Usability Test on the Development of the SIMACAE System

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Abstract. One of the main problems with very large paper-based surveys is data input. The advantages and disadvantages of data-input methods from paper-based data collection instruments are outlined. To contribute to the improvement of data input processes, a data input system (SIMACAE) has been developed and a usability test was conducted in order to identify drawbacks and to improve its quality. Effectiveness, efficiency and satisfaction were the criteria used to assess the system's degree of usability. The test was composed of two stages with eight participants. The results of the first stage allowed making improvements to the system, and the second stage showed the degree of improvement from the users' point of view.

Keywords. Data input, interface, data collection instruments, input methods, usability.

1 Introduction

Nowadays, paper-based data collection instruments are still being used, despite the existence of modern techniques and tools for data collection such as phones, the Internet and mobile devices [1]. There are many positive aspects of paper-based instruments. For example, as a more intuitive approach for data collection, they allow more flexibility than other kinds of instruments and scales, because participants work directly with the instruments, and they can be completed anywhere, at any time, and in any order. They have a minimum degree of risk due to technical failures [2]. However, there are also negative aspects such as printing costs, tedious interviews due to large instruments, the need for a legible handwriting, high data processing costs. They are complex, slow and more prone to errors due to hand entry [3].

Although there are many data input methods such as Optical Mark Reader (OMR), Optical Character Recognition (OCR), Intelligent Character Recognition (ICR) and Bar Recognition (BR), manual entry is by far the method that requires simpler

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software and hardware, the least amount of technical knowledge, and it is cheaper than other hi-tech methods. However, this method requires a very large staff. Tasks require many man hours to be completed. It requires high quality control procedures due to potential errors during data input, and staff must be motivated due to repetitive nature of their work [5]. All in all, the manual entry method is still used a lot in statistical software such as SPS, STATA and SAS [6]. They provide a spreadsheet to carry out the manual data entry; however, it is prone to making errors, especially, when data with a great number of variables have to be input [7]. Forms are tools designed to make data input easy and also decrease the number of errors with fields that can be validated and adapted to capture different data types such as numerical and string data. Furthermore, they dispose of the spreadsheet format. There are specialized software like CSPro [8] and Limesurvey [9] for interface design (forms) and data input, however, these kinds of software requires intensive training and a big investment. Therefore, the "*Sistema para el Manejo y Captura de Encuestas*" (SIMACAE) has been developed in order to improve the process of data input, so that it is neither as boring as the spreadsheet format nor as expensive as the use of complex forms.

2 Related Works

According to [10, 11], usability is an attribute of quality that assesses the ease with which interfaces can be used. Usability is not exclusively for computational elements. It can be applied to any kind of interface and englobe series of methods and metrics in order to make a system easier to use and learn. Therefore it should be included thorough out the process of software development in order to assure user's effectiveness, efficiency and satisfaction of the product [12, 13]. Nowadays, usability tests are applied to information systems of many kinds such as web-based, mobile, and desktop systems, because usability tests reduce development, maintenance and training expenses [14]. For example, by using low, medium and high fidelity prototypes [12], Romano et al. have shown the value of iterative usability tests in improving the usability of the webpage (U. S. Census Bureau's American FactFinder) during its development process [17]. Also, Bill and Morris point out that usability tests are more effective when they are carried out in the design process and that a way to encourage their use is by means of low, medium and high fidelity prototypes [18]. Usability tests were conducted by Prata, Mont' and Cuaresma to assess the searching, buying and evaluation process of applications in the two main stores in Brazil, Google Play Store and iPhone App Store, for mobile devices. Their results helped assess the Brazilian users' general opinions and their attitudes toward each system [19]. Hu, Yen and Guan emphasize the importance and usefulness of the data collection method "think-aloud" by using usability tests in order to find out the feeling of the users about difficulties faced during the development of each task during the tests [20].

3 Development of the System

SIMACAE was developed to fulfill the requirements of the "*Encuesta Nacional Sobre Movilidad y Estratificación Social en Zonas Rurales y de Escasa Urbanización*" (ENAMES-ZOREU), which is part of 91584 project funded by SEDESOL-CONACYT. The ENAMES-ZOREU is a paper-based survey which includes 10 sections: A, Family; B, Infrastructure and dwelling; C, Job; D, Migration; E, Education; F, Health; G. Culture; H, Social Capital; I, Social Welfare; J, Opinion, plus title page information such as folio, date, time, and place. The survey contains 23 pages and more than 900 choices and fields for registering data. The survey was used to interview approximately 4,000 people in the 11 poorest states of Mexico. Clearly, a manual input process in a spreadsheet format would be tedious and prone to errors.

SIMACAE has three main modules: question module, data input module and queries module. The question module allows manipulating information about the survey, such as sections, sub-sections, questions, multiple choice questions and instructions. The data input module automatically shows questions one by one and their possible answers. In addition, this module stores people's answers, which can be numerical (ages and salaries), open answers (names, opinions, places and addresses), and multiple choice answers. Also, the queries module allows getting specific information by means of cross references such as incomes, ages and states. Such information can be exported to STATA or Excel. In this paper we specifically focus on the data input module.

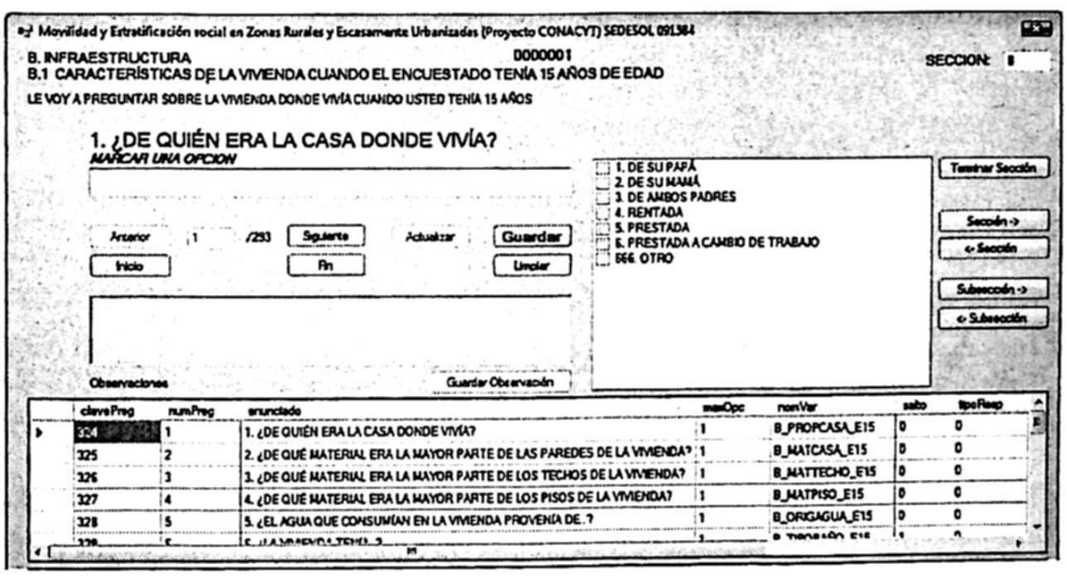

Fig. 1. Prototype of the Data input interface.

The data input interface includes specific information about the survey, such as folio, sections, sub-sections, questions and answer choices. The interface only has a text box to capture all kinds of answers (numerical, open and multiple choice). Some buttons were added to move between questions, sections and subsections, and other buttons allow saving, modifying and dropping a selected answer. A text box for

commentaries in each section of the survey was also added. A table located at the bottom of the interface shows the questions which belong to the sub-section of the question displayed at the moment. A high fidelity prototype of SIMACAE is shown in Figure 1.

4 Usability test

The usability test reported in this section is specifically for the data input module and the results were obtained by using a high fidelity prototype. Observation, the Think Aloud method and the System Usability Scale questionnaire were the research techniques used to carry out the data collection [16, 21].

Such test was done in two stages, 4 participants for each stage, in total 8 participants (3 beginners, 3 standard and 2 experts). According to Nielsen [11], the number of participants required in a usability study should be 5, because 5 participants indentify as many usability problems as with many more test participants. Also, a pilot test was done with an additional participant.

The goals of the usability test are as follows: to identify whether labels clearly describe what users have to give as input; to identify whether buttons clearly describe what users have to do; to identify whether users are able to input data, save, search, modify and delete an answer in the system; and to identify if users are able to navigate between sections thorough the search box and the buttons on the interface.

Effectiveness, efficiency and satisfaction were the criteria used to assess the system's degree of usability. No matter how long it takes, effectiveness is understood as the measurement in which the user finishes the asked tasks using the system. Efficiency is understood as the speediness and easiness in which the user completes the proposed tasks with the least number of mistakes. Satisfaction is understood as the general preference and likability for the system.

The tasks for the participants were designed and selected to perform the most important activities allowed by the data input module:

- Task 1. From the survey input page 1 in the title page section.
- Task 2. From the survey, section A, page 2, input sub-sections A1, A2 and A3.
- Task 3. From the survey, section B, page 9, input sub-section B1.
- Task 4. From the survey, section F, page 18, input the whole page.
- Task 5. From the survey, section G, page 19, input the whole page.
- Task 6. Section F, input the following commentary "Health section keeps information about diseases that the participant has had".
- Task 7. Subsection A3, question 12, update the father's job to "work cleaning" with the code 8124019.
- Task 8. Search for the survey '0110' and exchange the gender's participant, increase one more month to the birthday and increase in one hour to the ending visit.

4.1 Results of effectiveness

Table 1 shows the results of effectiveness from the two stages of the usability test. A successful task is one which is finished by the participant as it was designed to be carried out throughout the system.

Table 1. Results of effectiveness.

	Stage 1		Stage 2	
Task	**Successful tasks**	**Rate of effectiveness**	**Successful tasks**	**Rate of effectiveness**
1	4/4	100%	4/4	100%
2	¼	25%	3/4	75%
3	¾	75%	4/4	100%
4	¾	75%	4/4	100%
5	4/4	100%	4/4	100%
6	2/4	50%	4/4	100%
7	4/4	100%	4/4	100%
8	2/4	50%	4/4	100%

Table 1 shows that in stage 1 of the usability test. The participants couldn't finish all attempted tasks which were by the facilitator. The problems were linked to the ambiguous labels which did not represent clear information about what buttons and text boxes do. The participants hesitated or did not carry out correctly the task involved in saving, modifying, searching and dropping an answer. Participants also had some difficulties while moving between questions because operating the buttons was not completely intuitive. Most of the participants had difficulties while inputting commentaries for a section because the text box was not activated. Some participants were confused at the moment of saving an answer, they thought that pushing the key "Intro" would automatically save the answer. They also had difficulties navigating between sections. The search text box on the interface is a useful tool for navigating between sections but it was almost never used. Participants felt more comfortable using the set of buttons to move between sections, even though it was slower.

Tabla 2. Results of efectiveness.

	Participants	**Number of tasks**	**Successful tasks**	**Effectiveness**
Stage 1	4	32	23	72%
Stage 2	4	32	31	97%

The results of the usability test for Stage 2 clearly show improvement in the system and most of the difficulties indentified in stage 1 have been solved (see Table 2). The rate of effectiveness from the stage 1 to stage 2 is statistically significant, from 72% to 97 %.

4.2 Results of efficiency

A system is efficient if participants carry out the proposed tasks in a successful way as quickly as possible and the least number of mistakes. Table 3 shows the mean time invested by the participants to complete the proposed tasks in the two stages. The mean time from stage 1 is reduced in stage 2 because of the improvements to the system. Perhaps the time reduction is only for a few seconds as it was in task 8. However, if the task has to be done thousands of times, then this is a significant reduction of time.

Table 3. Results of efficiency.

	Stage 1	Stage 2
Task	Mean time	Mean time
1	05 min. 41 seg.	03 min. 41 seg.
2	08 min. 12 seg.	07 min. 17 seg.
3	03 min. 59 seg.	02 min. 16 seg.
4	05 min. 15 seg.	04 min. 19 seg.
5	02 min. 58 seg.	02 min. 56 seg.
6	01 min. 59 seg.	01 min. 36 seg.
7	01 min. 56 seg.	01 min. 28 seg.
8	01 min. 33 seg.	00 min. 29 seg.

4.3 Results of satisfaction

Results of satisfaction represent what participants liked the most and the least about the SIMACAE during stage 1 of the test. Also, some recommendations are given by the participants to improve the system. Their points of view are given in the following list:

1. What they like the least. The system is complex. Some instructions are not visible. Data input requires a lot of concentration. At the beginning, data input is tedious. Some parts are not understandable. The interface has a small and non-attractive design. Some elements of the interface may cause confusion. The interface agglomerates a lot of information and many answers can be stored at once.
2. What they like the most. Mistakes can be corrected. The display of questions is done automatically. The mobility between questions is dynamic. The functionality of the interface is good. The interface is practical. The system is good, easy to use, efficient, and quick. The interface is intuitive.

4.4 Recommendations to improve the system

Some of the recommendations were to add icons to the buttons, replace labels in order to increase clarity of actions, improve functionality of the interface in order to move between sections, sub-sections and questions; make error messages clearer by explaining its solutions, keep the text box for comments activated, and finally, hide the table which contains questions of a sub-section because if creates confusion.

Fig. 2. Interface of the data input module after improvements of the usability test.

4.5 Latest version of the SIMACAE data input module

Figure 2 shows the latest version of the improved data input interface of the SIMACAE. It was modified according to the difficulties observed throughout the test and recommendations suggested by the participants were set up to achieve a clearer design which is better organized whit a more intuitive interface.

5 Conclusions and future work

A system was developed to handle paper-based instruments of data collection which is simple and easy to use. So far, it has been tested with a social mobility survey, but it can be used with any other instrument of data collection allowing the addition of sections and sub-sections, open questions and multiple choice questions. Moreover, it does not require changes on the interface. Additionally, the system can be used not only for paper-based instruments, but for phone interviews too. Finally, usability test results allowed significant improvement of the SIMACAE data input module by solving the indentified problems and participants' recommendations.

In the future we plan to adapt the data capture module to be installed on Personal Digital Assistants, which will make data processing and analysis much faster and to enable the system to work throughout the internet.

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