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using semantic technologies

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Abstract: This document first identifies and analyzes typical problems with the usability of e-government portals. It then describes a general strategy for resolving problems, and gives some examples to illustrate the strategy.

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1 INTRODUCTION

This document lists and describes typical problems with the usability of e-government portals. It includes an analysis of the causes of problems, and describes a general strategy for dealing with usability problems.¹ It also gives some examples to illustrate the strategy.

Problems using a portal are a key topic in FIT, since the goals of FIT can be described as: automatic detection and localization of problems, automatic adaptation to solve some problems, and alerting of the web master to irresolvable problems and opportunities for usability improvements.

2 USABILITY

We start with a definition of usability since the goal is to analyze problems of usability. Usability and related terms are defined by ISO 9241-11 (1998) Guidance on Usability as follows:

Usability is the extent to which a product [a portal] can be used by specified users to achieve specified **goals** with **effectiveness**, **efficiency** and **satisfaction** in a specified context of use.

Effectiveness is the accuracy and completeness with which a user achieves specified goals.

Efficiency is a measure of the resources expended in relation to the accuracy and completeness with which a user achieves goals.

Satisfaction is freedom from discomfort and positive attitudes towards the use of the product.

For the purposes of problem analysis we will mostly ignore the issue of satisfaction, since it is a subjective judgement that is hard to measure using the objective web-usage data, which is the main feedback mechanism for a self-adaptive portal. Therefore, as a simplification, usability will be equated with the efficient achievement of the user goal.

3 USABILITY PROBLEMS RELATED TO WEB SITES

Usability is a problem for web sites (portals). Nielsen (2006 p.22) says that in usability tests, 34% of users do not manage to complete an assigned task at a specified site. Of course, these statistics are much better if users are already familiar with a site and the way it works. This implies that standardized layout and navigation for similar functionality would be a big plus for e-government web sites. On the positive side, 34% is an improvement over failure rates in the 90s, which were around 60%.

¹ In this document the terms *web site* and *portal* are used synonymously.

Having recognized the usability problem, the U.S. government has a comprehensive web site dedicated to the topic of creating usable e-government web sites. It offers, for example, guidelines for designing usable sites. See <http://usability.gov/guidelines/>.

Member EU states have also developed usability guidelines. An example is the Austrian guideline to designing online forms, Mittheisz and Wiesner (2004).

Clearly, designing for usability and testing for usability is, therefore, an important topic and business-consulting companies, like Forrester, advise companies about both topics, and have developed a methodology for evaluating (also called reviewing) web sites for interaction flaws, that is, problems with usability. It is called the Forrester Web Site Review methodology.

As described in Forrester (2005), an expert in interaction design evaluates the site against 25 criteria grouped into four areas: *value*, *navigation*, *presentation* and *trust*. The 25 criteria of Forrester are evaluative questions, but can equally well be seen as problem statements. In the list given below, they have been re-stated as problems. Evaluation is always in the context of trying to accomplish a specific user goal, e.g., *complete an application for student aid*. A second expert repeats the evaluation as a check on the results of the first reviewer.

The list of criteria/problems from Forrester can serve as a good starting point for analysis of typical problems in e-government portals (web sites) for a number of reasons. First, the list represents Forrester's expertise in web usability; it is a heuristic list developed from the best practices of leading companies. Second, the criteria in the list are considered to play a critical role in enabling users to accomplish their goals efficiently. Finally, Forrester does apply this method to evaluate e-government web sites, so that it can be taken as representing a list of crucial usability questions about an e-government portal.

It may be interesting to note here that U.S. government web sites must at least equal the usability of best-practice private-sites, since they must serve all users, that is, be Section 508 compliant, and provide service to people with limited English proficiency. In other words, achieving the desired levels of usability for e-government is at least as challenging as designing a successful commercial site.

3.1 Usability problems according to Forrester

What follows is the list of usability problems according to Forrester (2005). Some examples and explanatory notes have been added in parentheses:

Value

1. The home page does not give evidence that the user goals can be completed
2. Essential content is not available where needed (or not available at all)
3. Essential function is not available where needed. (note: a function might be a service or an activity in a service in FIT terminology.)
4. Essential content and function are not given priority on a page (so might be overlooked)

Navigation

5. Category and subcategory names are not clear and mutually exclusive (so the user has difficulty deciding where to go. An example of confusing category names is a list

of top-level choices: *services, programs, departments*. A common mistake is to use internal department names as choices rather than choices that correspond to the user's goals.)

6. Menu categories do not immediately expose and describe their subcategories (the subcategories reinforce a correct interpretation of the categories and give the user insight into the site structure)
7. Items are not classified logically
8. Task flow is inefficient. (A task is a step in a user workflow)
9. Hyperlinks are not clear and informative
10. Keyword-based searches are not comprehensive and precise

Presentation

11. The site uses language that is not easy to understand (e.g. jargon)
12. The site uses graphics, icons or symbols that are not easy to understand
13. the text is illegible (e.g. it cannot be read because it is too small or blurred)
14. Text formatting and layout make it difficult to scan
15. Page layouts do not use space effectively. (Poor layout can increase the time it takes the user to orient himself and find things on the page.)
16. Form fields and interactive elements are not placed logically on the page. (For example, if a navigation button, like *submit request* is too far from the input fields, or is separated from them by unrelated elements, the user cannot find the button, or takes a long time to find it. This is because people expect related things to be together.)
17. Interactive elements are not easily recognizable
18. Interactive elements are not consistent
19. The site does not accommodate the user's range of hand-eye coordination

Trust

20. The site does not present privacy and security policies in context (making the user worry about whether any policies on other pages are applicable or not; the user may backtrack to re-read them, or may even abandon the site. A site should link to policy information everywhere that a user is requested to enter personal data, and the link should be close to the entry fields.)
21. Pages do not provide location cues (which may cause the user to be confused about where he is)
22. Site functionality does not provide feedback in response to user actions (so users may do something multiple times or be unsure of having achieved their goals)
23. Contextual help is not available at key points (an example of good contextual help comes from a site to renew a driver's license. There an image of a sample license highlights the location of the information requested from the user.)
24. The site does not help users recover from errors (a minimal aid would be to at least provide a link to a FAQ)

25. The site does not perform well

3.2 Forrester review of seven major e-government web sites

Forrester (2005) analyzed seven major U.S. federal e-government web sites and found that usability is in general poor, much poorer than commercial sites. Most of the problems discovered are in the categories: *value* and *navigation*. Moreover, every site had significant design flaws that could only be removed by a user-centric re-design to identify and support the most important user goals. To solve the problems, Forrester advocates persona-centric design. Briefly, a *persona* is a make-believe person, who is representative of a group of users with specific goals and interests. Personas are used to focus discussions and to guide decisions about the site design. Use of personas in design was popularized by Cooper (1999).

For a brief introduction to personas see

http://www.sapdesignguild.org/editions/philosophy_articles/cooper.asp

Three key questions should guide every site design or re-design:

- 1) Who are your users?
- 2) What are their goals?
- 3) How can you help them accomplish their goals?

To round out the discussion with some examples of usability problems, here are some actual examples of problems that the site reviews uncovered:

Example of problem related to value:

The evaluator went to the medicare site in the role of a senior with the goal: *find out information on new Medicare drug benefit: basics, eligibility, covered drugs*.

Problem: terms and links did not indicate where to find information on drug coverage options. The evaluator was unable to meet his goal; it was not supported by the site, the most basic problem.

Example of problem related to navigation:

The evaluator went to the recreation site as a camper with the goal: *make a camping site reservation for August 2005*.

Problem: Links that purported to lead to reservation services for National Parks lead to lists of park-specific sites or press releases. Many users at that point would probably call the listed phone number of the park rather than continuing with their original goal of making an online reservation.

4 PROBLEMS – A VIEW APPROPRIATE FOR FIT

Currently evaluation of usability is done manually by humans. So, heuristic criteria like those from Forrester are selected and grouped to help an evaluator carry out a web site review. FIT intends to develop a self-adapting system, which implies that some evaluation must occur automatically. Therefore, categories of problems have to be organized in a way more appropriate for evaluation by machines.

Problems with usability can be sorted into three major categories that it should be possible for the system to detect, possibly not all the time, but at least often enough to make the system effective.

- 1) The user is unable to find the desired information or service (function in Forrester terms)
- 2) The user is unable to achieve his goal, even though the system supports it and he has started along the path to achieve it
- 3) The user is able to accomplish his goal, but not efficiently, e.g., easily and quickly.

The last two of these problems are directly related to the two major aspects of usability: effectiveness and efficiency, respectively. So, both objective problems of usability, effectiveness and efficiency, are covered. It might also be the case that a user is dissatisfied, in spite of being able to efficiently achieve a goal. But, this is a subjective fact that is not easy to detect.

Other problems, such as those identified by Forrester, can be seen as potential causes of these more general, easier to detect problems (machine detectable). They might all be offered as potential explanations of a user problem. In some cases it may be possible to narrow down the list of potential causes based on other information.

Of course, detection of the user goal then becomes the key to problem detection. Therefore, semantic annotation must be used to mark the relationships between web pages and user goals.

Semantic annotation will extend the limits of web analytics for usability testing. Forrester (2005) criticizes the limits of web analytics (e.g. weblog mining) for usability testing, saying that analytics “reveal behavior, not intent”, showing only “what users did — not why.” Clearly, the key to turning web analytics into a more powerful tool is to provide an indication of the *why* by means of semantic annotation, as FIT intends to do.

5 PROBLEM CATEGORIES AND POTENTIAL CAUSES

This section lists the main categories of problems to be detected by the self-adapting system, together with the potential causes of those problems. A cause of a problem is, of course, a problem as well. For example, the problem *jargon* might be the cause of a user being unable to achieve a desired goal. The series of lists of problems in this section and section **Error! Reference source not found.** is a compilation of problems which Forrester (2005) identified as being critical to usability, supplemented with the relevant major usability problems identified by the recognized usability expert, Nielsen (2006). The list has been organized to suit the purposes of FIT, that is, to enable adaptation to the user.

The user is unable to find the desired information or service

Potential causes:

- 1) It does not exist on the web site
- 2) The information or function is not prominent enough on the page
- 3) The information or function is not available where expected; the information architecture of the site is not intuitive or does not match the user's expectations
- 4) The home page does not provide evidence that the user goals can be accomplished
- 5) Keyword-based searches are not comprehensive or are imprecise

- 6) The information is only visible by scrolling; most users do not like to scroll
- 7) There is no site map, or it is not helpful for finding information or services

Note that the non-existence of a service or information may indicate an opportunity for extending the offered information and services. This is an opportunity that the system might be able to detect based on keyword searches, for example.

The user is unable to achieve his goal, even though the system supports it and he has started along the path to achieve it

Potential causes (all elaborated in the next section):

- 1) Navigation problems
- 2) Presentation problems
- 3) Content problems
- 4) Performance problems
- 5) Lack of supporting information or functions
- 6) Poor match to user

The user is able to accomplish his goal, but not efficiently, e.g., easily and quickly.

Potential causes:

- 1) The task flow is inefficient
- 2) The other potential causes are the same as those listed in the second problem.

5.1 Elaboration of potential causes

This section elaborates on the categories of causes from the previous section. It also makes explicit the problems related to a mismatch between the site and a user. These are implicit in the Forrester criteria, since every evaluation is done for one particular type of user with one particular goal. The problems are organized in an outline list to show which problems might be the cause of others. For example, *confusion as to where to go next*, might be caused by *hyperlinks that are not clear and informative*.

Navigation problems

- 1) Confusion as to where you have been
 - a) Visited links do not change color in the usual and expected way
- 2) Confusion as to current location
 - a) Lack of location cues
- 3) Confusion as to where to go next
 - a) Category and subcategory names are not clear and mutually exclusive
 - b) Menu categories do not immediately expose or describe their sub-categories
 - c) Items are not classified logically
 - d) Hyperlinks are not clear and informative
 - e) The home page does not provide evidence that the user goals can be accomplished

f) Presentation problems cause confusion (see presentation problems)

Presentation problems

- 4) Jargon is used in text.
- 5) The text is not legible, e.g., it is too small to read
- 6) The text formatting and layout make it hard to scan
- 7) There was too much text, and the user did not read it. In general, people read 25% slower when reading from a screen as compared with paper. Besides, most readers feel uncomfortable reading a screen. So, there should be 50% less text on a screen than on a page as a general rule.
- 8) The page layout does not use the space effectively, e.g., there is too little or too much white space or the elements are not well placed
- 9) Graphics symbols or icons are not easy to understand
- 10) Form fields and interactive elements are not placed logically on the page,
- 11) It is not easy to recognize interactive elements, e.g., it is not easy to pick out links
- 12) Interactive elements are not consistent
- 13) Interactive elements cannot be seen unless the user scrolls; many users hardly ever scroll; moreover, scrolling can slow the user down
- 14) The look of the page is distracting
 - a) e.g., a large graphic unrelated to the user's task attracts the user's attention away from the task at hand. This can slow the user down or even cause him to overlook necessary information or interaction elements. In general, larger elements attract more attention than smaller ones.
 - b) e.g., colors, images or animation seem inappropriate

Content problems

- 15) There is too much information on one page
- 16) The information is not up-to-date
- 17) The information is incomplete
- 18) The information is inconsistent or confusing

Performance problems

- 19) The site does not perform well, so the user is slowed down or even abandons the site
- Lack of supporting information or function
- 20) The site does not present privacy and security policies in context, causing the user to hesitate and search for them
 - 21) The site does not provide feedback in response to user actions
 - 22) The site does not help users recover from errors
 - 23) Contextual help is not available where it is needed
 - 24) It is not clear what syntax to use to enter data

Poor match to user

- 25) The task flow does not match the user's expectations or usual navigation strategies
- 26) Text uses terminology that does not match the user's expectations or knowledge
- 27) Text size is too small or too large for the user
- 28) Skill level relative to service is not taken into account, e.g., need to provide more guidance and information for less experienced users; stream-line process and information for more experienced users
- 29) Different levels of language and cultural skills (e.g. non-native person) are not catered for, e.g., text does not match the user's language skills
- 30) The site does not accommodate the user's range of hand-eye coordination, e.g., scrollbars and buttons are too small for the user
- 31) Technology mismatch between the site and the user:
 - a) The site uses file formats that the user's system cannot display, e.g., the user has no PDF viewer
 - b) The site uses screen rendering technologies that are not supported or allowed by the user's browser, e.g., a scripting language
 - c) The device has limited capabilities, e.g., is a PDA
 - d) The bandwidth of the user's connection is too low for the content, e.g., multi-media content
 - e) The user's browser is incompatible with the site
- 32) Security mismatch
 - a) The site uses, or even requires cookies, but the user's browser is configured to disallow them
 - b) Premium services, such as those from the virtual department of building, can only be provided with qualified electronic signature (however, this is outside the scope of the project)

6 STRATEGY TO ACHIEVE BETTER USABILITY

This section describes an overall strategy to achieve better usability. Some more detailed scenarios are given in the next section to show how this strategy might work in practice.

The basic idea underlying this strategy is that the FIT system will help users achieve their goals efficiently, thereby improving usability. This requires the system to recognize the user goal. Such recognition might be enabled by semantically annotating a web page with its related goals.

Furthermore, the system must recognize the factors that affect goal achievement. These are such things as:

- user profile, e.g., age, skill level in using the web, skill level in language of the site
- user navigation strategies
- bandwidth of user device

- user software

Such factors as these are the basis of user categorization.

The overall strategy is that the system adapts to the user by recognizing the user goal and user category in order to apply the adaptation rules which help that type of user achieve that goal efficiently. A simple example of adaptation is as follows. The system recognizes the goal of the user, and highlights the navigation path that leads to accomplishment of the user's goal. If the user goal cannot be precisely determined, the system can list possible goals as *see also links*. To allow for user-centric adaptation, a web designer can provide different services, navigation paths or information for the different categories of users and the different user goals.

An important part of the adaptation strategy is to use the experience of previous users to adapt to similar users. User experience is captured in web server logs that are data mined to extract that experience.

Adaptation based on user-experience is called experience-based adaptation. An example is: the system determines from mining that few users accomplish a goal, but all those who did manage it, read the help text. So, in future, the system always displays the help text for users who have that goal. This is an example of a short-term fix. It is also an example of self-adaptation, in which the system learns from the experience of some users to help other users. Longer term, of course, the web master will need to re-design the service so that most users can succeed in completing it.

Normally, a web master would review the adaptation rules and approve them before the system would apply them. But, automatic self-adaptation can be achieved by generic or meta-rules that specify which types of rules the system is allowed to apply automatically. For example, if the example adaptation rule described above is specified as a generic rule that can apply to any service automatically, then the system is able to automatically self-adapt any service that exhibits this type of problem.

6.1 Web master in the loop

At the same time that the system might automatically create a short-term fix, the web master would be alerted to the problem to initiate a long-term fix, e.g., to simplify the task. So, through data mining, the system also detects problems that are not fully solved by adaptation and alerts the web master to them, putting him into the long-term adaptation loop.

The system may also be able to offer the web master a partial explanation of the cause of the problem, a checklist of potential causes, or even be able to prioritize the problems. In general, by means of semantic annotation, the system should at least be able to pinpoint where a user abandoned a goal and/or the web site. Some possible causes for abandonment may then be able to be determined by the system. See section 8 for some examples of possible causes that the system might be able to detect.

In addition to detecting problems the system can detect opportunities to improve itself. Some examples are given in section 11.

6.2 Feasibility of strategy

The idea of detecting where the user abandons the site has been described in the literature for commercial sites, e.g., in Kohavi and Parekh (2002). On commercial sites the goal is to sell something, which is called conversion. The tasks along the way to conversion are called micro-conversions. One function of existing web analytics is to calculate micro-conversion rates and determine why the user was not fully converted. This type of analysis is also applicable to e-government services, where the activities in a process are the equivalent of the micro-conversions of a commercial site. Similarly, achieving a goal is the equivalent of conversion. This example from the commercial world shows that it is possible to instrument or annotate the web site to enable detection of task/goal achievement or partial achievement. Thus, it can be seen that the proposed strategy is feasible.

7 EXAMPLES OF APPLYING THE STRATEGY

This section gives a few more detailed examples of applying the strategy to improve usability.

7.1 Example: user has a particular goal

The system may recognize that a user has a particular goal and apply adaptations related to that goal, possibly independent of user category. Note that a goal is accomplished by completing a task, so in the discussion, task completion is the same as goal achievement.

Possible adaptations for a particular goal

This discussion makes use of the fact that usability studies have shown that different users develop different navigation strategies, e.g., Fukuka (2003), to accomplish the same goal. Some users are more efficient than others. So, in some cases, the user may be categorized by navigation strategy as explained below.

It might be possible to determine a few common well-worn navigation paths for the task, recognize which path the current user seems to prefer, and guide him along that path by highlighting suggested next choices. Alternatively, the system might try to guide the user along the optimal path, but this might be confusing if the user has a preferred navigation pattern that does not match the optimal path. Another adaptation option is to try to guide the user along only those paths that have been successful in the past for other users, and that best match the user's navigation style.

In fact, the system could conduct online experiments to test which of the alternatives results in better usability. Usability measures for deciding which options are better are: percentage of users who complete the task and the time it takes to complete it. These measures could be made separately for the different categories of users, where a category here is a preference for a certain style of navigation, if this can be determined for the user. The system can choose the guidance strategy that has the highest success rate for the user's category. Such experiments could be conducted automatically in online field trials of a web site.

As described previously, the system can also use the experience of previous users to adapt the portal to similar users, e.g., users with the same goal, e.g. few users accomplish a goal, but all those who did manage it read the help text, so in future always display the help text for users who have that goal.

As mentioned before, yet another adaptation option is to add *see also links* to services and information that are closely related to the goal of the user. These might be ordered or highlighted based on whether other users with the same goal actually used or consulted them.

7.2 Example of user category: elderly user

According to Fukuda (2003 p.220) elderly users require approximately 50% longer than younger users for all kinds of tasks on the web. This finding is based on empirical data collected in a usability study based on eye-tracking to observe user behavior. This clear difference in time to perform tasks may make it possible to detect elderly users by real-time click stream analysis. Other facts may reinforce this interpretation, e.g., a goal commonly pursued by elderly users.

In general, the vision and fine motor function of elderly people is less efficient than that of younger people. Concretely, this means that they have trouble reading characters smaller than 10 points. They also have trouble clicking on small navigational buttons and narrow scroll bars. Fukuda (2003 p.224) also observes that they tend to re-use a learned navigational strategy, even when it's not the most efficient.

Possible adaptations for elderly users

Having recognized that the user is elderly, the system could automatically increase the size of text and interaction elements like scroll bars and buttons. Preferably, because it's less intrusive, the system could offer the option to increase the sizes, using one large button placed in a prominent position.

7.3 Example of user category: user who navigates inefficiently

This example overlaps with the example that categorizes users based on their goal. As already observed, elderly users often navigate inefficiently, requiring more navigational steps than necessary to accomplish a goal. So, the system could apply this category automatically by default to the elderly user category.

To continue the discussion, it is necessary to first consider that there are three different types of navigation to complete a task (to achieve a goal): *nominal*, *as-designed*, and *actual*. *Nominal* navigation flow is based on analysis of the task, and is independent of the web site implementation of the task. It is like a theoretical optimum. *As-designed* web site navigation designates the navigation possibilities as designed by the web master. Finally, *Actual* navigation is the actual navigation behavior of users as reflected in the web server log.

It probably requires a usability expert to determine if the as-designed navigation is as efficient as the nominal navigation. However, the system could be taught to detect sub-optimal actual navigation patterns. For example, the system could be taught the as-designed navigation to perform a task, say by the web master. Then, usability testing could establish the most common actual user navigation paths. Finally, this information can be used to detect inefficient navigation.

Possible adaptations for inefficient navigators

The adaptation options for this case are the same as for the example of a user with a particular goal.

7.4 Example of user category: user with low bandwidth

The system could detect a user with a low bandwidth connection.

Possible adaptations for low bandwidth

To adapt to a user with low bandwidth, the system could substitute content suitable for low bandwidth in place of the usual content.

7.5 Example of user category: potentially lost user

Fukuda (2003 p. 223) indicates that relatively fast traversal of pages followed by a long time on one page might indicate a confused user. If this behavior is combined with a change of goals (as indicated by the next pages visited), the system might conclude that the user needs some navigation help.

Possible adaptations for lost users

If the system thinks a user is lost, it might direct him to a site map or the home page. If, on the other hand, the system can guess at user goals, it might make the links related to these goals more prominent.

8 DETECTION OF CAUSES

If web pages are annotated with goals and their related activities, then the system can potentially detect that a user has abandoned a goal. For example, if the user leaves the site without achieving the goal, he has abandoned it. Or, if the user switches to some other goal, he has abandoned the first goal.

When the system detects that a user has abandoned a goal at a particular page, it can be hypothesized that the user encountered a problem at, or near, that page. Then some static checks can be made to detect some common problems. Examples of problems that can be detected by static analysis are:

- Broken links or anchors
- Misspellings
- Deep pages (possibly the user has become lost because the navigation structure is too deep)
- No height-width attributes on images
- Dense text
- Browser incompatibility
- Section 508 accessibility problems
- Syntax problems, e.g., in html
- Jargon?

It may be possible to detect jargon, for example, some tips to avoid jargon in German are to avoid nouns that end in 'eit' and 'ung', and to avoid acronyms typically used only in public administration.

It may also be possible to detect a terminology mismatch. If a user searches for something, does not find it, but still proceeds to achieve a goal, it may be hypothesized that the search contained synonyms related to the achieved goal. For concepts that are commonly designated by synonyms, the system might provide glossary entries that list the synonyms, and link the entries to the appropriate pages.

9 RECOGNIZING THE USER GOAL AND CATEGORY

Goals and their sub-goals (where a sub-goal is a goal to be achieved as part of reaching a goal) can be related to the portal content to enable detection of the intended goal of a user. Given the relations between pages and goals, collection and mining of web usage data allows estimation of effectiveness and efficiency. That is, for each user, the system is able to tell if they achieved their goal or not (effectiveness), how they achieved it, and how long it took to achieve it (efficiency). (There may also be some characteristics of user behavior that enable the system to distinguish browsing users (users without goals) from users with a goal). Goal recognition might also be based on some empirical data, e.g., data mining might be used to learn that 90% of users who start on a certain page accomplish a certain goal.

Usability studies and web usage analysis can also enable calibration of the system to recognize goals and user categories. For example, the system might be calibrated as follows. A record is made of the behavior of a user who knows how to use a service optimally. This is the baseline behavior pattern for that service. Usability testing by users who are unfamiliar with the service enables detection of common ways of deviating from the baseline. This enables the system to learn how the successful users accomplish their goal. Similar users with the same goal can be guided in the footsteps of the successful users.

In general, categories of users may often have to be empirically determined by a combination of usability testing and the analysis of web usage data. For example, it is known that elderly users take 50% longer to complete a task. But, empirical data is needed to calibrate the system to detect this extra 50%. For example, the time it takes a young person to complete the task may need to be measured. Alternatively, this empirical measurement may serve as a sanity check on the typical task-time for elderly users that the system estimates based on web usage data.

9.1 The evidential basis for goal recognition and categorization

This section lists the potential evidence that can be used to recognize goals and categorize users.

- relations between web pages and user goals or sub-goals; these relations might be expressed as annotations to web pages
- where the user came from, the referrer
- what search string the user entered to get to the site
- what page the user started with
- which pages the user visited
- how long the user stayed on each page

- any correlations between pages/goals and user attributes (e.g. experience level, age, sex, occupation, education level)
- other information about the user such as bandwidth, client software, host, etc.
- information about other users and web pages; this information would be gained, e.g., by web log mining
- information that can be inferred from the above, e.g., the user's goal

Subjective feedback mechanisms, e.g., online questionnaires, supplement the objective usage data collected by the portal, and might also give some evidence that can be used to recognize goals or categorize users.

10 GENERIC ADAPTATION OPTIONS

This section lists the generic adaptation options, most of which have already been listed in the state-of-the-art. They are included here as a reminder of the generic types of adaptations that the system might make. They are listed in outline view to show a specialization relationship between options, e.g., *sort links* is a specialization of *change links*.

- 1) Change text or other content, filter text (optional detail or explanations)
- 2) Change links (e.g. to recommend links)
 - a) Sort links
 - b) Hide links
 - c) Annotate links
 - d) Generate new links
 - e) Highlight links of interest to the user
- 3) Offer guided tour, using, for example, next and back buttons.
- 4) Change layout/format
- 5) Make pages that many users are interested in easier to get to (popular pages)
- 6) Connect related pages
- 7) Cluster similar documents in listings of documents
- 8) Substitute content (e.g. to adjust to bandwidth limitations and compatibility problems)
- 9) Generate additional natural language text (not a topic in FIT)
- 10) Adapt canned text to the user (e.g. multi-lingual, or varying degree of detail)
 - a) Insert or remove fragments of text
 - b) Dim fragments, e.g., sidebar, smaller font, footnote, pop-up
 - c) Highlight fragments by colors
- 11) Adapt the site map itself; the site map is a navigational aid that is often a hierarchy of the web site content.

10.1 Adaptation and types of links

Link adaptation may very much depend on the type of link being adapted. The types of links, according to Nielsen (2000), are: *structural*, *associative* and *see also*.

Links for structural navigation are usually on an edge (top or left) of the page. They enable the user to go to parts of the information space.

Associative links usually appear as part of the content of a page, often as underlined words. They link, for example, to pages with more information about the content of the current page.

'*See-also*' links are usually a list of additional references; their main purpose is to help the user find the desired information in case the current page is not the right one. As mentioned previously, these *see-also* links might be shown where the user goal cannot be determined precisely.

11 OPPORTUNITY DISCOVERY

In addition to detecting problems, the system can detect opportunities for improvement. Such opportunities would be discovered by data mining, and the web master would be alerted to them. Alternatively, the web master might specify some meta-rules that enable the system to automatically apply some suggestions/rules. Below is an initial list of the types of opportunities the system might discover:

- Suggestion to combine multiple services that seem to be used one after another by many users. If they overlap this can result in time savings for the user.
- Suggestions for new services, which users looked for but did not find
- Suggestions to link pages that are not yet linked
- Suggestions to make some pages more prominent because of heavy use
- Suggestions that some pages might be removed because they are never used
- Opportunities to optimize performance to match the common usage patterns
- Discovery of new categories of users

12 CONCLUSION

Usability, which can be equated with the efficient achievement of the user goal, is recognized as a problem for e-government portals.

To improve the usability of e-government portals, the FIT system will help users achieve their goals efficiently. This requires the system to recognize the user goal. Such recognition might be enabled by semantically annotating a web page with its related goals.

Furthermore, the system must recognize at least some of the factors that affect goal achievement. These are such things as: age, skill level in using the web, user navigation strategies, etc. Such factors are the basis of user categorization.

Having recognized the user goal and user category, the system can apply the adaptation rules which help that type of user achieve that goal efficiently. An important part of the adaptation strategy is to use the experience of previous users to adapt to similar users.

There are three basic usability problems that the system can potentially detect:

- 1) The user is unable to find the desired information or service
- 2) The user is unable to achieve his goal, even though the system supports it and he has started along the path to achieve it
- 3) The user is able to accomplish his goal, but not efficiently, e.g., easily and quickly.

The problems that cause these problems are much more difficult to automatically detect. Nonetheless, some of them might be able to be detected by a combination of static analysis of pages and user click-stream analysis.

Seen from the point of view of problems, the goals of the FIT system can be described as: automatic detection and localization of problems, automatic adaptation to solve some problems, and alerting of the web master to irresolvable problems and opportunities for usability improvements.

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A PRELIMINARY ANALYSIS OF SOME USABILITY DATA

To collect data about usability we constructed a general questionnaire for end users of a portal, including instructions on how to turn it into an online questionnaire for a specific portal. Using the instructions, the FIT end users converted the questionnaire into an online form. We received enough results, close to 300 responses, from the Greek ministry portal to perform some preliminary analysis, which is reported in this appendix. The general questionnaire is included in appendix B.

Longer term, the data collected will be analyzed to create user models and correlate user characteristics with problems using a portal. The analysis can also, secondarily, be used by the portal provider (FIT end user) to learn more about the users and the problems they have using the portal.

The questionnaire was based on advice about user profiling from:

<http://www.agimo.gov.au/publications/2004/06/toolkit/user/concepts>

It advises that information about the following categories should be collected: demographics, web behavior, user needs, user goals and expectations, barriers or problems and diversity.

This questionnaire in German also provided guidance.

<http://www.e-gov.bs.ch/fragebogen.pdf>

Close to 300 responses to the questionnaire were collected from the Greek ministry and analyzed to yield a preliminary view of typical perceived usability problems. The next figure shows that about 91% of respondents were mostly satisfied with the information provided by the site.

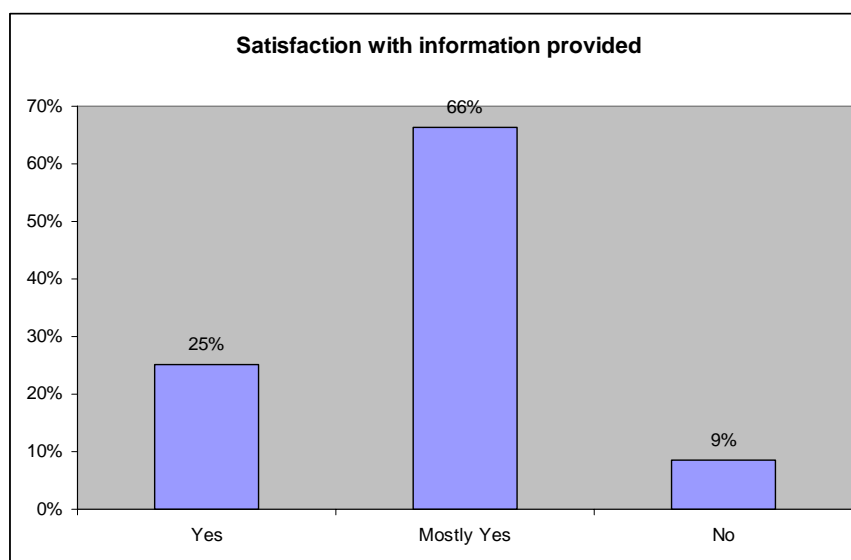


Figure 1 Satisfaction with information provided

In spite of overall reasonable satisfaction, a number of usability problems were reported as shown in the following table:

PROBLEM	Percent of respondents reporting problem
Do not find hoped for information	18%
Do not easily find information	16%
Feel confused about location in the site	23%
Do not find site map useful	29%
Site structure is in need of change	84%
Layout is distracting or hard to read	53%
Text is too small, too wordy or uses jargon	40%
Information is out-of-date, incomplete, inconsistent or confusing, or there is too much of it	65%
Links are difficult to pick out or their purpose/destination is unclear	43%
Response time is unacceptable	11%
Browser cannot present site content	6%

Table 1 Summary of reported problems

Three main problems areas seem to be particularly prominent: the information architecture & site structure, the information content, and technical problems, which judging by user comments, are more common than might be thought. A fourth problem that was not emphasized in the questionnaire, nevertheless was singled out by respondents for comment, the search functionality. Also included below is a list of information or functionality that respondents would like to see added to the site.

A.1 Information architecture

The information architecture of a web site is the blueprint for its site structure. Judging by user responses, the information architecture of the site could be improved. About 84% of the respondents think that something about the site structure should be changed. Of that number, 24% think a new structure is needed. This may also explain why 29% of respondents do not find the site map useful; a site map also reflects the information architecture of the site.

A problematic information architecture is also indicated by the fact that 23% of respondents feel confused about their location in the site as they navigate through it. Similarly, the fact that 43% had problems with links is also indicative of problems with the information architecture.

Some statements by respondents, explaining why they had trouble finding information, also support the idea that there are problems with the information architecture. The list below contains most of the explanations that did not involve the search functionality.

- This site is not easy to use
- Complicated menu

- The information is not well organized
- Information is not categorized
- I can't find the certified services that κερ offer
- Generally public services' pages are not easy to use
- A lot of navigation is needed in order to find information
- A lot of information but it is not structured
- Often the categories are not useful, there are more than one access paths to information
- The layout doesn't help you find out if a specific page contains that you look for

A.2 Information content

About 65% of respondents had problems with the information content. Of those, 47% thought the information was out-of-date, incomplete, inconsistent or confusing. The others thought there was too much of it. However, given the overall satisfaction rates, it might be concluded that problems with information content are localized rather than applying to the site as a whole. There do, however, appear to be some problems with the presentation of the information, e.g., the page layouts and text, since 53% and 40%, respectively, report problems with them. These might also be localized problems, since, as mentioned, 91% of respondents were mostly satisfied or entirely satisfied with the information provided.

However, there was one comment critical of the type of content on the site: “The content must abstract new services or governmental announcements. Publication of encyclical is meaningless and many people don't understand them.”

A.3 Search functionality

Users who were unable to find the information they needed were asked to provide an explanation. A fair number of answers had to do with the search facility as this selected list of response illustrates.

- The search facility is not good
- The search facility is not easy to use
- Searching is difficult, there is no adequate illustration
- The search engine results are not that I want
- Search engine doesn't provides accurate results
- Search engine doesn't perform well. Search using keywords of the procedure's title would be better
- The search engine doesn't work. I use Firefox

Even a respondent who was very positive about the site as a whole said: “Very good site, very useful links, enough information concerning required documents for an application. The search engine must be improved.”

A.4 Technical problems

More technical problems than might have been expected were reported. About 11% of respondents had problems with the response time of the site. At least one had problems with reliability, since “reliable communication links” was included in the wish list (see below). About 6% of users had problems presenting content from the site in their browser.

Respondents mentioned some particular technical problems, among them:

- Some hyperlinks are broken
- Technical problems - the web page is not recognized
- The search engine doesn't work. I use Firefox
- Often the webpage is presented at Russian and not at Greek language
- Fonts are not compatible with Macintosh
- PDF problems
- There is no text scale facility
- Character encoding is wrong at home page
- The pages are opened in Russian language
- Many times (9/10) character encoding is not Greek
- Not recognized font
- Firefox doesn't presents frames correctly
- Compatibility problem
- ISDN speed problem
- The form used for questions submission is problematic. I cannot submit my questions. An error message is presented
- Loading of pages is time-consuming

A.5 Other quality issues

Another issue raised by one respondent was that “employees of citizens service centres (κκεπ) don't have the knowledge to answer my questions.”

A.6 Wish list

Users were given an opportunity to indicate which information or functionality they would like to find at the site. Most of the answers are listed below as they appear in the raw translated data. Some more work is needed to interpret them properly. Some initial guesses at interpretation are included with a question mark, in parentheses at the end of some entries.

- A new thematic area is needed which will contain news and new services
- Issue of certificates can be started via internet e.g. a form can be filled in directly on the web

- More digital applications concerning public organizations should be available
- Online applications for certificates or other documents issue. The requested documents can be delivered by mail or obtained at Citizens Service Centres
- European health card
- Public procurement law, registration of a new company
- Information about new proclamations
- ΑΣΕΠ and public sector proclamations
- More detailed proclamations concerning ΑΣΕΠ exams
- Exams proclamations
- National printery
- Cadastre applications
- Ambiguous required documents (list of required documents?)
- Required documents for a new passport
- The required documents for a certificate issue are confusing
- Names of candidates for military schools
- Applications & documents for benefit (having many children)
- Search for encyclical, law, urban planning topics
- Telephone numbers for some services are wrong
- Public employees' permutation (location?)
- Public sector employees' code (code of conduct?)
- Information concerning public sector's topics
- Online applications
- Complete list of required documents for moving from one municipality to another - certificate of residence
- Up to date information, especially concerning news of public sector's services. Timeliness
- Information about which online services exist (if there are any). Information about telephone services of 1502
- Access to legislation
- Concerning the headquarters relocation and the revenue service
- Deontology code of municipalities
- Licentiate for secure systems installation
- Information about seeking work
- Public sector employment-κεπ

- Proclamations about new jobs
- Online CV
- Labour law
- News concerning labour law
- Schools
- Information concerning foreign languages adequacy
- Information for out-migrants
- Guidelines for reports
- More links
- More modern layout of the website
- Easier navigation
- Up-to-date information. More detailed description of the process that we must follow in order to obtain each service
- Reliable communication links
- Several respondents wished for “up-to-date information”
- Better search and site structure and more up-to-date information
- Better links and pages with more width
- Better search engine, more structured information and more detailed description of the process that must be followed to obtain a service

A.7 Summary

The results of this subjective survey indicate that the information architecture and corresponding site structure are the main problem area for this site. A weak information architecture causes navigation problems, which, in turn, cause users to attempt to solve their problems by searching. This factor may have contributed to the unexpected criticism of the search functionality. The results also indicate that overuse of search may imply problems with the information architecture.

Another unexpected result of this survey was the number of technical problems; 11% of respondents had problems with response time. A fair number of respondents had other technical problems, many of them to do with compatibility, e.g., font incompatibility with the Macintosh. This indicates that some static compatibility tests may be very effective as a first step to improving usability.

Finally, the large number of entries in the wish list shows that a survey like this can be effective in finding out what users would like to have.

B SAMPLE QUESTIONNAIRE

This is an example of the online questionnaire in the English language. A modified version in Greek was used to collect the data analyzed in the previous annex.

1. Information about yourself

1.1 Do you live in x? (city, area that the web site serves)

- yes
- no

1.2 What is your mother tongue? (adapt list for country)

- German
- French
- Other (please specify) _____

1.3 Which gender are you?

- female
- male

1.4 How old are you?

- less than 18
- 19-30
- 31-40
- 41-50
- 51-65
- over 65

1.5 Which of the following best describes what you do? (needs modification for the country)

- studying or in training
- employed
- employed in management position
- self-employed
- housewife or house-husband
- seeking work
- retired

Other (please specify) _____

1.6 Which of the following is the highest educational degree you have achieved? (must be adjusted for each country)

- PhD Degree
- Masters Degree
- Bachelors Degree
- High School Diploma or equivalent
- Vocational Degree
- no degree

1.7 How many hours do you spend on the Internet each week?

- more than 10 hours
- 3 to 10 hours
- less than 3 hours
- none

1.8 Which device do you use to access this web site?

- PC
- handheld
- mobile telephone

1.9 Which browser do you use to access this web site?

- Microsoft Internet Explorer
- Mozilla Firefox
- Opera
- Netscape
- Konqueror
- Apple Safari
- iCab
- other (please specify) _____

1.10 Are you employed by x? (x is the provider of the web site, e.g., city or ministry)

- yes
- no

2. Information about your use of this web site

2.1 How often do you visit this web site?

- daily
- at least once a week
- at least once a month
- less than once a month
- never

2.2 What is your overall impression of the web site?

- very good
- good
- average
- below average
- inadequate

2.3 Which information provided by this web site do you use?

(This list has to be provided by each end user partner)

- XXXX
- ...
- Other (please specify) _____

2.4 Which information did you hope to find at this web site, but did not find?

- please specify: _____

2.5 Which services provided by this web site do you use?

(This list has to be provided by each end user partner)

- XXXX
- ...
- Other (please specify) _____

2.6 Which services did you hope to find at this web site, but did not find?

- please specify: _____

3. Problems using this or other web sites

3.1 Navigation

3.1.1 Are you able to easily find the information you need?

- yes
- no

If you answered no, please specify what you think the cause of the problem is:

3.1.2 Are you able to easily find the services you need?

- yes
- no

If you answered no, please specify what you think the cause of the problem is:

3.1.3 Do you feel confused about where you are as you navigate the web site?

- yes, often
- yes, sometimes
- no, never

If you answered yes, please specify what you think the cause of the problem is:

3.1.4 Do you find the site map helpful for navigation?

- yes, I use it often
- yes, sometimes I use it
- no, I never use it

3.1.5 Do you think that the site structure needs to be changed so that some navigation paths are shorter?

- yes, a new site structure is needed
- yes, some modifications to the site structure are needed
- no, the site structure is good

If you answered yes, please specify what you think the cause of the problem is:

3.1.6 Are you able to customize the web site to your needs?

- yes
- no

3.2 Information

3.2.1 Below is a list of potential problems with information on a web page. Please tick all the problems you have found on this or similar web sites.

Layout

- The look of the page is distracting, e.g, colors, images or animation seem inappropriate.
- The layout of the page makes it hard to read.
- Other (please specify) _____

Text

- The text size is too small to read
- The text is too wordy
- The text uses too much jargon
- Other (please specify) _____

Content

- There is too much information on one page
- The information is not up-to-date
- The information is incomplete
- The information is inconsistent or confusing
- Other (please specify) _____

Links

- It is difficult to pick out the links on the page
- The purpose or destination of the link is unclear

3.2.2 Are you satisfied with the information that is provided?

- yes
- mostly yes
- no

3.3 Services

3.3.1 Below is a list of potential problems with services offered by this web site. Please tick all the problems you have found on this or similar web sites.

- The pre-requisites for using the service are not clearly explained
- The instructions for using the service are unclear
- It is difficult to recover from mistakes made in using the service, e.g., it is not easy to correct mistaken data entries.
- The forms are difficult to fill out, e.g., it is unclear what syntax to use for data fields like dates

It is not possible to track the status of services that require action by some government office.

Other (please specify) _____

3.4 Is the response time of the web site acceptable?

yes

mostly

no

3.5 My browser cannot present content from this web site or presents it incorrectly?

yes

no

If you answered yes, please specify what you think the cause of the problem is:

4. Please share with us any other comments, problems or suggestions you have: