Measuring the Usability of Web-Based Services Exemplified by University Student Information System

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For measuring the usability of web-based services a checklist tool is developed. It presents a modification of SERVQUAL model for measuring service quality extended with usability dimensions. By this tool a quantitative usability index is determined. A case study with university student information system including 179 students is carried out. By a structural equation model the weighting coefficients of the usability index are determined. By stepwise regression analysis the checklist dimensions and items with highest and lowest contribution to web-based service usability are determined.

The web-based services gain increasing importance in the last years. For example Google became the main competitor of Microsoft. The development of good quality websites requires sophisticated methods for design and evaluation like (Frokjaer, Hertzum & Hornbaek, 2000), (Hornbaek, 2006), (Li, Tan & Xie, 2002), (Nikov, Vassileva, Anguelova, Tzvetanova, & Stoeva, 2003), (Sauro, & Kindlund, 2005).

For measuring the service quality, the SERVQUAL model (Parasuraman, Zeithmal & Berry, 1988) and its modification for web-based services (Li, Tan & Xie, 2002) are most widely used. These models are not considering usability dimensions. Usability presents “the capability to be used by humans easily and effectively”; “quality in use”; “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).

For overcoming this drawback of SERVQUAL a checklist tool is developed. It presents a modification of SERVQUAL enhanced with usability dimensions. The performance of this tool is investigated by a study with the web-based student information system of Fatih University.

Description of the Checklist Tool for Measuring of Web-Based Service Usability

SERVQUAL (Li, Tan & Xie, 2002) is measuring web-based service quality in the scale [1,5] by 28 checklist questions in 6 dimensions. For extending SERVQUAL to measure the usability of web-based services these 6 dimensions and the usability dimensions according to usability heuristics (Nielsen, 1994) and standard ISO 9241-10 (ISO, 1998) are studied (cf. Table 1). Only “Navigation” and “User control and freedom” in usability heuristics and “Controllability” in ISO 9241–10 are outside of SERVQUAL dimensions (cf. Figure 1).

Figure 1. Comparison of Web-Based Service Quality and Usability

Construction of Checklist

29 questions were selected for the checklist tool of modified SERVQUAL. They include also 3 aggregated questions for measuring effectiveness, efficiency and satisfaction. In this study the effectiveness is measured by the indicator completion percentage of the tasks; the
efficiency by task completion time and the satisfaction by a 5-point semantic distance scale. In this way, objective and subjective parameters are measured.

By pretests with limited number of students using the student information systems of Fatih University some questions were changed and deleted. The final checklist tool is shown on Figure 3.

**Usability Index**

Discussions of how to measure the quality of computer systems have gone on for several decades, first under the heading of ergonomics and ease-of-use, and later under the heading 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, there is a need to represent the entire construct of usability as a single dependent variable (usability index) without sacrificing precision (Sauro, & Kindlund, 2005). The usability index is a measure, expressed as a per cent, of how closely the features of a web site match generally accepted usability guidelines (Keevil, 1998).

It is widely accepted that usability evaluation depends on efficiency, effectiveness, and satisfaction. In (Frokjaer, Hertzum & Hornbaek, 2000), **effectiveness** is defined as the accuracy and completeness with which users achieve certain goals. Indicators of effectiveness include quality of solution and error rates. **Efficiency** is the relation a) between the accuracy and completeness with which users achieve users certain goals and b) the resources expended in achieving them. Indicators of efficiency include task completion time and learning time. **Satisfaction** is the users’ comfort and positive attitudes towards the use of the system. Users’ satisfaction can be measured by attitude rating scales.

The correlations among these usability dimensions depend in a complex way on the application domain, the user’s experience, and the use context. 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 independent dimension of usability and all be included in usability measuring (Frokjaer, Hertzum & Hornbaek, 2000).

The usability index can be determined by the aggregated evaluations of the usability dimensions effectiveness, efficiency and satisfaction (cf. Figure 2):

\[ UI_1 = a_1 \times \text{effectiveness} + a_2 \times \text{efficiency} + a_3 \times \text{satisfaction} \]  

(1)

We propose to calculate the usability index \( UI_2 \) based on the relevant usability checklist items and dimensions as shown on Figure 3.

The structural equation modeling (Arbuckle, 1997) can be applied for determining the weighting coefficients \( a_1, a_2 \) and \( a_3 \). By substituting \( UI_2 = UI_1 \), the usability can be studied by regression analysis.

\[ IU_2 = b_1 Q_1 + b_2 Q_2 + \ldots b_{26} Q_{26} + b_{27} \]  

(3)
Table 1. Clustering Different Checklist Formation Approaches

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<td>Tangibles</td>
<td>Physical constraints</td>
<td>Tangibles</td>
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<tr>
<td>Reliability</td>
<td>Call-back Systems</td>
<td>Flexibility and efficiency</td>
<td>Suitability for the task</td>
<td>Reliability</td>
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<tr>
<td>Responsiveness</td>
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<td>Consistency and standards</td>
<td>Suitability for the task</td>
<td>Responsiveness</td>
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<td>Assurance</td>
<td>Competence</td>
<td>Match between system and real world</td>
<td>Assurance</td>
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<td>Empathy</td>
<td>Empathy</td>
<td>Match between system and real world</td>
<td>Empathy</td>
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<tr>
<td>Quality of information</td>
<td>Quality of Information</td>
<td>Match between system and real world</td>
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<td>Integration of Communication</td>
<td>Web Assistance</td>
<td>Recognition rather than recall</td>
<td>Suitability for learning</td>
<td>Integration of Communication</td>
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<td>Navigation</td>
<td>User control and freedom</td>
<td>Controllability</td>
<td>Controllability &amp; Navigation</td>
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Case study
The checklist tool was experimentally studied by testing and evaluating the web-based student information system of Fatih University.

Data Collection
179 undergraduate students were selected from five different departments: 58% from Management Department, 17% from Department of International Relations, 10% of the students in Department of Public Administration, 9% from Department of Industrial Engineering, and 6% from Economics Department. 40% of the students were male and 60% female. Participant’s English knowledge was good enough to perform the tasks. To make the questions more understandable they were translated also in Turkish.

All tests were carried out in the computer laboratories of Fatih University by allocating one computer to each participant. The number of the people working around and the noise level was nearly the same.

The participants received checklists containing the aim of the survey, how they would proceed and some descriptive questions such as their names, departments, and gender. They were asked to perform three tasks using their personal accounts in Fatih University Student Information System. These tasks were the same for all participants. After the session they were asked to fill out the checklist. Performing the required three tasks and answering the questions of the checklist took 30-45 minutes per student.

Results and Discussion
Most of the current methods to represent system or task usability in a single metric do not include all usability dimensions: effectiveness, efficiency and satisfaction. When researchers or developers use a narrower selection of usability measures for evaluating a 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, Hertzum & Hornbaek, 2000).

By the structural equation model shown on Figure 4 the coefficients $a_1$, $a_2$ and $a_3$ of (1) were determined as follows:

$$\text{UI} = 0.27 \times \text{efficiency} + 0.04 \times \text{effectiveness} + 0.69 \times \text{satisfaction}$$

(2)

Figure 4. Structural equation model

The results of regression analysis confirm the predictive power of regression model ($R^2 = 0.48$). 42% of the variance in usability index is directly explained by the most important checklist items Q4, Q27, Q9, and Q26 (cf. Table 2). In this way these four items explain 90% of the total variance. Their standardized regression coefficients are statistically significant at 0.001 significance levels.

The following checklist items and dimensions have the highest influence on web-based service usability and should be taken into account for designing web-based services:

- Q4: Is the relation between time to perform a task (planning, execution, error correction) and task complexity adequate?
- Q27: Is the screen visible at a range of distances and in various types of lighting?
- Q9: Is the use of terminology, controls, graphics and menus consistent throughout the system?
- Q26: Are function buttons large enough to be usable?

The worst predictor variables in the model are the checklist items Q5, Q20, Q7 and Q13. They almost do not have any influence on web-based service usability. It should be reconsidered their inclusion into checklist tool or they have to be changed:

- Q5: Does the system guide novice users sufficiently?
- Q20: Is it possible to search for information (e.g. phone number) rather than entering the information directly? (Integration of Communication)
- Q7: Does automated or humane e-mails responses or serving pages give users prompt service?
- Q13: Is the tone of messages consistently courteous?

### Conclusions

For measuring the usability of web-based services a checklist tool is developed. It presents a modification of SERVQUAL model for measuring service quality extended with usability dimensions. By this tool a quantitative usability index is determined. A case study with university student information system including 179 students is carried out. By a structural equation model the weighting...
coefficients of the usability index are determined. The results of stepwise regression analysis showed that the most significant checklist item influencing web-based service usability is connected with the relationship between time to perform a task and task complexity. The least important checklist item found was the system guidance of novice users.

Further studies on web-based service usability could include together with subjective data, measured by checklist, also objective data from biophysiological measurements.

References