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Using simulation to aid decision making in managing the usability evaluation process

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ABSTRACT

Context: This paper is developed in the context of Usability Engineering. More specifically, it focuses on the use of modelling and simulation to help decision-making in the scope of usability evaluation.
Objective: The main goal of this paper is to present UESim: a System Dynamics simulation model to help decision-making in the make-up of the usability evaluation team during the process of usability evaluation.
Method: To develop this research we followed four main research phases: (a) study identification, (b) study development, (c) running and observation and finally, (d) reflexion. In relation with these phases the paper describes the literature revision, the model building and validation, the model simulation and its results and finally the reflexion on it.
Results: We developed and validated a model to simulate the usability evaluation process. Through three different simulations we analysed the effects of different compositions of the evaluation team on the outcome of the evaluation. The simulation results show the utility of the model in the decision making of the usability evaluation process by changing the number and expertise of evaluators employed.
Conclusion: One of the main advantages of using such a simulation model is that it allows developers to observe the evolution of the key indicators of the evaluation process over time. UESim represents a customisable tool to help decision-making in the management of the usability evaluation process, since it makes it possible to analyse how the key process indicators are affected by the main management options of the Usability Evaluation Process.

1. Introduction

"Usability" is a quality attribute that assesses how easy a software user interface is to use. It constitutes a necessary precondition for good User Experience [1]. The term usability also refers to methods for improving ease-of-use during the design process. The usability inspection methods are the most-used and best-known methods for evaluating usability. Usability inspection is the generic term for a set of methods based on having evaluators inspect usability-related aspects of a user interface. A usability inspection is aimed at finding usability problems in a user interface, and then treating these problems to make recommendations for fixing the problems and improving the usability of the software product [2].

The number and expertise of the evaluators employed to judge usability are two essential factors that affect the results of an evaluation process. Knowing both the number and expertise of evaluators, it is possible to estimate the number of problems that will be found using the mathematical model presented by Nielsen and Landauer [3]. These two essential factors also affect the costs incurred by the developer in using the evaluation method. Therefore it is possible to estimate the final values for both the number of problems found, and cost. However, because the time available for developers to produce high-quality usable software is becoming a crucial limitation, time must be considered an additional key factor in any software development process.

Since the early 1990s several simulation models have been developed to respond to different questions related to the software process. However, none of these models has addressed issues related to usability and the user experience in software development.

In relation with this context, the present work considers the following general Research Questions:

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RQ1. Would it be possible to simulate the process of usability evaluation?
RQ2. Would the simulation of this process help decision-making in the composition of the usability evaluation team?

To be more specific, we considered if, by means of a simulation model, we could provide answers to questions such as "What if ...?" For example, what would happen if we mixed evaluators with different levels of experience in the evaluation team? How would this affect the execution of the process? What would the effect be on its cost and length? What would the ideal process configuration be for a given budget to achieve the optimum usability results? How long would all this take?

Dynamic modelling and simulation could be used by developers to make the usability evaluation process visible, and let them observe its behaviour over time; alternative choices and decisions could be simulated and their outcomes analysed before they are made and implemented. Therefore, in the context of usability evaluation, these techniques could greatly aid the decision-making process.

We therefore propose the application of modelling and simulation techniques to help decision-making in the process of usability evaluation. To illustrate the effectiveness of these techniques for this purpose, we present a simulation model, UESim, and three cases. UESim simulates the usability evaluation process using usability inspection methods. This simulation allows us to analyse the effect that alternative different compositions of the usability evaluation team would have on the outcome of the evaluation, namely on *time*, *cost* and *number of problems found*.

The paper has been structured by relating its sections to the phases of the research methodology used. In Section 2 we set out the phases of the research conducted, with a brief summary of the work undertaken in each, and referencing those sections of the paper where we present the outcomes of these steps.

2. Materials and methods

To develop this work we have followed an approach consisting of four main steps. These phases are common in different research methods, such as the Action Research method [4,5] or [6]. Table 1 shows both the outcomes obtained in each step of the study and the section of the paper in which they are presented. The phases we followed are as follows:

1. Study identification: This phase studies the different usability evaluation methods, centring specifically on inspection methods and how they are carried out, paying special attention to the factors that intervene. This leads us to formulate the conjectures on which we base our simulation model. In addition, in this phase we have also performed a literature review about the different applications of simulation modelling in the scope of software process.
2. Study development: Several different proposals have been set forth for developing simulation models, but they share a series of steps and recommendations [7–11]. We can summarise them into three main tasks: to build, validate and experiment.
3. Running and observation: To carry out this phase three different experiments have been performed in which we can observe the effects of different compositions of the evaluation team on the outcome of the evaluation process.
4. Reflexion: Finally, having analysed the results obtained following the model simulation process, we reflect on these along with the possible threats to validity. We conclude by contrasting our initial research questions.
5. To facilitate the task of building and validating UESim, we have used the Vensim® simulation environment [12]. To perform the survey used in the simulation validation phase we have used the online tool *encuestafacil* [13].

Table 1
Summary of research phases.

Research phase	Outcome	Paper section
1. Study identification	Process of usability evaluation description	Section 3
	Modelling and simulation literature revision	Section 4
2. Study development	Model design and Model building	Section 5
	Model validation	Section 6
3. Running and observation	Model simulation	Section 7
4. Reflexion	Discussion	Section 8
	Conclusion	Section 9

3. The process of usability evaluation

Usability inspection is the generic term for a set of methods based on having evaluators inspect usability-related aspects of a user interface. Each method has its particular objectives but they all have the general objective of identifying potential usability problems and providing design-relevant information. This involves employing several evaluators to examine the interface and judge its compliance with: the development of user tasks, recognised usability principles (namely heuristics), usability guidelines or standards.

Fig. 1 presents the general process of individual usability inspections formalised using BPMN (Business Process Modelling Notation). The process illustrated is based on Nielsen studies [2,14] and consists of the following phases:

- **Planning**: First, it is necessary to plan the evaluation session, choose appropriate evaluators, determine the criteria that will be adopted, and prepare the necessary material. In the planning phase the decisions about the make-up (number, expertise and dedication) of the evaluation team are made.
- **Training**: Before beginning the evaluation session itself, the evaluators usually need some training for the particular evaluation proposed. In this training, the person who manages the evaluation, normally named the "observer", will explain the method, the objectives of the evaluation, the criteria to follow, as well as the concepts and characteristics that the evaluators need to know about the domain of the system to be evaluated.
- **Evaluation session**: During the evaluation session, each individual evaluator will use the interface several times and identify the usability problems. It is very important that the evaluations be performed independently to prevent bias due to the evaluators influencing each other. Finally, each evaluator will provide a list of the usability problems found in relation to the inspection goals.
- **Analysis of results and drafting of the final report**: After all the evaluations have been completed, the problems found are analysed and grouped to obtain a single list of problems. Evaluation of the severity rating of the usability problems found can be made during the evaluation session; these ratings can be reflected in the individual reports to be analysed later, or once the problems have been grouped, in a final debriefing session with all the evaluators.

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