

Attractiveness and Learnability to Support Operability in Web Applications

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Abstract—One of software quality criteria that is vital to determine the success of a software system is usability (ISO/IEC 9126-1:2001), also known as operability (ISO/IEC 25010:2011). There are a few sub-criteria that support operability and two of them are attractiveness and learnability. There is still lack of systematic review with regard to usability or operability with the focus on attractiveness and learnability mainly in Web applications. As more software systems nowadays are web-based, studying these quality factors are indeed essential. This study adopts a systematic literature review method to investigate existing works on the two sub-criteria besides exploring the works in both usability and operability in Web applications in general. The results specifically examine the issues, strengths and weaknesses that also conclude the gaps in existing works on attractiveness and learnability in Web applications besides the focus on existing frameworks.

Index Terms—Attractiveness; Learnability; Operability; Systematic Literature Review.

I. INTRODUCTION

In tandem with the utilization of the Internet, Web-based applications have been broadly used by various demographic of users to enlighten their workloads instantly [1],[2]. While surfing a website, users consider the attractiveness quality while getting the required information. They also consider how data is exhibited and explored. Websites or web applications with proper way of presentation can lessen users time in learning process in order to meet their needs and accomplish the objectives [3],[4].

This study refers to the ISO/IEC as the guide in investigating the attractiveness and learnability sub-criteria under the usability criteria that is now known as operability. ISO/IEC 25010:2011 characterizes attractiveness quality as “the degree to which the software product is attractive to the user” and learnability is “the degree to which the software product enables users to learn its application” [5]. Both factors mainly involve user interface (UI) and specifically user interface design (UID).

Some studies have inspected existing criteria or acquainted new ease of use criteria in line with the development of Web applications, including the ISO/IEC 259010:2011 and W3C guidelines. For example, Massey et al. [6] have created and assessed Microsoft Usability Guidelines that focus on Web application design. In addition, Zhang and Dran [7] and another work by Palmer [8] have analyzed the utilization of ease of use criteria in the Web application design stage that also concern about attractiveness and learnability. In spite of the fact that there have been various proposed works, they are not widely used in development specifically in design stage.

Numerous software developers or designers do not use the

current guidelines or proposed solutions, as they hardly understand them [9]. This issue is also supported by Lazar et al. [10] that state limited technical knowledge among software developers may contribute to misunderstanding of usability criteria in the current works or guidelines. For example, developers may define attractiveness as an imaginative image in a Web application [11], but other developers perceive attractiveness as a criterion that should focus on website navigability [12]. For the learnability aspect, some developers may focus on the ease with which users can complete their tasks [13], while others may concern on how to lessen the burden on users’ computer resources to ensure that every transaction run on a Web application can be done faster [14]. In addition, Kato et al. [15] highlight that misunderstanding may cause conflicts among software developers, while Alghamdi et al. [16] state that these conflicts may lead to disagreements among software developers that can affect the success of a software project.

In short, the success of a Web application depends on the quality sub-criteria that are closely related to UI and UID to support operability through the concerned two quality factors that are attractiveness and learnability. Thus, systematic investigation is necessary in order to identify the issues, strengths and weaknesses of existing solutions and the gaps.

This paper adopts a systematic literature review (SLR) method to study the issues, strengths and weaknesses of existing works and their gaps in attractiveness and learnability in Web applications besides the review on the works in usability and operability in general. The following Section II includes the related work, while Section III analyzes the review process. Section IV reports the result and discussion and finally Section V concludes the investigation and offers recommendations for future works.

II. RELATED WORK

Usability criteria is a basic issue for Web applications because of client desires [9]. Herrera et al. [17] specify that convenience issues will have a negative effect if the points of interest of ease of use criteria are not actualized legitimately. The work by Aziz et al. [18] report the quality aspect using integrated map models that show attractive websites always lead to excellent feedback on user satisfaction. Learnability criteria include client desires such as insignificant activity at each exchange, permitting consistency and self-depiction at each navigational level.

Another examination by Shivade and Sharma [19] proposes the usability analyzer technique. The study reflects that attractive Web applications should be interactive, user friendly, designed consistently with systematic layout and

suitable color. Another work by Conte et al. [20] proposes Web design perspectives-based technique. It concludes that an attractive Web application should consider its information structure besides the way menus and buttons work. It is vital to ensure navigation and user interaction are represented well to reduce users' learning curve and assist them to distinguish, analyze and recover from errors with ease.

In addition, Baharum et al. [21] suggest that it is crucial to ensure the attractiveness in a website as it also involves learnability and acceptance level of users that contributes to the strength of a website. Consistency is really important as it influences a website attractiveness from the aspect of the menus, graphics, layouts, and design that ease user navigation and promotes the feeling of pleasure among the website users [21],[22]. Among the components in UID that should be the focus towards attractiveness include font size, color, graphics, background, animation, and its overall design [21],[23]. Samsuddin et al. [24] highlight the importance of navigational mechanism in UID for Web applications with the aim to improve the learnability factor among users.

Besides, both works by Baharum et al. [21] and He [25] indicate that attractiveness has the potential to increase users' understanding and reduce the learning curve among users mainly Web applications. In the nutshell, attractive websites will inspire users to use concerned website in a longer duration of time, tend to navigate and explore more information [26]. Thus, this paper has the main goal to study existing works with the focus on attractiveness and learnability factors that support operability mainly in Web applications, as there are still limited systematic reviews that investigate these sub-criteria of operability. The systematic review in this paper is an extension of the previous SLR [27] with more thorough discussion on the derived results.

III. REVIEW PROCESS

This section includes the existing studies in the literature on attractiveness and learnability factors in Web applications. This research adopts the SLR method by Kitchenham [28]. The steps taken are indicated in the following sub-sections.

A. Research Question

To identify a research question, some criteria must be taken into consideration that are population, intervention, comparison and outcomes as shown in Table 1.

Table 1
Criteria and Scope of Research Question

Criteria	Scope
Population	Papers that propose the solutions to improve attractiveness and learnability in Web applications
Intervention	Existing works that address issues in attractiveness and learnability
Comparison	Strengths and weaknesses of each proposed work
Outcomes	Issues and the gap in attractiveness and learnability in Web applications, the proposed work to overcome the issues

The detailed research questions for this systematic review are as follows:

RQ1: What are the issues discussed on attractiveness and learnability in Web applications?

RQ2: What are the strengths and weaknesses of the proposed works to overcome attractiveness and learnability issues in Web applications?

RQ3: What are the gaps on attractiveness and learnability criteria in Web applications?

B. Search Process

The main goal of this research is to find existing works on attractiveness and learnability for Web applications and refine the search until getting the relevant information. Several steps have been taken to find information using iterative techniques, from initial step to refine step, and several keywords have been applied as listed in Table 2.

- i. The initial search in online database repository: The tools used include Engineering Village and End Note X7, with keywords as listed in Table 2.
- ii. Refine search in major indexing databases: The main search is based on digital repositories that are listed in Google Scholar, with specific sources including Science Direct, ACM, IEEE, Springer Link and CiteSeerX.
- iii. Record search results.
- iv. Organize and categorize papers according to types of publications: Works were organized based on type, including conferences, journals, book chapters, thesis, technical books, technical magazines, reports, websites and guidelines.

Table 2
Search Keyword Code

Keyword Code	Detail Keywords
K1	Attractiveness and learnability in Web applications
K2	Operability in Web applications
K3	Usability in Web applications
K4	Attractiveness in Web applications
K5	Learnability in Web applications

C. Inclusion and Exclusion Criteria

The papers must be written in English. Papers of other languages are included if translation using Google Translate is successful. The study included papers from the computer science, human computer interaction, and software engineering fields. Based on the search process, the papers were required to include keywords such as usability, operability, learnability, attractiveness, and Web application.

There are also exclusion criteria for this research. Firstly, excluded papers were not written in English or failed to be translated using Google Translate. Papers that did not contain related keywords, even though from a related field, were excluded. Finally, papers were excluded that meet the keywords but were not in any relevant field.

D. Quality Evaluation

In order to validate the quality of selected articles, a few questions have been developed to serve as a guideline to select relevant articles for this research. Table 3 contains a list of the questions used in the quality evaluation phase.

Articles will be included based on an evaluation of the stated categories: (i) discussing attractiveness and learnability factors; (ii) defining the proposed works (technique/ approach/ model/ framework); and/or (iii) discussing gaps and issues. Thus, for articles that partially meet the evaluation process, the search process will be refined to get relevant information on attractiveness and learnability in Web applications; otherwise, the articles will be excluded. Only refereed works or published works from journals and proceedings are considered. Hence, unpublished materials on

websites are excluded. The selected papers on usability and operability are those related to Web applications but not limited to attractiveness and learnability.

Table 3
Research Question Structure

Question	Answer
Do the articles discuss attractiveness and learnability in Web applications?	[Yes/No/Partially]
Do the articles discuss the strengths and weaknesses of existing works to overcome the attractiveness and learnability issues in Web applications?	[Yes/No/Partially]
Do the articles discuss the gaps in existing works?	[Yes/No/Partially]

IV. RESULTS AND DISCUSSION

The SLR result is presented using a table format and graph as suggested by Felizardo et al. [29]. In the initial process, a lot of papers hit the search keywords, but only a small number of articles discuss attractiveness in their research in Web applications. For example, papers on facial attractiveness [30][31][32] are excluded. Figure 1 depicts the search process from initial to refined search, leading to the final 77 articles.

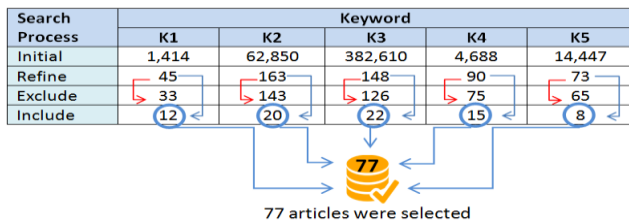


Figure 1: Selection process of articles

Figure 2 depicts that the search on “usability” keyword (K3) is the highest (29%) followed by “operability” (K2), “attractiveness” (K4) and both sub-criteria (K1) while only 10% covers “learnability” (K5). From the search process, the selected articles are summarized based on search keywords and the proposed works as in the Appendix.

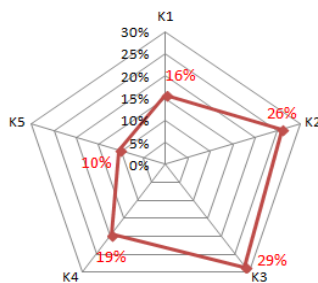


Figure 2: Percentage of articles selected based on keyword codes

Selected articles were analyzed to answer the research questions as mentioned in Table 3. This study only includes the articles meeting “Yes” (both criteria) or “Partially” criteria (either one of the criteria) to answer the research questions.

A. Do the articles discuss attractiveness and learnability in Web applications?

Discussions on both criteria were gathered from 12 selected articles, partial discussions on attractiveness criteria were gathered from 15 articles, and partial discussions on

learnability criteria were gathered from only eight articles as described in the following paragraphs and the findings of the proposed works are summarized in the Appendix.

The work by Ulrich et al. [33] states that modern educational Web applications are normally very attractive for teachers and learners that can be successfully exploited for technology-enhanced learning in a short period. Some works specifically study on websites [18],[34]-[36]. Attractive websites can improve user perception on its functionality, while learnability is when users easily execute their tasks and use certain devices with less time and effort [18]. Besides, website attractiveness promotes user satisfaction, while learnability represents the ease to interact with the system, learning and understanding contents, and reduce retention and time to learn [34]. Attractive websites consider graphical representations such as icons and colors, while learnability represents users' ease of use and learning new features with minimum guidance [35]. The study by Jabat et al. [36] reports that attractive websites are visually pleasant, attract the interest of users to complete given tasks, while learnability is when users can start using the site with minimal guidance, and easy to start. Likewise, attractiveness in Web applications must also consider a sanitization, while learnability process becomes easier and faster when doing evaluation activities on the application [37]. Attractiveness can lead to attractive features to inspire users to present the task correctly and smoothly and learn the applications easily with minimum guidance, effort and time [38]. Another study on an e-Appeal system [12] has attractive criteria with good navigability to ensure users do not become lost and it measures user learning process by the time taken and how easy the system is utilized.

Moreover, a few studies focus on Web applications for e-learning such as Moodle (an online learning delivery system) that is attractive, clear and easy to read with less guidance [39]. According to Hu et al. [40], Web applications are widely applied in e-learnings as they are more convenient and help students to improve their studies. Another study [41] states that e-learning systems must be simple and attractive such as uncluttered, readable, and memorable; users require the minimum effort of actual interaction and make learning more effective, exciting and learning time can be reduced. Besides, attractive icons will increase users' curiosity to learn more about the application, while learnability comes from users' positive emotion on the UID, miniaturized designs to increase their interest and motivation to learn more in a short time [42].

Fifteen articles discuss attractiveness criteria only as described in this paragraph. The first article [11] states that usability criteria include attractiveness when color is balanced and consistent in every page, the page layout is structured. Secondly, the IRON concept (Isolated, Rich, On-demand, and Networked) [43] preserves the attractiveness, dynamic with the latest technology to improve toughness and predictability of Web applications. Another work [44] states that aesthetics, speed, easy navigation, interactivity and offered information can improve tendency and users' knowledge. Criteria such as colors, fonts, pictures, and bulleted versus paragraphs of text will be tested to satisfy of the website usage and deal with users' attraction [45]. Interactive systems include color, symmetry/aesthetic design, structured layout, pleasant design, choice of media, creative and special design, have a positive attitude or orientation [3] and the final design must be in formativeness [46]. Attractive Web applications can be classified into type and material such as images in Flickr and videos in YouTube, while

colorfulness leads to positive navigation [47], while attractive aesthetics and customized information support accessibility and diversity of the information, design and navigation as the website is aesthetically pleasing to the eye [48]. Colors and layout help to visualize and influence usefulness, enjoyment, and ease-of-use of the Web application [49]. Another work [50] studies the increase in users' mood and their overall evaluations of the system, such as the influence of aesthetics, trust and credibility. Loss et al. discuss [51] the need to manage own preferences, such as the public display of feedback and the broad sharing of photographs. Ebner et al. [52] state that page design must be flexible to allow dynamic resizing and fixed-size designs, easy to learn and efficient to handle. Besides, it is vital to consider users' emotions and feelings with basic criteria such as balance, clarity, simplicity and affordance [53]. In a different perspective, performance is an attractive criterion that will improve overall application [54] and will lead users to trust and loyalty [55].

Finally, eight articles discuss learnability factor only. Rafique et al. [13] state that software interaction in certain protocol assists users in effective interaction to begin the learning process, it will be increased to satisfy them, and this leads to better productivity quickly. In addition, minimal action and memory load, less user guidance and consistency in self-descriptiveness in Quality in Use Integrated Measurement (QUIM) [14] is also vital besides the fact that quality in Web applications reduces users' effort in learning the application and the learning time to complete a given task [56]. Collaborative Applications via Data Annotations (ColADA) adopt a minimal set of annotations in language to ease learnability and reduce development time [57], while Action-Based Technique (ABT) guides users on how to use related commands that are relevant to a set of tasks to meet specific goals within a short time through the application [1]. Furthermore, the latest technology such as Web 2.0 contains user interfaces that are easy to use and are predictable [58]. Donyaee et al. [59] concludes that learnability and user performance are different aspects, which need to be evaluated, with the focus to reduce time and cost during testing, while one of the criteria in quality assessment is how the user can learn easily to use Web interface functionalities with minimal guidance and help, in a short time [60].

B. Do the articles discuss the strengths and weaknesses of existing works to overcome the attractiveness and learnability issues in Web applications?

Most works related to attractiveness and learnability mention techniques or approaches to help other researchers to understand their works more clearly and may adopt or adapt their idea to propose the new novel idea. The strengths and weaknesses are summarized in Table 4.

Table 4
Strengths and Weaknesses of Existing Works on Web Applications

Work	Strength	Weakness
Interaction model [7][61]	<ul style="list-style-type: none"> • Easy to manage an application because it binds together related modules called "model" • Use conceptual model, easy to understand 	<ul style="list-style-type: none"> • Users' interests toward something that is not theoretical, and far from the reality • The design of such applications requires more rigorous methods to create the environment

Work	Strength	Weakness
Heuristic Approach [27][62][63]	<ul style="list-style-type: none"> • Can use it together with other usability testing methodologies • Can obtain feedback early in the design process and provide some quick and relatively inexpensive feedback to designers 	<ul style="list-style-type: none"> • It requires knowledge and experience to apply heuristics effectively • Trained usability experts are sometimes hard to find and can be expensive
Framework based [64][65]	<ul style="list-style-type: none"> • Empowers developers to integrate more complex features into their Websites • Quicker development of applications - websites created in a very small window 	<ul style="list-style-type: none"> • Lost Understanding by relying on the features of a framework • Developer tramlines - the developer has to do things the way that framework suggested • Interests toward something that is not theoretical, and far from the reality • The design of such applications requires more rigorous methods to create the environment
User based [66][50]	<ul style="list-style-type: none"> • Users might be given details of true or imaginary stories • Users are a design tool generally used within interaction design to help to give the interaction design team an idea • Use conceptual model, easy to understand 	<ul style="list-style-type: none"> • The design may be based on the needs and goals of the main user only • Other users may not be satisfied with an interaction designed for the main user
Design based [67][68][69][45]	<ul style="list-style-type: none"> • Design can directly provide "users with the specific needs" to ensure that users are happy to complete tasks with the website successfully • Design base is an evaluation iterative design process to improve its usability 	<ul style="list-style-type: none"> • To understand the design, designers use their desire to develop both functional and aesthetic of the UID • The psychological response to architectural design is often described in terms more perceptual than quantifiable
Knowledge based [70][71]	<ul style="list-style-type: none"> • Can access the different levels of information and might also contribute to the enrichment of knowledge • New knowledge can be inferred from the original information provided by the operator 	<ul style="list-style-type: none"> • Knowledge representation approaches are only able to provide the perception or observation • Knowledge gained is explicit as rules are either satisfied or not

The first work is an interaction model studied by Zhang and Dran [7] and Sheng et al. [61] that define an interaction model as information on the relationship between user actions. Secondly, three works by Alistair [26], Bartell [62] and Kurecic [63] have implemented a heuristic approach in the process of gaining knowledge or specific information by intelligent guesswork.

Thirdly, a framework empowers developers to integrate more complex features into their websites [64],[65]. The fourth work involves the user based approach and normally relates to interface design in Web applications that can be rejected or accepted if the designer or developer understands the behavior of the user in the Web application, and improves

the access modes to help them obtain valuable information [66],[50]. The fifth work states that by using a design based approach, developers have the basic guidance in Web application development and users should always be presented with the most relevant information for their goals.

The following works involve design-based approach. A design pattern is an essential step to help developers in Web application development with minimal time and effort. Thus, design pattern can be improved to adapt to the development environment [67]-[69],[45]. Lastly, the approaches mentioned from the results are knowledge based, which always involve users or experts during the development of Web applications, especially in the requirement elicitation phase. Both parties will contribute their ideas, arguments on user preferences and contexts, adjustment of user queries, and finally, experts' advice in making decisions or reengineering the application [70],[71].

With regard to framework that is the focus in this study, Zaitun and Ramasamy [72] mention that a framework provides a mechanism to guide users using an extensible structure for describing the set of concepts, methods, technologies, and cultural changes necessary. Additionally, Paikens and Arnicans [73] state that a framework is a basic conceptual structure used to solve complex issues, especially in a software context. There is a strong relationship between the type of software platform used such as PHP and .NET and the design of a Web application. Table 5 presents the summary of the limitations of nine existing frameworks for attractiveness and learnability.

Table 5
Limitations of Existing Frameworks for Attractiveness and Learnability in Web applications

Existing framework	Limitation
.NET [74]	<ul style="list-style-type: none"> • Developers need to figure out on their own how to use cryptographic primitives correctly
PHP4DB [65]	<ul style="list-style-type: none"> • Centralization environment • Awareness on the technological whirlwind
Semantic UI [75]	<ul style="list-style-type: none"> • Limits the developer's direct influence on the concrete visualization of his UI • It is difficult to achieve when automatically generating the UI at run-time based on the semantics
FIZ [76]	<ul style="list-style-type: none"> • The application must have compatibility with Java. • FIZ encourages designers to focus on a high-level structure • Task depends on interactors (top-level classes that manage interactions with the browser)
Scaled Agile [77]	<ul style="list-style-type: none"> • Suitable only for iterative and incremental software development • Most frequent SCRUM meetings are daily
XFormsDB [78]	<ul style="list-style-type: none"> • Good XML and SQL database knowledge is needed • Suitable for server-side • Suits well for developing small- and medium-sized Web applications and widgets
OpenACS [79]	<ul style="list-style-type: none"> • Focus on online communities only • Need to install a package and use Tel tool
cakePHP [80]	<ul style="list-style-type: none"> • The documentation for CakePHP needs to be improved • CakePHP is not so easy to learn • One-way routing in CakePHP
PRADO [72]	<ul style="list-style-type: none"> • Must have knowledge of how to configure PRADO properties • The application must have compatibility with PHP

Existing frameworks have limitations that need further improvement. Duong and Rizzo [74] describe that vulnerability is one issue in the .NET framework when using a cryptographic protocol. The applications are even more exposed if they use security features provided by .NET framework, especially form-based authentication. Research by Delía et al. [65] report that development using the PHP4DB framework must in be in a centralization environment to allow PHP4DB to obtain homogeneous interfaces, easing posterior maintenance. Huynh et al. [75] discuss limitations in using a Semantic UI is a developer's direct influence on the concrete visualization of his UID. Ousterhout [76] in the FIZ framework stated that the application must have compatibility with Java with a focus on a high-level structure, and to run tasks depending on interactors. Tomanek et al. [77] scale the agile framework, which suitable for iterative and incremental software development. However, this method requires frequent meetings. The study by Laine et al. [78] reports that developers using the XFormsDB framework in Web application development must have good skills and knowledge in XML and SQL databases.

Hernandez and Grunet [79] highlight that the OpenACS framework is more suitable for online communities. To use the framework, developers need to install a package and use Tel tools. Hustinawati et al. [80] conclude that the cakePHP framework is not easy to learn. The documentation for CakePHP definitely needs some extra work. Zaitun and Ramasamy [72] state that the PRADO framework requires developers to have skills on how to use PRADO because PRADO properties must be configured.

Based on the existing works investigated, there is a possibility to produce a framework which may take into account a combination of approaches. Shi et al. [81] indicate that a combination of techniques or approaches can be used to avoid the subjective one-sidedness of weight, and it will increase the trustworthiness rating of software usage. Thus, bases on the reviewed strengths and weaknesses, researchers and practitioners may explore more possibilities to eliminate the weaknesses in the concerned quality factors.

C. Do the articles discuss the gaps in existing works?

Attractiveness criteria have not yet been fully applied in the Web application development process, especially in Web design. Bernd et al. [3] state that there is an insufficient explanation of theoretical approach for website attractiveness in learnability factor in existing work. Alistair [26] conclude that designers do not have enough guidance for creating attractive user interfaces regarding ease of use and reduce the time taken during the learning process. Besides, cultures must be considered to accommodate the needs of users of diverse backgrounds [82].

Vemulapalli and Shashi [83] highlight that many organizations still lack the awareness about attractive criteria, which can help their users to expedite learning of their Web applications, such as community portals. Aziz et al. [84] state that aesthetic attractiveness is a composite variable that varies in understanding between individuals, including developers, as summarized in the saying "beauty lies in the eye of the beholder". In a nutshell, a number of the selected articles directly mention the gaps in existing works that provide an insight to researchers and practitioners in reducing these gaps.

V. CONCLUSION AND FUTURE WORK

This study has selected 77 articles related to operability, usability, attractiveness and learnability specifically in Web applications using the SLR method. The review includes the results and discussion on the issues, strengths and weaknesses of current works and their gaps in the two sub-criteria of operability that are attractiveness and learnability. The studies on operability and usability, in general, are also considered for a better understanding of the main criteria. In conclusion, the existing works on attractiveness and learnability tend to focus on the users’ point of view about UI and UID. Indeed, UID of a Web application must be attractive to ensure ease of use and user satisfaction; simultaneously it contributes to make the Web application easy to be understood and reduce the time to learn and complete a particular task.

Future work will be to propose a framework that focuses on both attractiveness and learnability from software developers’ point of view. The framework aims to guide developers on how to improve both factors in Web applications during the development phase specifically in the design phase.

APPENDIX

Summary of the Selected Proposed Work

No	Type of Work	Key-word	Finding
1	Effort-Based Usability Model [22]	A, T	user satisfaction and the level of ease for a subject to learn to use the software with mental effort (brain activity and eye tracker) is essentially the amount of brain activity required to complete a task
2	Quality in Use Integrated Map Model (QUIM) [18]	A, T	User satisfaction is when users can minimize their actions, and require less user guidance with a smooth system
3	Usability Evaluation Methods (UEMS) [34]	A, T	Attractive design can support ease of learning and reduce the time taken
4	Website Analysis and Measurement Inventory Method (WAMMI) [35]	A, T	Visually pleasant UI appeals the user’s interest; graphical UI representation
5	Website Analysis and Measurement Inventory Method (WAMMI) [36]	A, T	Achieving a sufficient level of competence, ease of use, in less time or effort by productively using the software
6	“Usability Analyzer Tool” Approach [37]	A, T	User interaction should be user friendly, and easy to memorize and learn
7	Matalab Simulink Software (Fuzzy Logic Toolbox) Model [38]	A, T	Easy to understand and learn, and inspires the user to perform tasks correctly
8	Usability Model [39]	A, T	Interactive design; easy to read and learn; easy to collaborate and minimizes the time taken
9	Software Quality Model [86]	A, T	Navigability consumes limited time in system usability, is easy, and reduces time taken
10	Model-Driven Development (MDD) Approach [87]	A, T	Facilitates the learning process; and is easy to determine the result of action and memorability of the function

No	Type of Work	Key-word	Finding
11	Bayesian Network Model [41]	A, T	Interfaces that offer a relaxed user experience using user-oriented template and common features
12	Web Design Perspectives-based Technique [42]	A, T	User interaction has to be properly represented with consistency and standards; user control and freedom; value reached when the system is easily understood by different users
13	Usability Framework [11]	P	Able to complete all tasks without guidance, and in a short amount of time
14	Quality in Use Integrated Measurement (QUIM) Model [14]	P	Effort necessary; accessibility to operate and control a software product leads to efficiency, satisfied users, and increased trustfulness and usefulness
15	User Inter-action and Content Presentation (UICP) Model [56]	P	User efforts for operations and operation controls are influenced by mobility for interactive tasks while interactive tasks include data input and navigation such as input/form design
16	PHP4DB Framework [65]	P	Application needs to consider relationship with any table of any DB engine
17	Model-Driven Development (MDD) Approach [87]	P	Method used to indicate the relationship between the elements that have been mapped
18	Testing Approach [88]	P	To test operability - a way of assessing whether a component, application, system or service performs as expected
19	“IT-as-a-Service” Model [89]	P	Operability among different components of systems and computing devices
20	Levels of Conceptual Interoperability Model [90]	P	Interrelation between systems - entities become quite easy to define, and require exchange of data, supporting data exchanges between systems
21	Complex Applications Interoperability Language Model (CARL) [91]	P	Consider integration and interoperability among different applications and their enabled cross-communication. Applications need to share a common understanding and common grounds in terms of the input and output data they exchange
22	Performance-based Method [92]	P	Increase reliability and timely function of reading and writing data. Easy to manage the devices on the network
23	Action-Based Technique [1]	P	Usability by tracking users’ actions and providing help accordingly
24	WEB Framework [93]	P	Developers could study the user’s habits quickly and improve the Web application system operability
25	Effort-Based Usability Model [94]	P	Capability of a user to use the software to accomplish a specific goal while assessing operability requires measuring several characteristics such as operational consistency; error correction in use; and operational error recoverability in use
26	“Usability Analyzer Tool” Approach [19]	P	Failure in system operability may contribute to software failure

No	Type of Work	Key-word	Finding
27	Model-Driven Development (MDD) Approach [95]	P	Operability related to user performance, and to the attributes of a Web application that facilitate user control and operation
28	Bayesian Network Model [96]	P	Operability criteria in system refers to how these technologies interact with the end user's system and contributes in a way that seeks to help the end-user by simplifying his actions
29	Web Design Perspectives-based Technique [20]	P	Operability is an example for qualitative analysis, and is a sub criteria in ISO 9126
30	Web application testing Approach [97]	P	Tester can discover the operations (operability) that have same environment precondition (EPRE) and environment post condition (EPOST)
31	Data Model [98]	P	A series of events that represent interactions between users and systems; useful framework to promote inter-operability between the many various sources of social media data, both static and streaming
32	Lexicon Model [99]	P	Initial steps are made to design frameworks enabling inter-lexica access, search, integration and operability
33	Service (SaaS) business Model [100]	U	Many researchers and designers have developed usability guidelines but applications that have low usability are easily left for others
34	HHS, JISC and ISO DIS 9241-151 guidelines [23]	U	Usability guidelines could assist the relevant users and stakeholders, quality of existing web design and usability guidelines tends to be uneven
35	informatics-based Heuristic Evaluation Approach [101]	U	Usability problems in a UID by having a small set of evaluators examine the interface and judge its compliance with recognized usability principles (the "heuristics")
36	Usability Evaluation Methods [95]	U	The need for usability evaluation methods specifically crafted for the Web, and technologies such as Web artefacts with different methods addressed
37	Remote evaluation based Approach [102]	U	In usability evaluation, automatic tools can provide various types of support in order to facilitate this activity, and to identify possible usability problems, because usability analysis is not easy to interpret.
38	Quality Model [56]	U	The differences in the form factors and input capabilities strongly influence the usability of an application. Usability and functionality are important, and are currently a major threat for the success of mobile Web applications
39	Architecture Patterns [17]	U	Usability is frequently analyzed without looking at its implications for architecture and architectural patterns, a direct influence on usability

No	Type of Work	Key-word	Finding
40	Usability Patterns [103]	U	Usability is a critical success factor for successful Web applications (Simple, Intrinsic, and Circumstantial); and usability patterns describe solutions that improve usability attributes
41	Usability Method [104]	U	Lack of formal domain expertise can be a significant hurdle for carrying out effective usability evaluations, and understanding how domain complexity affects usability practice is more important
42	UCD (User Centered Design) Method [105]	U	Accomplished presentations in order to satisfy the user's requirements (learnability, user friendliness, well integration of functions, and ease of navigation, simplicity and consistency of the design) and there are relations between the usability and the aesthetics
43	User-centered Method [106]	U	Usability focuses on user experience, covers UI, the content or the information, and functionalities that the application could perform
44	User-centered Method [107]	U	Usability functionality has a major impact on web application design, and it should be addressed during the early development phases
45	Usability Evaluation Methods (UEM) [108]	U	Usability problems may occur from poor design decisions or internal procedure problems, which are always based on user experience, while the product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context
46	Milano-Lugano Evaluation Method (MiLE) [109]	U	Not just a resource with a nice "look and feel"; focuses on communicates contents, and structures the interaction in such a way that facilitates the learning experience, knowledge and practices would enhance the adoption of usability techniques
47	Browser logs and Task Models [110]	U	Evaluators to identify usability problems and possible improvements in the interface design; usability evaluation in which users and evaluators are separated in time and/or space
48	User-centered design Method [111]	U	Quality in development process that focuses on making the interface easier to use; the ease of use of a site relies heavily on user trust. Poor usability contributes to loss of site credibility, which plays a role in its success or failure
49	Cross-sectional Method [112]	U	Iteratively designing and reviewing interfaces with customers who focus more on 'first-time' experiences with products that may arise within the first hour or two, which trends the results more towards 'discoverability' or 'learnability' problems
50	Agile Method [15]	U	Usability and satisfaction have a relation; correlation is proficiency and usability

No	Type of Work	Key-word	Finding
51	Online Approach [10]	U	Providing accessible feedback, unique and clear hyperlink text, properly structured layout, logical grouping of questions, clearly identified data format and required form fields, and conducting regular accessibility evaluations
52	Design Approach [113]	U	To be easy to learn, efficient to use, easy to remember, should not allow users to make errors and satisfactory to use. Designed to be intuitive, interactive and self-explanatory
53	User Centered Approach [16]	U	Usability goals are the backbone of web application design and implementation; it is related to human-computer-interaction and interfaces. The purpose of aesthetics of the design is to assure ease of use and navigability
54	Web-based GIS Method (Geographic information systems) [114]	U	Usability evaluation should have become a part of a software development life cycle, since it can increase software quality. Software usability is an ability of a system to fulfil all explicit (expressed) requirements and implicit user needs in a given context of use.
55	Usability Framework [11]	A	Page layout is structured and symmetrical; background color/image is eye-catching; and media (photos, videos, and audio) is well used
56	Usability Assessment Method [84]	A	Navigability of a website, so user is not lost when navigating around it
57	Conceptual Framework [44]	A	Aesthetics, speed, easy navigation, interactivity and offered information could contribute to the attractiveness. Information should influence the application tendency and the website's attractiveness
58	Pre/post-test Experimental Design [45]	A	Attractive aesthetics such as colors, fonts, pictures, and bulleted versus paragraphs of text lead to satisfaction with website users
59	Conceptualization Model [3]	A	Attractiveness of a digital system should affect individual perceptions, attitudes and behavior such as social interaction
60	Classification and Regression Models [47]	A	Shared annotated material (images in Flickr, videos on YouTube, bookmarks in del.icio.us, etc.) and granularity of the image, or colorfulness, emphasize artistic aspects and colors, positive statements
61	Recruitment Model [48]	A	Web application must be informative, well-designed, easy to navigate, diverse, speedy to access, aesthetic and contain customized information
62	Technology Acceptance Model Framework [49]	A	Website is aesthetically pleasing to the eye, and leads to influence usefulness, enjoyment, and ease-of-use, which can help user "intrinsically enjoyable experience"
63	two path-models [50]	A	Visual aesthetics of an interface significantly influences users' perceived ease of use of the entire system

No	Type of Work	Key-word	Finding
64	Social Networking Sites Model [51]	A	Self-presentation and impression management while the public may display feedback, different images and attributes are desirable
65	User Experience Framework [52]	A	UI is suited to the work context of the user, and whether it is easy to learn and efficient to handle; pages must always be designed to allow dynamic resizing, fixed-size designs, and use a simple, mainly text-based interface with few small images
66	User eXperience (UX) Approach [115]	A	Help users to easily understand how to accomplish the associated tasks; user is considered on emotions and feelings by using a basic design criteria of balance, clarity, simplicity and affordance
67	Provision Technique [54]	A	Dynamically provision resources to balance the request load on performance, which can improve the overall application workload
68	Conceptualization website design Model [116]	A	Use of color, symmetry/aesthetic design, structured layout, pleasant design, choice of media, creative design, and use of special design
69	Technology Acceptance Model [55]	A	Usefulness of website content, the layout of must be appeal to users, contributes to trust in the company and users' behavioral intentions regarding the company, affective and more intuitive reaction
70	"Think-Aloud Protocol" Technique [13]	T	How easy and quickly it is for users to accomplish basic tasks the first time; new users can begin effective interaction and adequate productivity during the learning phase; this will enhance their satisfaction
71	Quality in Use Integrated Measurement (QUIM) Model [14]	T	Minimal action, minimal memory load, less user guidance and consistency in self-descriptiveness
72	Quality Model [56]	T	User's effort for learning the application in a short time
73	Usability In Software Quality Models [84]	T	Learnability evaluated based on the functionality and task performance easiness as well as on the time it takes for the user to learn
74	Web 2.0 Models [58]	T	Ability to quickly figure out how to use a web site is a critical success factor in user acceptance, UI should be easy to use and predictable
75	Quality assessment models [601]	T	How easily the user can learn to use Web interface functionalities
76	Action-Based Help Technique [1]	T	Ease of which users are able to understand the contents and functions that are available through the application, "allowing users to reach a reasonable level of usage proficiency within a short time"
77	Quality Model [13]	T	How easy it is for users to accomplish basic tasks the first time they encounter the software application and provide satisfaction to new users

Search Keyword: A - Attractiveness; T - Learnability; U- Usability; P – Operability

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