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Systematic guidance on usability methods in user-centered software development

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ABSTRACT

Context: In order to ensure usability, it is necessary to schedule activities and methods to be applied throughout different stages of the development process. There exists a substantial number of usability methods to be applied in user-centered software development. However, the application of each usability method largely depends on specific constraints that should be closely considered. Even so, these constraints are not always known beforehand, remaining unidentified or under uncertainty at early stages of the project.

Objective: This paper presents an approach to automatically recommend 43 usability methods depending on the project's stage and constraints. Our approach deals with uncertainty to recommend usability methods regardless of the completeness of the information available, which makes it suitable for enhancing initial scheduling. Besides, a supporting tool intended to schedule and guide on usability methods is presented in order to systematize the recommendation mechanism.

Method: To validate our approach, we present two application scenarios demonstrating the suitability of the mechanism, including also an expert analysis to observe the recommendation appropriateness in terms of recommendation gap. Also, a user testing was accomplished to evaluate the usability of the approach with key users.

Results: A low recommendation gap was observed (< 2.5%) and, according to the results obtained in the user testing, high percentage values for usefulness (82.38%) and satisfaction (87.89%) were obtained. The user evaluation also reported high values concerning other dimensions such as ease of use (89.00%) and ease of learning (92.38%).

Conclusions: Results obtained helped answer main research questions, demonstrating that it is possible to create a mechanism to recommend usability methods according to a software project's constraints, even under uncertainty, and also affirm that it is possible to systemize the recommendations with a scheduling tool being satisfactory for key stakeholders, denoting acceptable levels of recommendation appropriateness, usefulness, and overall usability.

1. Introduction

Nowadays, usability and user-centered design have become essential issues in order to guarantee the quality and success of a software project. A software failing to include usability aspects may lead to a decrement of productivity and low acceptance from final users. In fact, the number of studies about these concerns has recently increased, as there are real difficulties on systematically meeting the users' usability expectations [1–3].

Although the development of computer applications has evolved to tackle usability concerns, most of the existing efforts are mainly oriented to provide acceptable usability measures at the evaluation stage, focusing on improving efficiency, effectiveness and user satisfaction in a summative way, thus overlooking a formative vision. In general, usability assurance should be principally arranged and considered from the early stages of a software project, and hence it should be scheduled accordingly, proposing specific activities and methods according to the project's characteristics and constrains, which is essential to guarantee the usability in every particular software to develop [4].

In order to provide with a reference framework, there exists the standard ISO/TR 16982 [5], which provides recommendation for 12 usability methods to be applied in software projects depending on a set of constraints. This helps project managers decide whether a usability method can be applied in a certain stage of the development process. However, this standard is specifically oriented to project managers, which makes it unsuitable for real software projects today involving

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agile and multidisciplinary development teams, where members take on different usability tasks. In addition, the standard is restricted to a small number of usability methods, also failing to provide detailed explanation about the application of the methods in each stage of the project. Additionally, the standard requires knowing all the constraints at the very beginning of the project, which can be difficult in practice as some parameters are initially unknown or difficult to be estimated early.

1.1. Research questions

Based on the drawbacks previously described, we define the following general questions to conduct our research:

- *[RQ1] Is it possible to create a mechanism to provide appropriate recommendation on usability methods according to specific project constraints, even under uncertainty?*
- *[RQ2] Is it possible to systematize such recommendation mechanism by means of a supporting tool to schedule and provide additional information about each usability method, being satisfactory for key stakeholders?*

1.2. Contribution

To overcome the aforementioned difficulties and give an answer to the proposed research questions, we present a mechanism improving the original ISO/TR 16982 framework. Our approach is based on providing recommendations for a much more extensive number of usability methods (a total of 43) to be applied in different stages of a software project, taking into account the suitability degree of each method according to the characteristics of the project. Additionally, our approach deals with uncertainty by providing recommendation even when a certain constraint is unknown, empowering project scheduling at early stages.

Furthermore, the proposed mechanism has been systematized through the implementation of a tool called STRUM (*Scheduling Tool for Recommending Usability Methods*). This tool enables development team to schedule software projects in terms of the usability methods to apply, and it allows team members to include comments about the methods applied for tracking usability along the project. This tool has been conceived to be easy to use and learn, so key stakeholders, and not only project managers, can use it easily in multidisciplinary project teams.

This paper is structured as follows. Section 2 presents the related work, describing current approaches and analyzing their suitability for the problem stated. Section 3 presents a description of the proposal, including the preliminary research, the developed mechanism, the supporting tool's main features, and two application scenarios to validate the approach. Section 4 includes the evaluation of the approach and the analysis of the results obtained. Finally, Section 5 reports on conclusions and future work.

2. Related work

Currently, there is a lack of existing approaches to systematize the recommendation of usability methods in order to be applied in software project. Most of the related work is principally based on documents and information repositories rather than systematized solutions [4–9].

To cite a few, approaches such as *Usability Body of Knowledge* [10] aim to gather information about publications, conferences and professional experience coming from usability experts. Detailed explanations about some usability methods, as well as useful definitions, can be found in this approach. In fact, one of the most relevant aspects of this approach is the number of methods described, also including brief and concise definitions. However, the information provided is somewhat heterogeneous. A similar approach is *Usability Net* [11], a European Union founded project that provides access to reference sources and application guidelines on usability methods. There are also other projects such as *Usability.gov* [12], founded by the U.S. Department of Health & Human Services. This approach provides high quality information about several usability methods and advice on application. Nevertheless, the number of described methods is low as well as their findability. Other approaches consist in explanations about usability methods based on practical experience. This is the case for *Nielsen Norman Group* [9] site, which is specialized on user experience and provides information about the eligibility of different usability methods. However, the explanation reported for each method is very limited, and it is difficult to distinguish the suitability of the different methods with respect to the constraints of a specific software project. Other works, such as the ones described in [4,13], provide an extensive description of usability methods to be included in software engineering activities. These works can be considered as an interesting repository of usability methods that are explained and categorized for integration in different project stages. However, these approaches lack an explicit reference to specific constraints that may limit the application of the provided usability methods according to the project's characteristics.

A more related approach is *Usability Planner* [14], which comprises a web tool that provides recommendation on usability methods driven by risk and cost for specific project stages. This tool allows the user to modify the selected constraints to see how they impact on the recommendations made. However, this approach does not provide significant scheduling facilities based on dates and the current project stage. Also, the stages and constrains utilized differ from the standard, which makes it difficult to be generalized for a broader application. Besides, the recommendation system does not deal with uncertainty based on unknown project characteristics. In addition, this approach utilizes a star rating system to display recommendation results, being complex to contextualize and providing no specific explanations of the usability methods for further usage and application during the project.

All in all, analyzed approaches have been considered as a useful reference for creating and documenting our approach, thus helping study the way usability methods can be better recommended according to the project's stages and constraints.

3. The proposal

As explained in previous sections, the aim of this contribution is to systematize the way of obtaining recommendation about usability methods, taking into account the characteristic of a software project, even when there is uncertainty on such characteristics.

To carry out this task, we have based on the standard ISO/TR 16892 to initially determine which usability methods would be more suitable to apply in a certain stage of a project depending on certain constraints. More specifically, the standard describes the most common constraints that may arise during the development of a project and how they affect to the utilization of a specific usability method. To deal with this information, the standard utilizes qualitative values ranging from “recommended” to “not recommended” to rate each usability method. These information is codified in tables, so to know the suitability of a usability method application it is necessary to check the value associated to it according the corresponding project's stage and constraints. As in previous works [14] we have scaled these tables using numeric values, thus creating an algorithm that makes use of these values to determine which method is suitable in each case.

This way, the mechanism that we propose to automatize the methods recommendation is based on the interpretation and statistical treatment of constraint tables, also considering uncertainty values to predict recommendation when some project constraints are undefined or unknown. The idea is that key stakeholders specify the project constraints, defined in ISO/TR 16892, by filling in a questionnaire. Additionally, we have increased the number of usability methods included in the standard from 12 to 43, so we have created a recommendation algorithm based on larger information and considering uncertainty. This way, the algorithm calculates a recommendation