

How to Incorporate a Usability Technique in the Open Source Software Development Process

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Abstract— The growth in the number of non-developer open source software (OSS) application users and the escalating use of these applications have both created a need for, and interest in, developing usable OSS. OSS communities are unclear about which techniques to use in each activity of the development process. The aim of our research is to adopt the visual brainstorming usability technique in the HistoryCal OSS project and determine the feasibility of adapting the technique for application. To do this, we participated as volunteers in the HistoryCal project. We used the case study research method to investigate technique application and community participation. As a result, we identified adverse conditions that were an obstacle to technique application and modified the technique to make it applicable. We can conclude from our experience that these changes were helpful for applying the technique, although it was not easy to recruit OSS users to participate in usability technique application.

Keywords- *open source software; usability techniques; requirements engineering; visual brainstorming.*

I. INTRODUCTION

The usability technique definition and integration into OSS projects is a complicated process, about which there are few papers [1]–[4]. These papers suggest that usability techniques should be reconceptualized, but they do not explain how the OSS community should go about adaptation. Nichols and Twidale [5] are the only authors to put forward some general ideas for improving usability. However, the issues to be taken into account to adopt such techniques in OSS developments are unclear. In particular, few studies have reported the application of the visual brainstorming (VB) technique in OSS projects [4], [6]. It appears to be less straightforward to integrate usability into the OSS development process than into commercial development due to some of the characteristics of the OSS community. Consequently, usability technique adoption is a demanding task because most HCI techniques are not designed for the type of environment in which OSS is developed [7].

On one hand, the human-computer interaction (HCI) field offers usability techniques whose key aim is to build usable software. However, they are applied as part of HCI methods and not within the OSS development process. On the other hand, the OSS development process focuses on source code and thus on feature development. The OSS development process has a number of characteristics (i.e., a developer’s culture that may be somewhat distant from the interaction). This prevents many of the HCI usability techniques from being adopted directly [7].

Requirements engineering activities play a very important role in the success or failure of an OSS project. However, they are sometimes extremely hard to perform because there is no definition of OSS user segments before the software is developed. Also, it is far from straightforward to address all the requirements analysis activities due to the particular characteristics of OSS development groups. Additionally, OSS projects have not adopted many usability techniques related to the requirements engineering and product concept development activities [7]. The next step after selecting the activity is to pick one related usability techniques for adoption in the OSS development process. VB is a technique involving idea-sketches used to explore alternative designs [8]. This technique helps to focus product concept design on its hypothetical features [9], that is, developers can use this technique to discover a user’s mental model of the product. We selected the VB from among other techniques because it can benefit the user interface (UI) design process: it generates creative ideas in the process of solving specific problems, with one hour of session they obtain positive results, supports Conceptual design by generating metaphors for UI architectures and providing new ways to implement old functionalities [10]. On this ground, we selected the VB technique for adoption in an OSS project.

Our research spans two areas: OSS developments and HCI. We use usability techniques as a bridge to communicate these two areas, where our aim is to deploy HCI knowledge in the OSS development communities. If adapted, usability techniques can be adopted in the OSS development process [7]. Therefore, the aim of our research is to adapt the VB usability technique [11] for adoption in the OSS development process

and determine the feasibility of adopting this usability technique in a real OSS project. To do this, we first identified and analysed which obstacles had to be overcome in order to apply VB in OSS projects. This paper makes a significant contribution to the field of SE and particularly OSS development projects because there are few papers reporting the use of the VB technique and detailing how it has been applied in OSS development projects [4], [6]. The contributions of this paper are as follows: (i) We identify the adverse conditions that are an obstacle to the application of the VB technique in OSS developments, (ii) we propose adaptations for each of the steps of this technique to enable its adoption in the OSS development process, as there are no specified procedures for applying HCI techniques in this type of development projects, (iii) we give some recommendations on how to improve the UI of an OSS application by applying a collaborative usability technique (VB) to tailor the original interface design to real user needs.

This paper is organized as follows. After this introduction, we describe the related works. We then illustrate the research method. Then, we report the proposed solution. We then report the results and discussion. Finally, we outline the conclusions.

II. RELATED WORKS

In recent years, the worldwide OSS community has adopted just over 50% of the HCI techniques related to evaluation. However, only about 20% of the usability techniques related to requirements engineering and design activities have been adopted [7]. Therefore, more research is required to support the adoption of techniques related to requirements engineering in OSS developments. In view of the importance of HCI and SE, it is only logical to study the user-centred software development activities in OSS projects. This is especially true of the requirements engineering stage, because the discovery of user requirements during the early development activities is useful for putting right any defects in software detected later on [4]. In this paper, we adapt the VB technique used in the product concept development activity. According to Preece et al. [11], product concept development relies on the creation of a mental model based on psychological theories related to HCI. Ferré [8] explains that this activity covers issues regarding how users envisage the system. Therefore, this activity aims to provide a picture of the product before defining the features that the system should offer.

There are papers in the literature reporting the usability evaluation of some OSS applications [12], [13]. Assa et al. [13] study the usability issues facing software developers using code analysers by evaluating one of the popular open-source static-code analysis tools. Ternauciuc and Vasiliu [12] tried to inventory the existing methods for testing and improving usability, with a particular focus on e-learning platforms.

In particular, very few studies have reported the application of the VB technique in OSS projects [4], [6]. In the Carrot2 OSS project, the original application was redesigned according to its target end users (data mining researchers). This project adopted the VB technique in order to generate ideas for designing the new interface [6]. According to Osiński and Weis [6], the technique was applied as prescribed by HCI. However, the VB technique reported by Terry et al. [4] was adapted for

adoption to develop a bit map graphics application. In the adapted technique, ideas were gathered using a wiki instead of at face-to-face meetings as established by HCI. Thanks to the wiki, anybody involved in the project could put forward his or her interface design ideas.

On the other hand, Castro [7] proposes a framework for integrating usability techniques into OSS developments. This framework is composed of a number of general adaptations in response to the adverse conditions for adopting usability techniques in OSS development projects. Castro [7] has identified the unfavourable conditions that give rise to adaptations. Unfavourable conditions are classified into three groups (families of adaptations). First, some usability techniques require an expert in usability (most OSS projects do not involve experts). Second, certain techniques require the participation of users or that several of them are physically gathered (OSS users are geographically distributed throughout the world). Finally, some techniques require several steps for their execution, a previous preparation or need some initial information (the work in the OSS community is completely voluntary and performed in the free time of its members) [7].

Although research examining usability in OSS has been published, there is no standardized procedure for determining how to adopt usability in OSS development. The first step in our research is to study how the OSS community uses usability techniques in their development projects. Castro's work proposes an integration framework that can incorporate most usability techniques in OSS developments [7]. It is important to clarify that this framework only proposes the general adaptations that must be made to the techniques. These adaptations depend on the requirements of the technique that cannot be satisfied by the way the OSS community works. Castro's research [7] was validated on only two OSS projects and for three usability techniques (user profiles, direct observation and post-test observation). Therefore Castro's proposal [7] requires further validation by adapting new usability techniques and participating in more OSS projects.

III. RESEARCH METHOD

In our research, the collected data nature is qualitative (texts, images, documents) [14]. We used a case study as the qualitative research method to validate our research [15]. From a case study, we learn about the experiences of applying usability techniques adapted to OSS projects. This research method is used when the phenomenon under investigation (in this case, the adoption of an adapted usability technique) is studied within its real setting (in this case, an OSS project). OSS projects are the perfect setting for the case study reported here because OSS communities are, according to several authors [16], [17], unfamiliar with usability techniques. Small project teams in particular have little information about what techniques are at their disposal for improving usability [1], [18].

This case study aims to determine whether the VB usability technique can be adapted for use in requirements engineering activities in an OSS project. There are several OSS project repositories. One of the most popular is SourceForge.net. This repository classifies OSS projects by categories. Since this technique is related to requirements engineering for product

concept development, we looked at projects with a low level of coding (that is, projects where key features were still being added) that were not overly ambitious and were at the very early development stages (alpha version) in order to select a suitable OSS project in which to adopt the selected usability technique. Considering the above, we selected the HistoryCal OSS project. Thanks to the characteristics of this project, we can adopt the VB usability technique in a requirements activity (product concept development). Therefore, the benefits of applying the technique will have a bigger impact on the development process and software system usability.

In this research, we first identified the obstacles to applying the VB technique in the HistoryCal OSS project. It is important to mention that the usability techniques cannot be applied directly in the OSS developments so it is necessary to make adaptations so that they can be incorporated in OSS. We then decided how to deal with the obstacles. Finally, we proposed the adaptations necessary to adopt the VB technique in the case at hand. We created web artefacts to improve communication with OSS community members and efficiently synchronize the necessary activities to apply the VB usability technique. The most important part of the data analysis process was to build a web artefact, since HCI does not recommend any specified document or particular tool for gathering information during the application of usability technique. An accurate description of the explanations given by users participating in the OSS project is essential for interpreting and laying the general foundations of our research. The web artefact used to test the feasibility of the proposed technique was a blog, because this is a technique commonly used by the OSS community [19].

We used blogs in the VB technique to gather information and collect sketches related to the UI of the application under study. Thanks to this web artefact, we were able to set up a virtual meeting point with OSS users who are geographically distributed all over the world. Using such web artefacts, we aimed to record user opinions about the selected OSS project UI. We selected a blog because it is a web artefact providing better control of the opinions expressed by users during our research (for example, the researcher controls the information or sketches submitted by users for transmission to the developers). Researchers should control the user-blog interaction in order to ensure that they focus exclusively on graphical interface design only and do not get sidetracked by topics unrelated to the research.

IV. PROPOSED SOLUTION

In this section, we describe the VB usability technique applied in an OSS project. Firstly, we describe the case study design. Secondly, we specify the characteristics of the selected OSS project. Thirdly, we describe the selected usability technique as prescribed by HCI. We then introduce the adaptations made to the VB technique for application in an OSS project. Finally, we report the results of applying this usability technique.

A. Case Study Design

Case study is a non-experimental design type, since we do not randomly assign the subjects, nor do we control the groups. In addition, subjects are observed in their real context.

Depending on the paradigm in which the researchers are located, they have decided to use a case study with a positivist approach. A positivistic case study within qualitative methods is particularly suitable for research in information systems. The research based on the positivist case study is characterized by: not manipulating the experimental units, the results are basically obtained from the capacity of integration that has the researcher in the case, the study should focus on current situations, the phenomenon is studied in its real environment, only one or a few entities (individuals, group, community) are examined, the phenomenon of interest is not isolated from its context and there is no controlled observation that involves manipulation of the experimental unit [20]. These characteristics are present in our research.

We describe the case study following the guidelines set out by Runeson and Host [15]. According to these guidelines, we divide our research into two parts: an exploratory part and a descriptive part. We start by looking at what happens in a real-world scenario and then we describe what happens when we apply the adapted techniques to improve application usability [15]. The aim is, to determine whether, thanks to the proposed adaptations, the VB technique can be adopted in the OSS HistoryCal project. Our case study is based on the following research questions: How to incorporate the VB technique in a real OSS project?

B. Context and technique execution

We selected HistoryCal as the OSS project in which to adopt VB. HistoryCal is a calculator designed to work with different world calendar schemes, calculating date ranges and ages based on these calendars. This application is written in C++, and the reported number of downloads from its website is one per week. As shown in “Fig. 1”, HistoryCal’s graphical UI has a lot of room for improvement. At the same time, it is a project of special interest since popular office suites do not usually include a date converter. HistoryCal has only one member, who plays the role of both developer and administrator. We selected a small OSS project, like HistoryCal, in order to control all aspects with a view to conducting a larger-scale study.

The VB technique is a tool for generating new ideas about a particular topic or problem [10]. A group of three to four people is the ideal number for applying this technique [10]. In this case, we got five OSS users. This is a large enough number of users to be able to apply the VB technique. However, we expected a higher participation rate because, according to the related literature, OSS application users are very cooperative [21]. We discuss this issue in the discussion of results.

As prescribed by HCI, the aim of the VB technique is to generate ideas for interface design [8]. This technique cannot be applied directly, that is, as is prescribed by HCI, in OSS development projects because the OSS community has, as discussed above, characteristics that are uncommon in the HCI world. In addition, OSS users are characterized mainly because they collaborate voluntarily, that is to say, without remuneration. As a result, recruiting and retaining new members is a critical success factor for an OSS project [22].

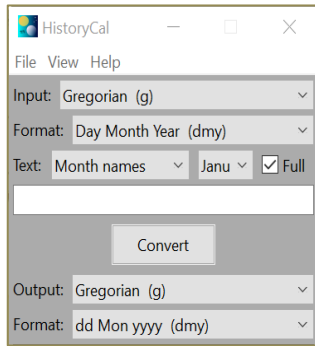


Figure 1. Original HistoryCal Interface

Even though usability techniques demand conditions that, as a rule, OSS projects cannot meet, the techniques can be adapted to bring them into line with the idiosyncrasy of the OSS world [1]–[4]. In the analysed literature [8]–[10], there are different procedures for applying the VB technique. Although they are all very similar, the procedure proposed by Wilson [9] is a good option for user-centred development processes because it gives a simple description of the steps for applying this technique. According to Wilson [9], this technique is composed of four steps. In the following, we describe these steps, the identified adverse conditions and adaptations proposed to tackle these adverse conditions. The first step is to arrange a meeting with the users to execute the VB technique. Alternative UI designs proposed by participants are explored and validated at small-scale meetings. This requires user participation at face-to-face meetings [9]. This is a condition that OSS projects cannot meet because of their particular features. To tackle this adverse condition, we suggest setting up a blog for users to post their comments on the UI. Due to certain developer and user language-related circumstances surrounding the selected OSS project, we created two blogs for this case study.

The second step is to gather the designs proposed by users (as mock-ups) based on which the UI is improved [9]. This step is problematic because the OSS community is distributed all over the world, and face-to-face meetings to build mock-ups are out of the question. Instead, we suggest using a blog where users can make comments and upload their designs. The third step is for users to evaluate the designs. To do this, they are required to attend face-to-face meetings [9]. Due again to the geographical location of users, OSS projects cannot meet this condition. On this ground, we suggest that the designs be posted on the blog at regular intervals for users to evaluate at their convenience. The designs were published an average of 2 per week during the month that the blog was active for this purpose. Finally, the fourth step is for a usability expert to design the selected user interface [9]. To overcome this obstacle (OSS project teams do not usually include a usability expert), we suggest that a HCI student under the supervision of mentor should stand in for the usability expert. It is important to mention that the mentor not only monitors the application of the technique, but also participates in the application of it. In addition, the HCI student's participation as a usability expert is competent thanks to the knowledge acquired during his studies.

Table I. summarizes the steps, identified adverse conditions and proposed adaptations for the VB technique [9]. There are mainly two adaptations. First, users participate online through web artefacts (e.g. blog). Second, we suggest that a HCI student or group of students under the supervision of a mentor replace the usability expert. In this case, the expert was replaced by a HCI student supervised by a mentor.

TABLE I. STEPS, ADVERSE CONDITIONS AND PROPOSED ADAPTATIONS

<i>Steps</i>	<i>Adverse conditions</i>	<i>Proposed adaptations</i>
1. Users meet to apply the technique	User participation at face-to-face meetings is required	Users participate posting their comments regarding the interface design in web artefacts (e.g., blog).
2. Users submit their design tips (in the form of mock-ups)	Users are located at different geographical sites.	Users provide feedback and attach their designs in their blog comments.
3. Users evaluate the designs	Users are not at the same geographical location.	The designs are published at regular intervals on the blog for evaluation by users.
4. An expert designs the final interface	A usability expert specializing in the technique is required	The expert is replaced by a HCI student or group of students supervised by a mentor.

V. RESULTS AND DISCUSSION

In this section, we describe the results of the case study that were taken into account to adopt the adapted usability technique (VB).

A. Results Analysis

As discussed earlier, we applied the adapted VB technique to the HistoryCal OSS project. We had difficulties recruiting real users to participate in technique application because the developer did not have a list of HistoryCal user emails. As we did not have access to this list of real users, we posted messages in the project forum and webpage inviting users to participate in the application of the VB technique. Finally, none of these real HistoryCal users replied to our invitation, and we decided to look at other user recruitment options (like social networks, email, LinkedIn and classmates). We then publicized the project using a mailing list with 150 LinkedIn contacts supplied by one of the researchers and 13 students of the HCI course taught as part of the Master in Information and Communication Technologies Research and Innovation at the School of Engineering, Autonomous University of Madrid. Finally, only five responses were received from all the users contacted (by email, LinkedIn and HCI students).

The VB technique was applied by creating two blogs on the WordPress platform: one in English¹ and the other in Spanish². We built two versions of the blog because not all users are fluent in English and the developer does not understand Spanish. When the users (all native Spanish speakers) submitted their design tips or comments by email to one of the authors of this paper, they were translated to English and published on both blogs. Then, the developer examined and responded to/commented on the tips or comments. All this feedback was published on the blog. Additionally, the

¹ <https://historycalhci.wordpress.com>

² <https://historycalhcies.wordpress.com>

developer responses/comments were translated and published on the Spanish blog. There is no risk of getting a low quality translation of these comments because they were validated by a bilingual member of the research team.

In the following, we summarize some responses given by five users and posted on the blog: two users highlighted that they had trouble understanding how the application worked and that an example should be added, such as the input date in the selected format and another user suggested adding a calendar as an input data picker control. The interface developed as result of applying this technique is shown in “Fig. 2”. This interface was created based on the inputs of users and the feedback received by the application developer.

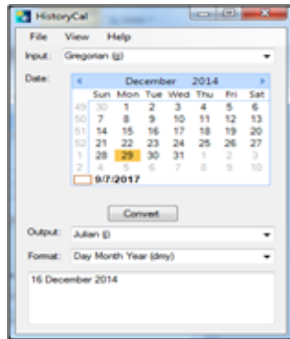


Figure 2. Interface design after applying the VB technique

The administrator was not very familiar with usability issues in the software development process. While he was acquainted with the concept of usability, his knowledge of usability techniques was limited. The project did not have a usability manager. Additionally, the administrator had not considered usability criteria in the design of the HistoryCal UI.

The results of applying the VB technique in the OSS HistoryCal project were sent by electronic mail to the project developer, who found our findings interesting. The project developer needed time to consider and build the findings into new versions of the HistoryCal project. On the other hand, several significant improvements were made to HistoryCal features following some of our recommendations. These improvements mainly consist of the inclusion of new calendars (i.e. Scottish, Julian, Gregorian). Another major improvement was the extension of the date format to comply with ISO standard: 8601.

B. Discussion Of Results

In this section, we discuss and answer the research question raised in this research: How to incorporate the VB technique in a real OSS project?

Usability techniques were built for other types of software development, that is, they were not designed bearing in mind the characteristics of the OSS development process. On this ground, the techniques need to be adapted. These adaptations are based on the adverse conditions for technique application. Some of the adverse conditions can be overcome using web artefacts (i.e., wikis) with which the OSS community is familiar. Thus, community members will be acquainted with the many of these adaptations, encouraging to some extent the application of the usability techniques. Within the OSS

community the blog is the most frequently used web artefact to facilitate open discussion and maintain communication through a distributed community of members [19]. Indeed, the proposed solution to use a blog has been effective in adapting the VB technique in the HistoryCal project: Note that we tested the feasibility of adopting usability techniques in OSS projects adapted using web artefacts (i.e., a blog) rather than the effectiveness of blog use as such. With regard to our proposal of substituting a HCI student or group of students under the supervision of a mentor for the usability expert, the expert was replaced in this case by a HCI student supervised by a mentor.

By applying the VB technique to the HistoryCal project, we were able to confirm that it is very hard to get a representative set of real end users, as discussed by Raza et al. in their empirical study [21]. However, our experience of participating in large projects (e.g., OpenOffice Writer) has revealed that it is very difficult to recruit real end users to participate in the application of usability techniques in OSS projects generally. We had banked on the OSS project leader keeping a list of e-mails of representative real end users, but this was not the case. The fact that OSS developers are unacquainted with their user profile is a problem that has already been detected in other papers [17], [23], [24]. One contribution of our research is to provide empirical evidence that this really is the case. The OSS user participation rate during technique application was low. We believe that there are two main reasons for this. Firstly, none of the users were had basic knowledge in graphic design. The technique requires users with notions of graphic design because they will be required to give tips for improving the UI, for example, by creating sketches (albeit with simple graphics programs like Paint) of UI improvements. Secondly, an OSS usability project is unlikely to be able to provide any sort of incentive to encourage user participation. Despite all these problems, however, the adaptation of the VB technique was reliable for adoption in the HistoryCal project, according to the theory when using the VB technique it does not take many users to get a reliable result (three to four people is the ideal number) [10].

The application of this technique would be better if users were allowed to submit, in either textual or graphic format via a web artefact (like a blog or wiki where user inputs are collected), their comments and designs at their leisure, that is, without passing through the project administrator filter. Note that the user proposals and comments were reviewed by Nick Matthews, the developer. Again, some sort of incentive, like, for example, recognition for having collaborated in usability technique application, should be included to engage more users and increase participation in usability projects in the field of OSS. It is important to mention that these improvements were not implemented during the time of the study case and these suggestions were established at the end of the research. Therefore, we consider as future work to apply the VB technique in another OSS project with similar characteristics and implementing the aforementioned improvements. The main limitation of our research is the number of case studies (only one). Another threat is that the participants recruited to apply VB are not representative of end users.

VI. CONCLUSIONS

The goal of this research was to evaluate the feasibility of adopting HCI usability techniques in OSS projects. Thanks to the technique adaptations, adoption was possible and we were able to account for some OSS development characteristics that pose an obstacle to the application of the techniques as per HCI recommendations. In particular, we adapted the VB usability technique for application in the HistoryCal OSS project.

The developer was receptive and interested in participating and receiving the results of the VB technique application to improve his software. After analysing and applying the usability technique, we found that there are adverse conditions that are an obstacle to technique application such as problems locating OSS users interested in applying the technique, geographical distribution and time differences and OSS community motivation.

This research sets out the procedure for applying the VB usability technique in OSS projects despite obstacles that are not exclusive to usability techniques: (i) lack of motivation causes a low user participation rate, (ii) OSS users are not usability experts, (iii) OSS users and developers are geographically distributed, (iv) there are language barriers between users and developers, and (v) OSS projects do not have HCI experts to help with the application of usability techniques. The results of this research are applicable to small projects similar to the one for which we volunteered (i.e. HistoryCal). This is because large OSS projects have different characteristics: (i) they are very active and popular projects with a large user base, (ii) bugs are reported in multiple sources, (iii) common problems are accessible in online infrastructures (e.g. email lists, forums, etc.), and (iv) their work practices and tests are documented. Being a qualitative study with these specific characteristics, an exact replication for other OSS project types would not be possible.

We believe that, in order to improve the integration of usability techniques in OSS projects, the OSS community has to start attaching importance to and raising awareness about the repercussions that the issues addressed by the HCI field have on software development. Additionally, as HCI techniques need to be adapted to overcome the adverse conditions for adoption in OSS development projects, the OSS community also has to broaden its view of software development in order to consider usability and not focus exclusively on feature development. In the future, we aim to conduct further case studies to adapt and apply other usability techniques in OSS projects. We will analyse other web artefacts that can be adapted to improve communication in OSS communities (for example, social networks) and gradually raise the awareness of OSS developers about the benefits of applying HCI usability techniques.

ACKNOWLEDGMENT

This research was funded by the SENESCYT-Ecuador, and Quevedo State Technical University. Also this research was funded by the Spanish Ministry of Education, Culture and Sports FLEXOR (TIN2014-52129-R) and TIN2014-60490-P

projects and the eMadrid-CM project (S2013/ICE-2715). Finally, this research received funding from the "DIUDA 22316 Project" of the University of Atacama.

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