensedrine [1], Chiemeké *et al.* [19] and Miranda [69] have used direct observation to examine the different facilities provided by the site. Bauer *et al.* [14] have preferred expert interviews for performing confirmatory factor analysis for e-banking site. Garcia *et al.* [33] and Sivaji *et al.* [95] have used heuristics evaluation for examining the e-government sites. Morrison *et al.* [72] have used balance score card approach by conducting extensive literature review to design the conceptual method for assessment of tourism site. Ip *et al.* [45] as well as Bastida and Huan [13] have used the inspection technique to verify the presence of specific features in the tourism sites. Keenan and Shiri [51] have used exploratory study to inspect the social sites for comparative analysis. Greene *et al.* [35] have conduct survey by downloading the recent wall posts and discussion topics from fifteen largest Facebook groups. Neiger *et al.* [73] as well as Korda and Itani [53] have devised conceptual methods for evaluation of contents of social networking sites. Vaughan [106] as well as Vaughan and Thelwall [107] have chosen the direct observation method to compare the quality of search engine sites.

Usage of User Based Evaluation Methods: Mavromoustakos and Andreou [64] have proposed the questionnaire method to collect the various measures of WAQE model. Rocha [87]

has proposed a conceptual model to evaluate the global quality of website using user questionnaires. Cebi [18] have devised a model to predict the website design quality with user questionnaires, however, he has used fuzzy DEMATEL theory and Choquet integral to aggregate the measures with proper weighing and compute index value for design quality. Gullikson *et al.* [37], Joo *et al.* [47], Suwawi *et al.* [102] and Tate *et al.* [103] have preferred survey with user questionnaires to evaluate the academic sites but Huang *et al.* [44] have concluded the survey with MCDM techniques using fuzzy theory. Santos [87] has proposed analytical-descriptive and informative approach to evaluate the quality of academic website by employing user judgement methods. The hotel site evaluation studies mostly employed the interviews, questionnaires, hypothesis evaluation along with numerical computation techniques like cluster analysis, cause and effect study, and statistical analysis [3, 9, 85, 114]. The E-Commerce website evaluations have been done mostly with numerical computation techniques by collecting the data samples from users [10, 32, 78, 80, 100, 101, 113, 116]. Shchiglik and Barnes [93] as well as Effendi and Alfina [28] have used user based questionnaire methods for evaluation of airline sites, however, Hu [43], Tsai *et al.* [105] and Elkhani *et al.* [29] have used user judgement along with numerical computation techniques like fuzzy MCDM, genetic algorithm, DEMATEL method, ANP, additive difference mode method and a method of expectancy disconfirmation theory. Chung and Paynter [25] have used direct observation along with user questionnaires to evaluate the e-banking sites whereas Weir [109] has relied upon sample data analysis using questionnaire approach for evaluation of e-banking site. Barnes and Vidgen [11] have used two focus groups to evaluate the e-government site whereas Verdegem and Verleye [108] have also used structure equation modeling along with focus group interviews. Papadomichelaki and Mentzas [79] have also realised user based surveys along with reliability and validity tests for the same purpose. Lu and Lu [60] as well as Corrigliano and Baggio (2006) have proposed survey using questionnaires for evaluation of tourism sites. Chu and Kim [24] as well as Lin and Lu [58] have conducted the case study to evaluate social networking site with the help of survey questionnaires plus structure equation modelling technique whereas Ellahi and Bokhari [30] have used questionnaire along with confirmatory analysis and regression techniques. Chinthakayala *et al.* [20] have proposed the analytical approach for case study of social site. Moreno *et al.* [71] have compared the medical sites using focus group technique by applying 2-tuple fuzzy linguistic approach.

Usage of Software Based Evaluation Methods: Zhu [117] adopted the web mining and OLAP (Online Analytical Processing) while designing and experimenting the WebQM model for evaluation of website. Alsmadi *et al.* [6] have used HTML parser and web crawler to analyse the structure of

website. A neuro-fuzzy based website quality evaluator has been designed by Malhotra and Sharma [62] with the help of web metrics analyser using MATLAB. Afonso *et al.* [2] have used automated tools to collect the data for various heuristics used in evaluation of an academic site. Schafer and Kummer [92] have proposed click stream and data mining approaches along with statistical analysis techniques to evaluate the E-Commerce site quantitatively. Petricek *et al.* [83] have successfully used the graph theory to study the structure of e-government site. Jati and Dominic [46] have evaluated the e-government sites with the help of various web diagnostic tools. Silius *et al.* [94] have devised and used WESQU (Web-based evaluation tool) to qualitatively assess the social site. Asmaran [7] has predicted the quality of search engine site with the help of automated tool 'Pingdom'.

Usage of Combined Evaluation Methods: In generic studies, Olsina and Rossi [77] have proposed the evaluation of various metrics of WebQEM either by inspection method or by automation. However, metrics are aggregated with the help of linear additive scoring method. Mich *et al.* [67] have also practised the website evaluation by using various online tools as well as by conducting the interviews and collecting questionnaires from domain experts. Chiou *et al.* [21] have proposed the questionnaire approaches from experts along with fuzzy linguistic methodology to calculate the quality of commercial sites. Kincl *et al.* [52] have used hypothesis evaluation along with statistical techniques to study the effect of user satisfaction on website quality. Mich [65] has proposed the use of multiple methods (Delphi inspections, comparative evaluation, experiment tests, questionnaires and interviews) to evaluate the various modules of website quality in order to determine and reduce the quality gaps between them. Kaur and Dani [48] have used combined approach which includes hypotheses evaluation along with automated tools like web crawler and link analysis to evaluate e-banking site. Lorca *et al.* [59] have used structure equation modelling whereas Chmielarz and Zborowski [23] have relied upon multilateral analysis for hypotheses evaluation of e-banking sites. Barnes and Vidgen [12] as well as Alomari *et al.* [4] have used survey data analysis with the help of ANOVA and multiple regression analysis respectively for assessing the e-government sites. Henriksson *et al.* [39] have combined questionnaire approach with automatic data evaluating at various levels of government by programming in spreadsheets. Grimsley and Meehan [36] have empirically evaluated the public value framework to study e-government websites. Corigliano and Baggio [27] have evaluated confidence levels with the help of small samples to predict the quality of tourism websites. Lu *et al.* [61] plus Bauernfeind and Mitsche [15] have used AHP with FSE (Fuzzy Synthetic Evaluation) and data envelopment analysis methods respectively to assess the tourism site. Chiou *et al.* [22] have conducted interview of vice managers as well as online-questionnaires to assess the tourism site both

qualitatively and quantitatively. Can *et al.* [16] and Sadeghi [89] have used automated tools along with human judgment to compare the search engine sites. Howitt *et al.* [42] has evaluated and compared medical sites by using STaRNet Website Assessment tool (SWAT) along with user questionnaires. Perez-Lopez [82] has compared the medical sites popularity with links provided by search engines whereas Martins and Morse [63] have used search engines along with score systems for the same purpose.

Results and Discussions: It was observed that the main methods used for website evaluation are based on the user based actor approach. Out of ninety one studies, it has been used in thirty eight studies in which twenty four studies have used it in isolation. So, 41.7% studies embraced this approach in spite of its biased nature. 15% website studies in commerce, search engine and medical domains have not used this method alone; rather it has been utilized in combination with other methods whereas 26% studies used these methods alone. The next esteemed methods involves expert oriented techniques, which have been used in 38% of total studies from which 18.6% studies have used it in combination with other actor based methods. The studies which used combined methods are 20.8% in which 8.7% studies have used the combination of user and expert based methods whereas 2% and 5.4% studies have involved user cum software and expert cum software approach respectively. 4.4% studies have used all actors for website evaluation whereas 25.3% are only dependent on researcher without involvement of any actor. Due to the new technique, automation has been exercised in 19.7% studies, whereas only 7.7% studies have employed the software oriented approach alone.

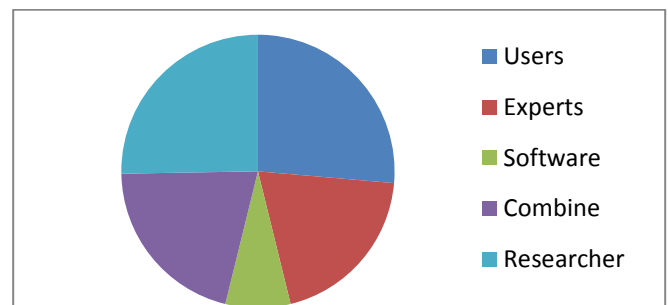


Figure 3 Distribution of all website evaluation methods in studies

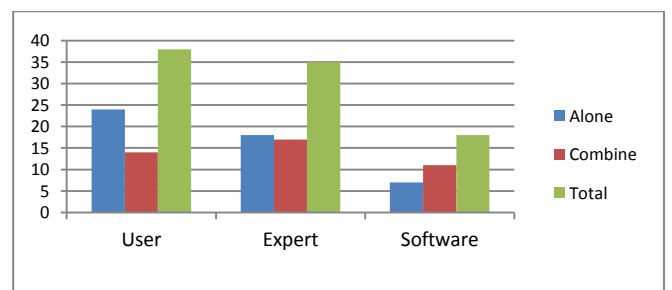


Figure 4 Analysis of actor-based studies

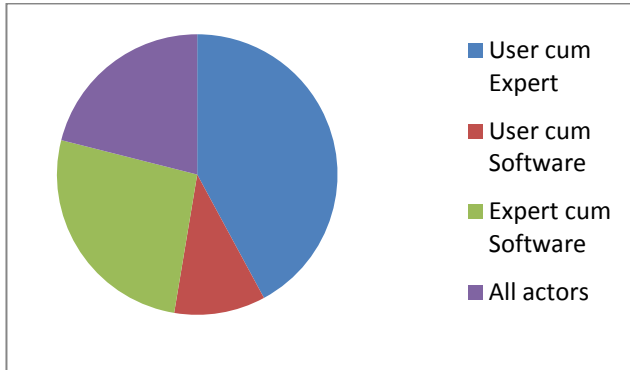


Figure 5 Distribution of combined evaluation methods in studies

The dissemination of website evaluation studies according to actor based approach has been depicted in Figure 3. It has been observed that most of the studies has given priority to the user based methods alone whereas with slight variation in number the second option is only researcher based (without involvement of any actor). Majority among these studies represent conceptual model. The next prior studies adopt expert based approaches as well as combined approaches. Both have been reported nearly equal in number. Very few studies have been observed which follows the automation for website evaluation. The relative usability of each actor based approach has been demonstrated in Figure 4. The usability of user-based methods alone has been reported in majority of studies whereas second account has been given to expert-based methods alone. Third prior approaches have been recorded involves combined expert based approaches whereas next account for combined user based approaches. Software based methods have been least preferred both in combined as well as alone approaches. The dissemination of website evaluation studies which have involved more than one actor, has been signified in Figure 5. The mainstream adopted has been observed as user cum expert based approach whereas user cum software has been least preferred.

V. RESEARCH GAPS AND FUTURE SCOPE

The main contributions of the paper are the summarization of the website evaluation methods and their usage analysis in previous studies. The results concluded that the large number of website evaluation studies have been relied upon the user based methods. They have designed the survey or online questionnaires to collect the views of users regarding the quality of website. These studies presumed that user is the final consumer of website and if users are well satisfied with the website, the site bears a good quality. But user based methods have the limitation of human biasing. Due to lack of universal standards in the discipline of design of websites, the websites are hardly estimated by software methods. Another fact lies in this discipline for the limitation of

technical knowledge by website owners to predict the quality of designed website. But in reality, the website must bear a good design quality to gratify the users and hence, makes the business a success. To overcome these limitations and research gap, there is a need to evaluate the website after design and before depletion by using software methods. There is a requirement of methods to predict the design quality of website so that quality gaps can be easily traced out in case of poor apparent quality of website observed by the user. User based methods cannot be ignored as user is the ultimate consumer of website but automated methods of evaluation would be used as a supplement to these methods.

VI. CONCLUSION

Upon recognizing the prevalent need of website design in every discipline of informative world such as academics, shopping, government, banking, business, entertainment etc., this paper aims at highlighting the methods used in website evaluation. These methods have been pigeonholed as per the person involved in website evaluation. Three types of website evaluators (actors) have been classified after deep investigation of literature viz – experts, users and software. So, three types of studies have been categorized first. However, two other categories of previous studies have been also unearthed i.e. the studies which involve more than one evaluator and the studies without any evaluator. The first type of studies among these two studies have been further disseminate into four kinds such as user cum expert based, user cum software based, expert cum software based, and the studies which involve all three actors. The second type of studies have been conducted which only need researcher without any actor. The methods used for website evaluation under each category have been brought into light.

The usage analysis of these methods have illustrated that the users are the foremost evaluators of the websites. The next prior evaluators are the experts where as software are the least preferred methods. However, researcher based studies have been realized in the literature equally to user based studies. It can be concluded that most websites have been evaluated constantly for up gradation to satisfy the users, so, users are the prominent evaluators in website evaluation studies. But equality in researcher oriented studies demonstrates that the website evaluation is a highly incredible discipline in the field of research in recent days. The future studies should develop and exercise the automated ways to enhance the quality of websites both after designing of the website as well as after deployment in combination with user based methods. The theories and algorithms from the discipline of human behaviour and psychology must be embedded in the discipline of website evaluation.

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