User Interaction Study in Public Websites based on Performance and Eye-tracking Data

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ABSTRACT

Online public services alleviate the workload of public administrations and provide convenient channels to citizens for easily carrying out administrative tasks. However, the interaction with these services is not always as intuitive and easy as desired. Online services are sometimes hard to find on the websites of public administration and citizens are often forced to consult about the location of them via other mechanisms such as search engines, phone calls, etc. These situations drive citizens to have a low perception of the public e-services' quality. In this paper, we explore the interaction of eleven users with four Spanish public administration websites. Some considerations for the design of these websites are proposed based on the results of the analysis of performance data and eye-tracking data gathered in the study.

CCS CONCEPTS

• **Accessibility design and evaluation methods**;

KEYWORDS

e-Government, user interaction, web design, visual complexity

ACM Reference Format:
Aritz Sala, Myriam Arrue, Sandra M. Espín-Tello, and J. Eduardo Pérez. 2022. User Interaction Study in Public Websites based on Performance and Eye-tracking Data. In *XXII International Conference on Human Computer Interaction (Interaccion 2022), September 7–9, 2022, Teruel, Spain.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3549865.3549905

interaccion2022, September 07–09, 2022, Teruel, Spain

ACM ISBN 978-1-4503-9702-5/22/09…$15.00
https://doi.org/10.1145/3549865.3549905

1 INTRODUCTION

The COVID-19 pandemic has forced public administrations to provide citizens with more e-services as they are often the only possibility to perform some of the administrative tasks. This new situation could be a great opportunity for governments to increase their digital presence and provide citizens with new services which could alleviate the workload of public administrations [1] . However, there is not a uniformly defined mechanism to follow by public administration for providing citizens with such e-services. Therefore, users have to adjust to each departmental public website and find the services offered online in a different manner by their own without any online help. This becomes a tedious task in some websites and users usually get a low perception of the quality of the public e-services offered by public administrations. This paper analyses the interaction of eleven users experienced in web browsing with four Spanish public administration websites. Performance data and eye-tracking data were gathered and analyzed. The results showed that all participants were able to finish the search tasks in the studied websites, they agree on the easiest and the most difficult tasks and show similar behavior when scanning the homepage searching for the objective but the design of the public websites did not always meet their expectations.

2 RELATED WORK

Many studies have been carried out in the last decade with the objective of evaluating e-government websites. However, most of them have been focused on the accessibility evaluation by the use of automated tools [5, 7] and did not considered the performance analysis based on real data gathered in the user interaction with the websites. Data gathered by eye-tracking proved to be useful for evaluating usability of websites in several research works. The study described in [2] evaluated the eye-tracker technology's contribution to be used like a usability measure. For this, different methods such as definition of areas of interest in the page to detect where users' gaze are applied [4]. Usability problems can be detected by analyzing the eye-tracking data [8]. In addition, eye-tracking data have been analysed in order to detect specific navigation patterns of some user collective such as people with autism and visual disabilities [3, 6]. In this study we aim at analyzing performance data and

Table 1: Visual Complexity Score (VCS) of the websites.

Website	VCS Homepage	VCS Mean
SEP	2.4	2.4
OSA	3.7	3.7
DNI	5.2	2.3
SGS	5.5	5.7

eye-tracking data in order to detect the difficulties and the unmet expectations of users in public websites.

3 EXPLORATORY STUDY

3.1 Participants

A convenience sample composed of 11 students (U1-U11) from the Faculty of Informatics of the University of the Basque Country was recruited by posting flyers on the bulletin boards of the faculty. Five participants (U1, U7, U8, U9, U10) were postgraduate students doing their Ph.D. studies whereas the other participants were undergraduate students. The mean age of participants was 25.6 years (SD 5.4), and five of them were females (U3, U4, U5, U7, U11). All participants reported having high experience with computers and Web browsing. All the experimental sessions with participants were carried out in a laboratory at the Faculty of Informatics of the University of the Basque Country. The same computer was utilized in all sessions: a Dell Precision M6700 laptop running a 64 bits version of Windows 7 Enterprise and Tobii Studio 3.2.1.190 for gathering eye-tracking data. An additional widescreen LCD monitor (aspect ratio 16:10) with a diagonal size of 24 inches and the display resolution set to 1920×1200 pixels was used to present public e-services to participants. This screen had a Tobii X-30 Compact device located at the bottom of the screen. All sessions were video-recorded and a 7 € ticket to spend at the faculty canteen was gifted to every participant.

3.2 Stimuli

Four public Spanish administration websites were selected as stimuli for this exploratory study: SEP, the public website of the Public Service of State Employment; OSA, the public website of the public health service in the Basque Country; DNI, the public website of the Ministry of Home Affairs; and SGS, the public website of Social Security. They all conform to web accessibility standards. Each website had different content and design but all of them provide users with the service of "making an appointment with the public service". Each user was asked to visit a different number of web pages on the site for reaching this service. The optimum path contained a different number of web pages on each website which were the following: SEP 2 web pages, OSA 1 web page, DNI 5 web pages and SGS 2 web pages.

The Visual Complexity Level was computed for each homepage of the public websites by the ViCRAM tool [6] as well as for the web pages in the optimum path. The obtained visual complexity score (VCS) was a value between 0 and 10 and it was computed by applying the defined formula to each web page that considers the type and number of structural elements. This tool is implemented within Eclipse Technology Project in the Accessibility Tools Framework (ACTF) and has been applied in several research works. The values of VCS for websites were not high as all of them obtained a value lower than 6. The maximum value was for SGS for both homepage and mean values (5.5 and 5.7 respectively). The lowest value was for SEP (2.4 in both cases). The values obtained for DNI website showed a great difference between the homepage (5.2) and the mean value (2.3). This meant that the web pages in the path were much simpler than the homepage. Overall, these websites could not be considered visually complex but the scores differed so we expected differences in the user interaction as well.

3.3 Procedure and Tasks

First, participants were briefed on the purpose of the experiment and then signed a consent form. Information on demographics and expertise was collected through a brief pre-session interview and the eye-tracking system was adjusted to each participant. Then, participants were asked to perform a set of tasks, one on each website; these tasks were presented in counterbalanced order. They were asked to search for the form to make an appointment with the service starting on the homepage. Participants were provided with an oral explanation of the search task at the beginning as well as a printed version of the explanation. The following is an example of the explanation given on the task in DNI: "Please access the website of the Ministry of Home Affairs and search for the form to get an appointment to renew your ID card". Participants were asked to inform the researchers when they thought they found the objective. Then, the researchers would confirm the end of the task or encourage continuing searching if it was not the objective. The time for completing the task was limited to 12 minutes. At the end of the experiment participants were asked to rank the tasks based on the easiness to find the objective.

4 RESULTS

4.1 Performance Data

All participants finished the tasks before the limitation time of 12 minutes. Table 2 shows the performance values obtained by each participant in the tasks. The mean task completion times in Figure 1 show that OSA was the e-service obtaining the lowest value (27 sec.) whereas SGS was the one on which the participants spent more time (3min. and 38 sec.). The lostness values in Table 2 show that OSA was the one with the lowest mean value (0.05) whereas SGS was the one obtaining the highest mean value (0.72).

The times obtained by participants showed that all of them spent the maximum time for the task in SGS. The case of U10 merits attention as this participant obtained low task completion times (less than 1 min.) for all the other e-services (SEP- 55 sec., OSA-28 sec., DNI-58 sec.) whereas it was more than 10 min. for SGS e-service. The lostness values show also more disorientation in SGS than the other e-services so participants had to visit more web pages in order to find the objective of the task (0.72 for SGS and values lower than 0.15 for the rest of e-services). The values show that most of participants in the sample took the optimum path to the objective in all the e-services except of SGS (8 participants in SEP, 9 participants in OSA and 7 participants in DNI). OSA obtained the lowest value of lostness (0.05).

Table 2: Performance values obtained by participants on the public websites.

User ID	SEP Time	SEP Lost	OSA Time	OSA Lost	DNI Time	DNI Lost	SGS Time	SGS Lost
U1	01:00	0.42	00:19	0	01:00	0.22	05:07	0.82
U2	01:23	0.33	00:27	0	00:56	0	03:36	0.66
U3	00:32	0	00:23	0	00:55	0	02:17	0.75
U4	00:43	0	00:12	0	01:53	0.37	03:37	0.88
U5	00:24	0	01:00	0.60	01:21	0.17	03:33	0.90
U6	00:17	0	00:39	0	00:50	0	01:20	0.42
U7	00:41	0	00:21	0	01:00	0	02:09	0.54
U8	00:51	0.42	00:25	0	00:47	0.26	03:49	0.75
U9	00:26	0	00:29	0	00:42	0	01:45	0.42
U10	00:55	0	00:28	0	00:58	0	10:17	1
U11	00:35	0	00:16	0.22	00:45	0	02:32	0.81
Mean	00:42	0.11	00:27	0.05	01:01	0.12	03:38	0.72

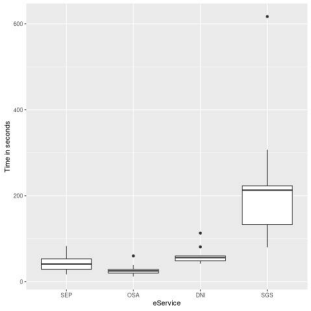

Figure 1: Boxplot of the time required by participants for finishing each task.

Table 3: AoIs identified in the homepages of the analyzed websites (the asterisk indicates first step of the optimum path to the objective).

AoI	SEP	OSA	DNI	SGS
Title	1	1	2	2
Navigation Menu	2	2	3	3
Right Menu	3	3*	4*	5*
Main Content	4*	4	5	6
Cookies	-	-	1	1
Advertisement	-	-	-	4

4.2 Eye-tracking Data

We defined the areas of interest (AoI) to be analysed by the eye-tracking for each website. For this, we identified the similarities between the homepages selected for the study and concluded on the main areas. All of them contained the area of "Title of the website" (Title), "Main navigation menu" (Navigation Menu), "Right navigation menu" (Right Menu) and "The main content" (Main Content). In addition, SGS and DNI e-services display "an alert of Cookies" (Cookies) and SGS displays some advertisements to users in the center of the homepage (Advertisement). Figure 2 shows the homepage of the analyzed websites with the AoIs highlighted as well as the first step of the optimum path to the objective (marked with red and/or an asterisk). Table 3 indicates each of the AoI in the homepage of the websites shown in Figure 2.

Most of the analyzed websites (OSA, DNI and SGS) included the first step of the optimum path to the objective of this study ("making an appointment with the service") in the Right Menu. Only SEP website included it in the Main Content area. The heatmaps of the data gathered by the eye-tracker are shown for each homepage in Figure 3. These heatmaps were computed using the Tobii Studio software with the data gathered by Tobii X-30 Compact device. It can be observed that the gaze is focused in the Right Navigation area in OSA website, where the optimum path to the objective is located. For the other websites the gaze is more dispersed. In SGS the majority of gazes were in the Navigation Menu and in the Cookies alert. In DNI the Navigation Menu and Right Menu are the areas obtaining more gazes. The Cookies area obtained not gazes in DNI. SEP is the website obtaining most dispersed gazes from participants. It can be observed that participants mainly focused on Title, Navigation Menu and Main Content. We analyzed the first look of participants in each website homepage. Figure 4 shows the first look by website and area of interest. The Navigation Menu obtained the majority of first looks for SEP, DNI and SGS (60%, 45.5% and 54.5% respectively). The Main Content area was the one obtaining most of first looks in OSA (60%).

5 DISCUSSION

All participants coincided picking OSA as the easiest website to search for the "making an appointment" service. All of them chose SGS as the most difficult one. Performance data completely supported these selections as OSA obtained the best values of time for task completion and lostness whereas SGS obtained the worst values. OSA was one of the websites obtaining the best values for VCS. Even if all websites obtained low values for complexity there are slight differences that may be important when users are searching for specific services. Therefore, considering the visual complexity and improving this value should be considered when developing public e-services. However, some elements such as cookies alerts and advertisements are not taken into account in VCSs.

(a) (b) (c) (d)

Figure 2: Areas of interest defined in the websites: SEP (a), OSA (b), DNI (c), SGS (d). The asterisk indicates first step of the optimum path to the objective.

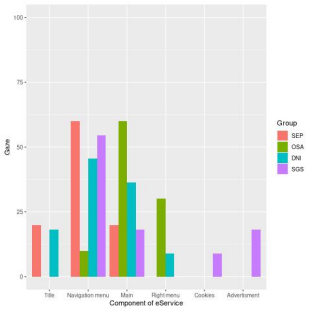

Figure 3: First looks of participants on the homepage of websites.

These elements may distract users making the websites more visually complex and it is necessary to study different ways for their implementation. For the cookies alerts two different mechanisms were used. The mechanism used in DNI is not disturbing users as gathered eye-tracking data showed that did not draw their attention. Participants were distracted by the Cookies alert in SGS (gazes in this AoI were gathered by eye-tracker). Therefore, special attention is required when including these kinds of alerts so users are not distracted and could navigate without difficulties. The location of the first step of the optimum path to objective was analyzed in this paper based of the gaze plots generated by Tobii Studio software. Data gathered by eye-tracking showed that participants first gazes were mainly oriented to the navigation menu. Then, users expected to find there the information about public online services. Nevertheless, the first step was not located in this area for any analyzed website. It was located in the Right Menu for OSA, DNI and SGS and in the Main Content for SEP. These locations in the websites were paradoxically one of the areas with less first gazes in the study. The design of the website homepage is crucial for the performance and satisfaction of users so most required or interesting services for citizens should be located in adequate areas of the web to be easily identified by the first gaze. This study is limited by number of participants in the sample and the number of e-services analyzed but this is a first step for making an interaction study of experienced young students accessing to public administration online services.

6 CONCLUSIONS

Four Spanish public administration websites were analyzed by gathering interaction and eye-tracking data of eleven users in a searching task. Performance results supported the users' perception of the easiest and the most difficult tasks. The user experience interacting with public websites was different even if the obtained visual complexity score for the analyzed public websites was similar. Eye-tracking data analysis proved to be useful for identifying design aspects necessary to be included in such scores and to be considered by designers in the development of this kind of websites. Future work will be focused on performing more analysis of the gathered data and extending the study with more users and applying this approach to other public e-services and tasks.

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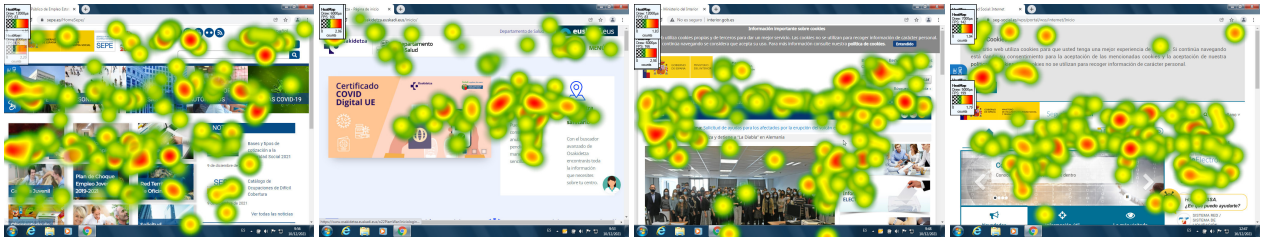

(a) (b) (c) (d)

Figure 4: Heatmap of gazes in homepages: SEP (a), OSA (b), DNI (c), SGS (d).