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UWIS: An assessment methodology for usability of web-based information systems

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ABSTRACT

A methodology for usability assessment and design of web-based information systems (UWIS) is proposed. It combines web-based service quality and usability dimensions of information systems. Checklist items with the highest and the lowest contribution to the usability performance of a web-based information system can be specified by UWIS. A case study by a student information system at Fatih University is carried out to validate the methodology. UWIS reveals a strong relationship between quality and usability which is assumed to exist by many researchers but not experimentally analyzed yet. This study depicts a strong relevance between web-based service quality and usability of web-based information systems. UWIS methodology can be used for designing more usable and higher quality web-based information systems.

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1. Introduction

Recently, the web services provided by web-based information systems (WIS) have gained increasing importance. The users would like to find information in a fast and convenient way. But unfortunately, many of WIS are still too slow to be usable and cannot satisfy many of their customers. Experts from computer science/information science, usability/human–computer interaction, and requirements engineering areas try to solve web-based information system design problems (Yang and Tang, 2003). For measuring their service *quality*, the ServQual model (Parasuraman et al., 1988) and its modification for web-based information systems (Li et al., 2002) are the most widely used approaches. ServQual presents a survey instrument which claims to assess the service quality in any type of service organization (Parasuraman et al., 1988). The service quality is determined as discrepancy between customers' expectations and perceptions for identifying dimensions that represent the evaluative criteria which customers use to assess service quality (Zeithaml et al., 1990). ServQual is used by a wide range of users from academicians and practitioners (Mei et al., 1999). However, ServQual has been also criticized in some studies (e.g., Babakus and Boller, 1992; Buttle, 1996; Carman, 1990; Cronin and Taylor, 1992, 1994; Teas, 1993) because the development of good quality websites requires more sophisticated methods for user-centered design and assessment which is fundamentally achieved by *usability* assessment studies (Frokjaer et al., 2000; Hornbaek, 2006; Li et al., 2002, 2003; Nikov et al., 2003; Sauro and Kindlund, 2005).

Usability stands for "the capability to be used by humans easily and effectively"; "quality in use" (Bevan, 1999); "the effectiveness, efficiency, and satisfaction with which specified users can achieve goals in particular environments" (Hornbaek, 2006); how easy it is to find, understand and use the information displayed on a website (Keevil, 1998); "the ultimate quality factor" for the software architecture (Seffah et al., 2008). Usability refers to 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 (ISO 9241-11). Usability is moving up the list of strategic factors to be dealt with, especially in software development (Juristo et al., 2007). Usability evaluation is one of the major cornerstones of user interface design but it should not be directly perceived as equivalent to human–computer interaction (HCI) (Greenberg and Buxton, 2008) which is definitely a more comprehensive term. There are various usability evaluation methods (UEMs) such as cognitive walkthrough, thinking aloud study, heuristic evaluation, and user testing (Nielsen, 1994; Hertzum and Jacobsen, 2003; Folmer and Bosch; 2004). For all UEMs a single evaluator is unlikely to detect the majority of the severe usability problems that can be detected collectively by a group of evaluators (Hertzum and Jacobsen, 2003). Having more than one evaluator brings the *evaluator effect* to the scene which should be handled carefully especially in qualitative usability studies. Determining the type of the evaluators is another matter of fact which can be related to the question "Who finds what in usability evaluation?" (Fu et al., 1998). It is observed that HCI professionals mostly reveal skill-based (perceptual and motor difficulties) and rule-based

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(consistency problems) problems whereas the real intended end-users identify knowledge-based (mental models) problems (Fu et al., 1998).

The abovementioned definitions reveal that there is an emerging need of a comprehensive methodology for measuring the usability of web-based information systems by integrating quality and usability measures. In this paper, such a methodology (UWIS) is proposed. It includes both quality and usability dimensions. UWIS methodology is comprised of a checklist based on ServQual enhanced by usability dimensions. It uses structural equation model for usability assessment. The applicability of UWIS is independent from at what phase of the process it should be adopted. Namely, UWIS provides a flexible methodology which can be implemented in any stage of the process (i.e. sketching, design, and prototyping) which in turn ensures *getting the right design* and *getting the design right* (Buxton, 2007). Usability should be better dealt with earlier in the development process in order to define and evaluate its impact on design as soon as possible to avoid design rework (Juristo et al., 2007). Therefore, it would be naïve to express that the earlier in the process UWIS is applied the cheaper the relevant modifications can be made.

2. Description of UWIS methodology

Discussions on how to measure the quality of information systems have gone on for several decades, first in the areas of ergonomics, ease-of-use, human–computer interaction and later in the area of usability. However, recently discussions recur on which measures of usability are suitable and on how to understand the relation between different measures of usability (Hornbaek, 2006).

To increase the meaningfulness and strategic influence of usability data, the entire construct of usability can be presented as a single dependent variable (usability index) without sacrificing precision (Sauro and Kindlund, 2005). The usability index is a measure, expressed as a percentage, of how closely the features of a web site match generally accepted usability guidelines (Keevil, 1998).

It is widely accepted that objective measures of usability assessment depends on efficiency, effectiveness, and satisfaction. The effectiveness is defined as the accuracy and completeness with which users achieve certain goals. It is measured by quality of solution and error rates. Efficiency is the relation (a) between the accuracy and completeness with which users achieve certain goals and (b) the resources expended in achieving them. It can be measured by task completion time and learning time. Satisfaction is the users' comfort and positive attitudes towards the use of the system measured by attitude rating scales (Frokjaer et al., 2000).

The correlations among these usability dimensions depend on a complex way on the application domain, the user's experience, and the context of use. During last three years in CHI proceedings, 11 out of 19 experimental studies involving complex tasks account for only one or two dimensions of usability. When these studies make claims concerning overall usability, they rely on risky assumptions about correlations between usability dimensions. Unless domain specific studies suggest otherwise, effectiveness, efficiency, and satisfaction should be considered as independent dimensions of usability and all should be included in measuring usability (Frokjaer et al., 2000). When researchers or developers use a narrower selection of usability measures for evaluating an information system they either (a) make some implicit or explicit assumptions about relations between usability measures in the specific context or (b) run the risk of ignoring important dimensions of usability (Frokjaer et al., 2000). Most of the current methods to represent system or task usability in a single metric do not include all usability dimensions, namely effectiveness, efficiency and satisfaction.

It is anticipated that usability and quality do affect each other (Bevan, 1995, 1999; Folmer and Bosch, 2004; Seffah et al., 2008). Most of the usability and quality assessment approaches have many overlapping items in their checklists. Therefore, these seemingly separate approaches can be combined and a new modified methodology can be created. This study mainly focuses on the integration of quality and usability approaches of web-based information systems. In the following, UWIS assessment checklist, assessment model and data analysis steps will be described.

2.1. UWIS checklist

In the development process of UWIS checklist, first of all the checklist dimensions should be determined and then for each dimension the corresponding checklist questions should be worded. Since our goal is to combine quality dimensions with usability dimensions, the most appropriate quality and usability assessment approaches for web-based information systems should be selected.

For measuring service *quality* the ServQual approach with 5-point distance semantic scale or 7 point Likert scale is the mainly used tool (Parasuraman et al., 1988). To assess WIS quality, an enhanced version of ServQual namely, the web-based ServQual with six dimensions measured by 28 checklist questions was developed by Li et al. (2002). However, neither of these approaches proposes a quantitative model to assess WIS quality. Based on ServQual, the WebQual approach evaluates the user perceptions of the quality of WIS (Barnes and Vidgen, 2003). It turns qualitative customer assessments into quantitative metrics for supporting management decision making. WebQual significantly tries to include usability dimensions in the assessment process. However, it does not mention the quality and usability dimensions and items in details and the names for the dimensions seem to be confusing. For example, it calls one dimension as *usability* but in fact this dimension is a combination of the several dimensions of other checklist approaches. Similarly, the *service interaction* dimension of WebQual is obviously a mixture of *integration of communication* (from ServQual) and *suitability for individualization* (from ISO 9241-10). Another modified approach based on ServQual is E-S-Qual, which assesses the quality of the websites in terms of *profitability* of the company (Parasuraman et al., 2005). On the other hand, there are several usability questionnaires/checklists (such as Sumi (Kirakowski and Corbett, 1993), Quis (Norman and Shneiderman, 1989), PutQ (Lin et al., 1997), and PSSUQ (Lewis, 2002)) which basically present modified versions of the abovementioned leading studies (or alternatively constitute the roots of them) and improves them in one way or another. However, their fundamental limitations can be listed as follows: (1) They ignore the strong implicit relationship between quality and usability. (2) They do not provide an analytical method and numerical evidence which would rank the emerging usability items in terms of their criticality for further improvement and remedy.

UWIS methodology proposes a broader approach applicable to both non-profit and profit-oriented web-based information systems which can also be applied to other systems. Therefore, in the creation of UWIS checklist the quality assessment approaches ServQual and WebQual, and the usability assessment approaches of Nielsen Usability Heuristics and ISO 9241-11 are selected. In Table 1, these approaches are compared and their overlapping and differentiating items are denoted. These distinctive overlaps can be exemplified by the following two sample questions which in fact assess the same dimension although they are denoted with different names in two approaches:

Is the use of terminology, controls, graphics and menus consistent throughout the system? This question is allocated to consistency and standards dimension of Usability Heuristics (Nielsen, 1994).