

A Systematic Literature Review on User Interface Design for Web Applications

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Abstract—Proper user interface design is vital for both users and software engineers toward satisfaction in developing usable Web applications. Software engineers may ask users randomly, but it may lead to rework if users are not satisfied with the design of the interface once it is in the implementation stage. Thus, a more structured way to support the process of user interface design will be useful to avoid changes at a later stage. This paper adopted a systematic literature review method to gather all related works that highlight the issues and the proposed works in user interface design for Web applications. Based on the results, we can deduce the gaps from the existing works that motivate the future work in user interface design.

Index Terms— Systematic Literature Review; User Interface Design; Web Applications.

I. INTRODUCTION

User interface design (UID) involves interaction from users with any devices such as mouse and keyboard. It is the foremost and replaceable components of any software [1]. The aim is to produce the interface that is easy to use and easy to understand, which also meet the desires of the future users and provision users in the chores they wish to undertake [2]. UID for Web applications involve users who use the Web to complete required tasks on the Website. Web applications offer the simple interface for accessing Web facilities over the Internet [3].

UID specifies what users need in term of look and feel of a software system and what software engineers understand based on user requirements. However, sometimes software engineers develop user interfaces with little or few supports or guidance from professional user interface designers [4]. Besides, UID is an overwhelming process basic to the achievement of a software system such that planning interactive system, which is attractive, accessible, and easy to use is a challenging task [5]. Occasionally, software engineers do not have enough time to study the UID that also leads to the misunderstanding of what users want. For example, Nasir et al. [6] state that MyEG as one of the G2C Web portal has been overwhelmed with UID problem that leads to complications in using the Web portal and causes the negative perceptions on MyEG UID.

UID is the design of interfaces that users can see from any devices such as computers and tablets. Galitz [7] defines UID as “a subset of the field of study called human-computer-interaction (HCI)”. UID acts as an intermediary for the user to interact with the system, and it only focuses on interfaces. Thus, UID needs to be understandable and easy to use by people. Good UID will make a mix of well-design input and output mechanisms that free from doubts and meet the user’s

needs, capabilities and conditions in the best way possible [7].

This paper adopts systematic literature review (SLR) to study the issues and the solutions related to the UID in Web applications. The main goal of this paper is to gather more information that is related to the UID for Web applications. The following Section II and Section III elaborate on the related work and the review process respectively. Section IV reports the result and discussion. Finally, Section V concludes the study and states its future work.

II. RELATED WORKS

UID should be useful to users. This requires an application that does not just focus on the important parts of users’ tasks; it should likewise allow users to interact with the application in ways that are instinctive and normal. Hence, the UID should be simpler yet easy to understand by the users. Friendlier software with constrained abilities is seen to be more usable as the user interface greatly affects the quality of the software product [8].

Furthermore, Web application is a common application to people nowadays. Ginige and Murugesan [9] describe that Web-based applications can be categorized into seven classes as shown in Table 1 in spite of the fact that a given application may belong to more than one class. The UID is important to make a Web application understandable and easy to use regardless of categories.

Table 1
Category of Web Applications [9]

Category	Examples
Informational	Online newspapers, product catalogs, newsletter, service manuals, online classified, online electronic books
Interactive (User-provided information or customized access)	Registration forms, customized information presentation, online games
Transactional	Electronic shopping, ordering goods and services, online banking
Workflow	Online planning and scheduling systems, inventory management, status monitoring
Collaborative work environment	Distributed authoring systems, collaborative design tools
Online communities, marketplaces	Chat groups, recommender system that recommends products or services, online marketplaces, online auctions
Web portals	Electronic shopping malls, online intermediaries

There are more and more applications nowadays are being relocated into Web applications. Thus, the design of the Web application interface should focus on its functionality to offer the simple, intuitive and responsive user interfaces that give the user a chance to complete things with less exertion and

time. For example, the work by Zhu et al. [10] portray the elements of a Web application and the UID that develops a particular element by depicting the presentation of input and output parts of the user interface. In addition, Islam and Bouwman [11] state that interface sign is the important elements of Web user interfaces such as navigational links, small images, thumbnails, short text, and button.

Some studies explain on behavior change and persuasive factors in HCI related to UID. Most of the works follow the Fogg Behavior Model (FBM) to examine the behavior change and its persuasive factors [12]. FBM is used to define and identify three influences which are motivation, ability, and triggers that control whether a behavior is performed. Thus, the FBM provides the guidance to designers and researchers on how to systematically think about the unexpressed behavior change such as in the existing works [13-15] that adopt FBM. However, such studies are not considered in this SLR as they are more towards HCI issue related to user experience or UX rather than UID.

There are limited existing works that use the SLR as their method to review UID issues systematically with different focuses. For instance, the work by Ngadiman et al. [16] discuss the attractiveness and learnability factors in Web applications. The SLR focuses on the issues, proposed work, and strengths and weaknesses of the related work that are limited to the attractiveness and learnability factors in UID. Besides, Islam [17] also uses the SLR as the method to identify the strengths, gaps, and challenges of the related work for the semiotics perception in user interfaces. Moreover, an SLR has also been used to a physical exploration of some related works to identify the criteria and gaps of usability and security in UID respectively [18]. Thus, the SLR in this paper aims to gather information about existing works in the UID for Web applications and specifically in the elicitation process of UID.

III. REVIEW PROCESS

The review adopts SLR method that includes the process of identifying, accessing and interpreting all accessible exploration important to a specific examination inquiry, or point zone, or phenomenon of interest [19]. Steps to be taken are indicated in the following sub-sections.

A. Research Question

The systematic literature review is conducted based on the research question constructed. This research applies two research questions that are:

RQ1: What are the issues associated with UID?

RQ2: What are the current solutions in UID?

The research questions include some criteria to be considered that are population, intervention, and outcomes as shown in Table 2.

B. Search Process

The main goal of this research is to find the existing works on the UID for Web applications. This research initiated the searching process by conducting a preliminary search to find the keywords of relevant terms using various combinations from research questions as stated in Table 3.

The data for this research are from four electronic database resources that are IEEE Xplore, ACM Digital Library, Google Scholar, and Science Direct. The title, abstract and index were used to identify whether the articles, conference

proceedings, book chapters and published journal papers could be used to conduct the research.

Table 2
Research Question Structure

Criteria	Scope
Population	Papers that propose solutions (example: techniques/approach/model) associated with UID
Intervention	Existing works that discuss the issues regarding UID
Outcomes	Issues in UID for Web applications, the proposed works to overcome the issues

Table 3
Search Keywords Code

Keyword Code	Detail Keywords
C1	Issues in UID
C2	Problems faced in UID
C3	Elicitation of UID
C4	Solutions of UID elicitation
C5	Issues in UID for Web applications
C6	Tools related to elicitation of UID

C. Inclusion and Exclusion Criteria

To conduct a systematic literature review, papers have been sorted based on the sources, including journals, conferences or proceedings, thesis report, technical magazines, books, and web pages. The selected areas of this study are computer science and software engineering. This research selected references based on the inclusion and exclusion criteria as stated in Table 4.

Table 4
Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
All papers are in the English language	Papers are not in the English language
Papers that highlight the studies in UID for Web applications	Papers that do not highlight the studies in UID for Web applications
All papers are in the range of the year 2000-2016	All papers are not in the range of the year of 2000-2016

This study reviewed the papers that focus on proposing the works in UID for Web applications. Besides, this study reviews literature that is in English since the journal and proceedings are mainly written in English. The main exclusion criterion is the papers that do not describe the process of the UID. Additionally, this research excluded the papers that are not written in English. The papers that do not specify UID for Web applications and the papers that are not in the range of the year 2000 until 2016 are also excluded.

D. Quality Evaluation

In order to access the quality of the selected articles, this research constructed a quality checklist. The quality checklist is composed by selecting the quality assessments that fit the research questions of this study. Table 5 describes the quality evaluation for research question structures for the selected paper, and it is applied to ensure the quality of the selected references. This research excludes articles that do not provide a clear focus on UID in Web applications in which the methods are not compatible with the study.

Table 5
Research Question Structure

Item	Answer
Do the articles discuss issues in UID?	Yes/No/Partially
Do the articles discuss current solutions of UID in Web applications?	Yes/No/Partially

IV. RESULTS AND DISCUSSION

The systematic literature review results are based on the major indexing databases that are IEEE Xplore Digital Library, ACM Digital Library, Google Scholar, and Science Direct. Based on the research questions in Table 5, the total number of the studies retrieved that are related to the UID for Web applications is 150. However, only 27 out of 150 were selected that met the selection criteria as defined in the previous section. Figure 1 depicts the search process from the initial until the part of keywords obtained in the specific articles according to the four electronic database resources.

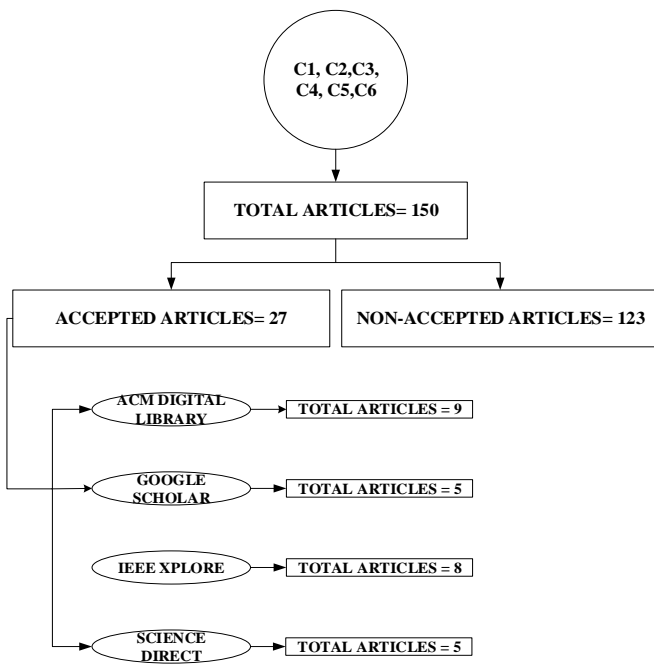


Figure 1: The Selection Process

To clearly show the trend on the UID in Web applications based on the selected articles, Figure 2 illustrates the trends of the related articles from the year 2000 until 2016. From the figure, it shows that in 2010, the highest number of articles related to the UID in Web applications have been published.

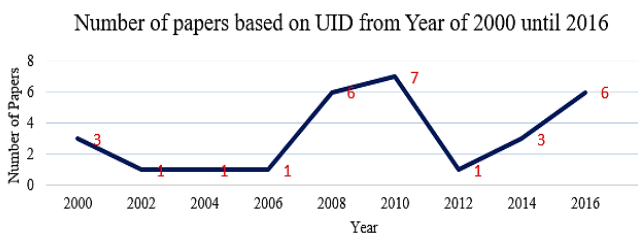


Figure 2: Number of papers in UID within the range of years

Selected articles were used to answer the research questions as elaborated in the following sub-sections.

A. RQ1: Do the articles discuss issues in UID?

Most of the chosen 27 related works only discuss the issues of UID in general. Table 6 summarizes the ten papers that are further selected from the 27 papers as they discuss specifically on the issues in UID.

Table 6
Summary of Issues in UID

Proposed Work	Issues
Adaptive system for automated UID [20]	Design issues include of stylistic preference and adaptable principles of achievement
Used Object-Z with UAN for explanation for design and Object-Z for the specification [21]	An absence of specific techniques for recording and reporting UIDs for the user by implementers and maintainers of a system Creative process are commonly non-linear and iterative which cause the modern user interfaces do not explicitly support the requires investigation, exploration, and the continual evaluation
Develop a set of procedures for UID [22]	The user-centered design method is still underused and hard to understand by software development teams and organizations
Discussed the major obstacles and related myths from both software and usability engineering communities [23]	Different data handling of a particular user of interface design has gotten to be significant problems, especially in data handling framework
Made a model design of the ship navigation information system to illustrate how the data processing of particular user marks the designs to address effect efficiently [24]	Usability becomes more complex in complex computer systems
Proposes an approach in solving user interface usability problems using a mix guidelines and adaptation techniques of UID [25]	UID is still not generally used due to deficiency of tool in helping designers to resolve UID problems
Propose a flexible model to represent UID Patterns and their relationship [26]	User interfaces being complex as systems face the ambiguity that suitable functions are combined but cannot be fully used
Considered a development process while user interface is recognized in product planning phase of user experience [27]	Regularity property for design models and components are severe subjects in software as the conflict may happen between design models that lead to an inappropriate result
Presents a consistency verification method based on proposed rules [28]	Emotions should be concerned because operator's practices are also impacted by the emotions in interface design
Pointing the answers about benefits of ecological interface in improving operator's emotional characteristics and in what way the emotions relate to interface usability features [29]	

Eisenstein and Puerta [20] state that the design issues involve the stylistic preference and the flexible standard of achievement as human designers frequently follow the organization and ignoring any strict rule-based processes. This means that the proposed components make design tasks to be difficult to computerize. Hussey [21] highlights that recording and documenting of UID has a deficiency of accurate methods to be used by implementers and maintainers of the system.

The experimentation, exploration and continual assessment are the creative processes that are commonly non-linear and iterative which the modern user interfaces are inexplicitly supported [22]. The user-centered method is still underused and hard to understand by software development teams and organizations as this technique is developed independently

from software engineering community [23].

Wenting et al. [24] state that with different background of users having a different cognitive processing that affects the way they use the computer may lead the UID to be a significant issue in information processing system. Besides, Obeidat and Salim [25] report that usability complication is unbearable as it affects the software systems negatively. Janeiro et al. [26] add that UID is still not generally used even though it is being a set of proven, well-documented, contextualized approval for solving problems in UID as the designers lack of tools to help them to resolve UID problems. Hirasawa et al. [27] indicate that the UID has become complicated as user interfaces are complex and software systems face the ambiguity when suitable functions are combined but cannot be fully used.

According to Chancheaw and Prompoon [28], the regularity property for design models and components are severe subjects in software as the conflict may happen between design models that lead to an inappropriate result. Lastly, software interfaces are important. Thus, interface design emotions should be concerned as operator's practices are also impacted by the emotions in interface design [29].

B. RQ2: Do the articles discuss current solutions for UID in Web applications?

Limited related works discuss how to overcome the problems related to the UID in a Web application. Most of the articles do not meet the inclusion criteria as stated in Table 4 because most of the related articles are in the year of 2000 below. Table 7 summarizes the four most related papers out of 27 papers that provide the details of current solutions for UID in Web applications specifically in the elicitation process of UID.

Table 7
Summary of Current Solutions in UID for Web Applications

Proposed Solution	Article
Propose a metadata approach for building Web application user interface	[30]
Propose the MashUpEditor based on an intelligent environment for End-User-Development	[31]
Propose the intended model and design expressive Web user interfaces by manipulating Semantic Web and Web 2.0 features	[32]
Propose a Web-based Support Tool for the User Interface Requirement Elicitation (WebSTUIRE)	[33]

Firstly, Saputra et al. [30] state that by using metadata to store the elements of Web application user interfaces, software engineers can manage the elements dynamically without having to go through the codes. This is because the approach uses the UI metadata editor as the tool to manipulate the metadata of user interface that allows people to edit the elements of user interface.

Secondly, the work by Ghiani et al. [31] proposes MashUpEditor that allows end users to create the Web by reusing the existing components without requiring any knowledge of JavaScript. It has an editor to create new mashup widget from existing Web application components using a Web browser. Besides, it also uses an intuitive and familiar copy-paste metaphor to create novel Web applications.

Next, based on Chavarriaga and Macias [32], by combining two presented features that are XML-content using Web 2.0 components different output formats and application architecture using semantic Web facilities, the Web interfaces

are generated automatically through an architecture for building and modeling application.

Lastly, Bojnord et al. [33] propose WebSTUIRE that can assist developers to elicit and analyze user interface requirements by using a combination of both scenario-based and prototyping techniques. This tool also helps developers to communicate with the end user in a Web-based environment. Besides, developers may also gather user interface requirements and improve the systems that are being developed based on the feedback from end-users regarding the user interface.

V. CONCLUSION AND FUTURE WORK

This paper reports the SLR on the selected articles that provide the information regarding UID for Web applications. Hence, issues were described based on the research questions and also include the existing works that propose the solutions to the issues in UID. The discussion in Section IV shows that there are solutions to the UID issues for Web applications that can be further enhanced.

Future work will be to propose a better solution to enhance UID for Web applications. The proposed solution and its tool should guide software engineers in the elicitation of UID that users wish to have in their Web applications to eliminate some issues related to UID and the gap in the current solutions.

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