

Exploring the Usability of Municipal Web Sites: A Comparison Based on Expert Evaluation Results from Four Case Studies

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The usability of public administration web sites is a key quality attribute for the successful implementation of the Information Society. Formative usability evaluation aims at finding and reporting usability problems as early as possible in the development process. The objective of this paper is to present and comparatively analyze the results of an expert usability evaluation of 4 municipality web sites. In order to document usability problems an extended set of heuristics was used that is based on two sources: usability heuristics and ergonomic criteria. The explanatory power of heuristics was supplemented with a set of usability guidelines. The evaluation results revealed that a set of specific tasks with clearly defined goals helps to identify many severe usability problems that occur frequently in the municipality web sites. A typical issue for this category of web sites is the lack of information support for the user.

Keywords: *Formative Usability Evaluation, User Testing, Expert Evaluation, Heuristic Evaluation, Ergonomic Criteria, Usability Problem, Municipal Web Sites*

1 Introduction

The quality of public administration systems is a priority for the successful implementation of the Information Society. In this respect, the accessibility and usability of municipal web sites is a key quality attribute that will make the actual use of public information and services easier for citizens.

At national level usability is still a research topic only in several research projects such as [1], [11], [12]. There is neither a current practice of usability evaluation before the software release nor experienced usability teams.

According to the time it is performed and its objectives, usability evaluation can be formative or summative. Formative usability aims at finding and fixing usability problems early in the development process [22]. This can be carried on by conducting an expert usability evaluation (sometimes termed as usability inspection) and / or by conducting a user testing with a small number of users. In the last case, the evaluation is said to be user-centered, as opposite to an expert-based formative evaluation.

The objective of this paper is to present and comparatively analyze the results of an expert usability evaluation of 4 municipality

web sites. The expert evaluation method is part of an integrated evaluation methodology that was developed during a research project funded from the Sectorial Plan of the Ministry of Communication and Information Society (MCSI). The methodology was experimented in 2009 when some shortcomings and limitations of the usability inspection method were detected.

The main problem was the weak task orientation which resulted in a low reliability and validity of the expert evaluation results. Therefore we conducted another expert evaluation in 2010 based on more specific tasks with clearly defined goals. In order to better understand the specific usability issues we carried on a usability evaluation on four municipality web sites.

The rest of this paper is organized as follows. In the next section we will briefly describe some related work in the area of usability evaluation of e-government web sites as well as current concerns regarding the usability evaluation methods. Then we will present the evaluation objectives, method and procedure. In section 4 and 5 we will present and analyze individually and comparatively the usability evaluation results. The paper ends with conclusion and future work in section 6.

2 Related Work

The ISO/IEC standard 9126:2001 defined usability as the capability of a software system to be understood, learned, used, and liked by the user when used under specified conditions [14].

According to Scriven, usability evaluation could be formative or summative depending on the purpose and the moment when is done [21]. Formative usability evaluation is performed in an iterative development cycle and aims at finding and fixing usability problems as early as possible. The sooner these problems are identified, the less costly is the effort to fix those [22].

Formative evaluation methods are grouped in two broad categories: inspection methods and user testing. Inspection methods are based on testing the user interface by a small number of experts. Usually this is done by evaluating the user interface against a set of broadly accepted principles. As such, the usability problems reported are anticipated problems (not real).

In recent years there is a debate on the reliability and validity of individual usability evaluation methods [6], [10], [15]. While usability inspection methods are faster and cheaper, user testing is more expensive and requires specialized expertise.

A general approach to increase confidence in results is to conduct both heuristic evaluation and user testing then to analyze and compare results. In this case, usability problems that were anticipated by the expert evaluation are validated by the user testing results.

All formative evaluation methods aim at finding and reporting usability problems. A usability problem was defined by Nielsen [18] as any aspect of the user interface which might create difficulties to the user with respect to an important usability indicator (such as: ease to understand, learn, and use, subjective user satisfaction).

Usability problems are ranked for their potential impact into severe, moderate and minor problems. A severe usability problem means that the user is not able to accomplish the task goal or the task ends with a significant loss of data or time. The problem is

moderate if they have an important impact on task execution but the user is able to find a solution. A minor usability problem is irritating the user but it doesn't have an important impact on the user's task.

Heuristic evaluation provides two kinds of measures:

- Quantitative: number of usability problems in each category.
- Qualitative: detailed description of individual usability problems.

Nielsen & Molich [20] proposed 10 heuristics for the evaluation of a user interface: visibility of system status, compatibility with the activity, user freedom and control, consistency, error prevention, recognition instead of recall, flexibility, aesthetics and minimalist design, quality of error messages.

Bastien and Scapin [4] proposed a set ergonomic criteria consisting of 18 elementary criteria grouped into 8 categories (general principles) and serving for both design and evaluation.

A formative evaluation report should be both reliable and useful for designers [10], [15]. Usability problems have to be well classified according to their impact, well explained and documented. An important aspect is the explanatory power of heuristics, principles or guidelines that are used to document the usability problems. In this respect, a wider set of usability prescriptions has an increased explanatory power [19].

Web sites usability is a key concern for the effective use of public administration web sites. Nevertheless, there are relatively few papers in the literature that are targeting the usability of municipal (i.e. local public administration) web sites.

Bertot [5] argued that usability, functionality and accessibility are a useful starting point for effective user-centered e-government services.

Barnes and Vidgen [3] evaluated online taxation systems and found that five factors are important for the user perception: usability, design, information, trust and empathy. In their study, usability was rated 20% based on an A/E score (actual/ expected ratio).

Baker [2] proposed to advance the usability

of e-government through enhanced usability benchmarks while Molina and Toval [17] proposed a more pragmatic user-centered design approach based on integrating usability requirements that can be evaluated at design time.

3 Method and Procedure

3.1 Usability Evaluation Methodology

In the afore mentioned project an integrated methodology for formative usability evaluation has been developed that consists of two main components:

- A usability inspection method that includes a structured set of usability heuristics.
- A user testing method that is using the think aloud protocol to register the user behavior.

This methodology benefits from the complementarities of the two methods and makes it possible to assess the effectiveness and efficiency of the usability inspection method.

The methodology was experimented in 2009 when heuristic evaluation was carried on for two municipality web sites.

The heuristic evaluations were performed by teams of 3-4 evaluators testing the user interface with some general tasks. Two reliability indicators were calculated: average detection rate and average agreement between any two evaluators [8].

Then a user testing was carried on for one of the two web sites. Three indicators of effectiveness of the heuristic evaluation method were calculated: validity, thoroughness and general efficiency [7].

The analysis of results revealed several weaknesses of the heuristic evaluation method as regarding the reliability and validity [12].

3.2 Usability Heuristics Set

In our methodology we are using an extended set of 24 heuristics which are grouped into six ergonomic criteria:

- User guidance
- Work load
- Adaptability and control.
- Error management

- Consistency and standards
- Compatibility

The set is presented in Table 1 and has been created by integrating the ergonomic criteria proposed by Bastien and Scapin [4] with the ten heuristics proposed by Nielsen and Molich [19].

Table 1. The set of usability heuristics

| | |
|---------------------------|-------------------------------------|
| User guidance | |
| 1 | Visibility of system status |
| 2 | Prompting |
| 3 | Immediate feedback |
| 4 | Grouping / distinction by format |
| 5 | Grouping / distinction by location |
| 6 | Legibility |
| Work load | |
| 7 | Concision |
| 8 | Recognition instead of recall |
| 9 | Minimal actions |
| 10 | Information density |
| Adaptability and control | |
| 11 | Flexibility and efficiency of use |
| 12 | Experience of the user |
| 13 | Explicit user actions |
| 14 | User control |
| Error management | |
| 15 | Error prevention |
| 16 | Quality of error messages |
| 17 | Error correction |
| Consistency and standards | |
| 18 | Consistency |
| 19 | Compliance with standards and rules |
| 20 | Significance of codes |
| Compatibility | |
| 21 | Compatibility with the user |
| 22 | Task compatibility |
| 23 | Help and documentation |
| 24 | Esthetic design |

Since both original sources have been validated in several studies we considered that they are useful both as coverage and explanatory power.

3.3 Tasks and Procedure

In order to increase the reliability and validity of the usability inspection method we performed an expert evaluation in 2010 for other four municipal web sites based on three clearly defined tasks:

- T1: to know where and how register for audience.
- T2: to identify and download the forms

needed to get a birth certificate for a child and benefit from the state allowance and also where to send the application.

- T3: to find the date of the next Local Council meeting and the contact person for getting informed on the agenda and also to find and read the minute of the last meeting held in 2009.

This approach is both efficient and reliable. On the one hand, it is not possible to evaluate the usability of all web pages of a complex web site. It is more pragmatic to concentrate on a set of key tasks performed by the user. On the other hand, a task-based expert evaluation helps to better estimate the severity of usability problems.

We used the heuristics and a set of usability guidelines mainly to document, analyze, and report the usability problems. In this respect, the method differs from a typical heuristic evaluation where heuristics are mainly used to identify usability problems.

The evaluation was carried on in March 2010 by a team of 4 evaluators. The four web sites belong to city halls of 4 important towns in Romania.

The lists of individual usability problems identified by each evaluator were consolidated for each task based on the "similar changes" criterion [8]. During consolidation phase, duplicates were removed and an agreement on severity was reached.

The result of the consolidation phase is a list of unique usability problems based on which following aspects were analyzed:

- Major usability problems: cause and suggestions to fix them.
- The nature of usability problems as regarding the ergonomic criterion / guideline not respected.
- Indicators of reliability: individual and average detection rate, average agreement between any two evaluators.

The reliability was estimated based on the average detection rate and average agreement between any two evaluators [7].

4 Usability Evaluation Results

4.1 Case Study 1

The number of individual usability problems

detected by the four evaluators varied from 5 problems (from which 3 major problems) to 12 (2 major problems). On each task, the results of individual evaluation are as follows: T1: 3 problems (2 major), T2: 8 problems (2 major) and T3: 6 problems (3 major).

After the collaborative consolidation (removal of duplicates, discarding of false usability problems and agreement on severity) a list of 15 unique problems resulted, as shown in Table 2. Most problems are related to the second and third task.

Table 2. List of unique usability problems

| Tasks | Total | Major | Moderate | Minor |
|-------|-------|-------|----------|-------|
| T1 | 3 | 0 | 1 | 2 |
| T2 | 6 | 1 | 3 | 2 |
| T3 | 6 | 2 | 0 | 4 |
| Total | 15 | 3 | 4 | 8 |

The three major usability problems are related to:

- There is no link to the institution who receives the application for the state allowance.
- It was not possible to find out the date of the next Local Council meeting.
- There is no contact information for the Local Council chair.

Table 3 illustrates the usability problems according to the heuristic that was not respected.

Most usability problems are related to three heuristics: visibility of system status, minimal actions and task compatibility. However, the major usability problems are related to the last two heuristics in the table.

Table 3. Usability problems by heuristic

| Heuristics | Total | Major |
|------------------------------------|-------|-------|
| Visibility of system status | 4 | |
| Grouping / distinction by location | 1 | |
| Minimal actions | 5 | |
| Task compatibility | 3 | 2 |
| Help and documentation | 2 | 1 |
| Total | 15 | 3 |

The individual detection rate varied between 13.33% and 80% with a mean of 45%. The average agreement between any two evaluators was 24.14%.

4.2 Case Study 2

The lists of individual usability problems produced by the four evaluators varied from 3 problems (2 major) to 11 problems (7 major). On each task, the results of individual evaluation are as follows: T1: 4 problems (1 major), T2: 17 problems (11 major) and T3: 12 problems (3 major).

After the collaborative consolidation a list of 15 unique problems resulted, as shown in Table 4.

Table 4. Consolidated list of usability problems

| Tasks | Total | Major | Moderate | Minor |
|-------|-------|-------|----------|-------|
| T1 | - | - | - | - |
| T2 | 8 | 1 | 4 | 3 |
| T3 | 7 | 3 | 2 | 2 |
| Total | 15 | 4 | 6 | 5 |

The four major usability problems are related to the following issues:

- No link to the institution who receives the application for the state allowance.
- Not possible to find out the date of the next Local Council meeting.
- Not possible to read the minute of the last meeting in 2009.
- No contact information for the Local Council chair.

Table 5 illustrates the usability problems according to the heuristic that was not respected.

Most of unique usability problems (86.67%) are due to three heuristics: minimal actions (40%), task compatibility (26.67%), help and documentation (20%).

All major problems are due to the last two heuristics.

Table 5. Usability problems by heuristic

| Heuristics | Total | Major |
|-----------------------------|-------|-------|
| Visibility of system status | 1 | |
| Minimal actions | 6 | |
| Explicit user actions | 1 | |
| Task compatibility | 4 | 2 |
| Help and documentation | 3 | 2 |
| Total | 15 | 4 |

The individual detection rate varied between 13.33% and 66.67% with a mean of 37.50%. The average any-two-agreement between

evaluators was 19.57%.

4.3 Case Study 3

The lists of individual usability problems produced by the four evaluators varied from 4 problems (3 major) to 13 problems (3 major). On each task, the results of individual evaluation are as follows: T1: 10 problems (5 major), T2: 15 problems (6 major) and T3: 11 problems (3 major).

After the collaborative consolidation a list of 15 unique problems resulted, as shown in Table 6.

Table 6. List of consolidated usability problems

| Tasks | Total | Major | Moderate | Minor |
|-------|-------|-------|----------|-------|
| T1 | 3 | | 1 | 2 |
| T2 | 7 | | 2 | 5 |
| T3 | 5 | 2 | 1 | 2 |
| Total | 15 | 2 | 4 | 9 |

The two major usability problems are related to the following aspects:

- Not possible to find out the agenda of the next Local Council meeting.
- No contact information for the Local Council chair.

Table 7 illustrates the usability problems according to the heuristic that was not respected.

Table 7. Usability problems per heuristic

| Heuristics | Total | Major |
|-----------------------------|-------|-------|
| Visibility of system status | 2 | |
| Minimal actions | 6 | |
| Explicit user actions | 1 | |
| Information density | 1 | |
| Significance of codes | 1 | |
| Task compatibility | 3 | 1 |
| Help and documentation | 1 | 1 |
| Total | 15 | 2 |

Most usability problems are due to three heuristics: visibility of system status, task compatibility and help / documentation.

Most of the unique usability problems (40%) are due to the following heuristics: minimal actions (40%), visibility of system status (13.33%), and task compatibility (20%). Major problems are due to two heuristics: task compatibility and help / documentation.

The individual detection rate varied between

13.33% and 73.33% with a mean of 45%. The average agreement between any two evaluators was 28.86%.

4.3 Case Study 4

The lists of individual usability problems produced by the four evaluators varied from 3 problems (1 major) to 12 problems (0 major). On each task, the results of individual evaluation are as follows: T1: 11 problems (0 major), T2: 12 problems (3 major) and T3: 13 problems (3 major).

After the collaborative consolidation (removal of duplicates, discarding of false usability problems and agreement on severity) a list of 13 unique problems resulted, as shown in Table 8.

Table 8. Consolidated list of usability problems

| Tasks | Total | Major | Moderate | Minor |
|-------|-------|-------|----------|-------|
| T1 | 4 | | 2 | 2 |
| T2 | 5 | | 3 | 2 |
| T3 | 4 | 1 | 1 | 2 |
| Total | 13 | 1 | 6 | 6 |

The major usability problem is related to the lack of contact information for the Local Council chair.

Table 9 illustrates the usability problems according to the heuristic that was not respected.

Table 9. Usability problems per heuristic

| Heuristics | Total | Major |
|-----------------------------|-------|-------|
| Visibility of system status | 1 | |
| Immediate feedback | 1 | |
| Legibility | 1 | |
| Concision | 1 | |
| Minimal actions | 6 | |
| Explicit user actions | 1 | |
| Help and documentation | 2 | 1 |
| Total | 13 | 1 |

Most usability problems are due to two heuristics: minimal actions and help / documentation. 6 unique usability problems (40%) are due to the heuristic "minimal actions".

The individual detection rate varied between 6.67% and 66.67% with a mean of 36.67%. The average any-two-agreement between evaluators was 27.02%.

5 Comparative Analysis of Results

5.1 Specific Usability Problems

The comparative analysis of case studies enables to infer some conclusion on the web sites usability, specific usability problems and reliability of the expert evaluation method.

The situation of usability problems and severity for each task is presented in Table 10.

Table 10. Usability problems by task

| Task | Total | Major | Moderate | Minor |
|-------|-------|-------|----------|-------|
| T1 | 10 | 0 | 4 | 6 |
| T2 | 26 | 2 | 12 | 12 |
| T3 | 22 | 8 | 4 | 10 |
| Total | 58 | 10 | 20 | 28 |

Most usability problems were anticipated for tasks T2 and T3. Most major problems were identified for task T3. There is one web site with no usability problem for task T1.

On total, 10 major usability problems were detected that are related to:

- No link to the institution who receives the application for the state allowance.
- Not possible to find out the date and / or agenda of the next Local Council meeting.
- Not possible to read the minute of the last meeting in 2009.
- No contact information for the Local Council chair.

These usability problems are specific to municipality web sites and are due to the lack of information that leads to the impossibility to accomplish the task goal. Firstly, few web sites are providing guidance as regarding the administrative procedures, documents and application forms. Secondly, the information is not well organized in that information regarding the same goal is wide spread along the web site. Thirdly, the contact information is rarely complete and updated.

5.2 Usability Problems by Heuristics

A synthesis of how usability problems relate to heuristics is presented in Table 11. Most usability problems are related to the "minimal actions" heuristic (39.67%). 6 out of 23 usability problems are moderate and 17 mi-

nor.

This heuristic corresponds to the general ergonomic criteria “work load” and the usability problems are related to the difficulties to navigate on the web site in order to get the information of interest. In this respect, there are two usability guidelines frequently ignored by the developers: provide content for long pages and provide facilities to find the information on in the web site.

Table 11. Usability problems by heuristics

| Heuristics | Total | Major |
|------------------------------------|-------|-------|
| Visibility of system status | 8 | 0 |
| Immediate feedback | 1 | 0 |
| Grouping / distinction by location | 1 | |
| Legibility | 1 | |
| Concision | 1 | |
| Minimal actions | 23 | 0 |
| Information density | 1 | 0 |
| Explicit user actions | 3 | 0 |
| Significance of codes | 1 | |
| Task compatibility | 10 | 6 |
| Help and documentation | 8 | 4 |
| Total | 58 | 10 |

Second category of usability problems is related to task compatibility (17.24%). An important number of usability problems (16 out of 58) are related to other two heuristics: visibility of system status and help documentation.

The 24 usability heuristics are grouped onto 6 general criteria. In Table 12 a synthesis of usability problems by ergonomic criteria is presented.

Most usability problems are due to work load (43.1%), compatibility (31.03%), and user guidance (18.97%). All major problems are related to compatibility which suggests that the web sites are not designed in a user-centered approach.

Table 12. Usability problems by ergonomic

| General ergonomic criteria | Total | Major |
|----------------------------|-------|-------|
| User guidance | 11 | |
| Work load | 25 | |
| Adaptability and control | 3 | |
| Consistency and standards | 1 | |
| Compatibility | 18 | 10 |
| Total | 58 | 10 |

Since we have only tested 3 tasks for each web site it is likely that the number of usability problems is higher and most major usability problems are related to the public services that are available. It seems that the two compatibility heuristics (task compatibility and help / documentation) have to be detailed by a set of specific usability guidelines.

5.3 Reliability of Evaluation Results

As regarding the reliability of results, the detection rate is easy to compute but it suffers from the fact that the minimum depends on the number of evaluators (i.e. 25% for 4 evaluators) [7]. In this respect, an individual detection rate should be interpreted in the interval from the minimum to 100%.

In the previous study [13] the average detection rate varied between 31.58% and 39.25%. In this study, it varied between 36.67% and 45%. Overall, the average detection rate is low since two of the evaluators have little experience in usability evaluation. In this respect, the increased detection rate in the second study is explained by the gain in experience during the project.

According to Hertzum and Jacobsen [8] a better reliability indicator is the average agreement between any two evaluators.

In the previous case study the average any-two-agreement varied between 2.08% and 10.66%. In this study it varied between 19.57% and 28.86%. The high level, as compared with data from literature, is explained by the similar expertise of the evaluators.

6. Conclusion and Future Work

This study is a part of the first systematic experimentation of a usability evaluation methodology in Romania. Inherently there are several limitations related to the available resources, the experimental character of evaluation (laboratory), the novelty of the evaluation activity and the evaluation expertise.

Molich et al (2004) demonstrated that usability evaluation results depend on the selected tasks, methodology and evaluators [16]. Their comparative studies (CUE 1 in 1998 and CUE 2 in 2004) revealed important differences between the results obtained by spe-

cialized usability teams at the evaluation of the same commercial web site.

This case study leads to similar conclusion: usability evaluation results depend mainly on testing the user interface with a set of tasks having a clearly defined goal and less on the set of heuristics used. On another hand, a wider set of usability heuristics is increasing the explanatory power and usefulness of the evaluation report.

As regarding expert evaluation, it is recommended to be carried on with a larger team (5 to 10 evaluators) with a different expertise. For municipal web sites it would be useful to include both developers and specialists working in the target public services. However, is recommended to consolidate the usability problems with 1-2 usability experts.

The current situation of web sites usability shows that designers need a collection of well-organized prescriptions organized in a hierarchical structure: ergonomic criteria, heuristics and guidelines.

Apart from typical web usability guidelines (home page design, information architecture, and navigation) specific content guidelines should be also provided in order to support users in their tasks. These guidelines should require a description of administrative procedures to be followed by the users that are requesting a public service.

In the next future we intend to elaborate on a set of specific usability guidelines for municipality web sites and to integrate them in a software tool in order to increase the efficiency of the evaluation process.

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