Use of Usability Evaluation Methods in France: The Reality in Professional Practices

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Abstract — **The aim of this study is first, to have an overview of current professional practices related to the use of usability evaluation and conception methods (user testing, interview, etc.) of a human-machine interface (HMI); and then, to determine the factors influencing their use. For this purpose, we have developed an online survey aimed at professionals sensitive to usability issues. The survey was open for the last quarter of 2012; the final sample size was 98 professionals. The relevance of this questionnaire is to identify the level of knowledge and use for each usability method. Our study highlighted the following results: while some methods are frequently used, such as user testing; others are unknown to professionals, such as automated evaluation. Certain methods are known to professionals but used anecdotally, such as card sorting. The study also reveals some factors influencing how the use of each method is done. The results show that the use of each method depends on the professional's expertise, academic background and the sector in which they work. In a longer term, we want to conduct interviews with professionals to know about their practices in more detail. One of our final objectives is to provide an aid system to help designers to choose the best association of usability methods according to all of the contextual elements.**

Keywords - usability evaluation methods; user-centered design; professional practices.

I. INTRODUCTION

A. Usability & User-Centered Design

The continuous development of new technologies and the emergence of new uses lead us to focus more and more attentively on human-environment interaction [1]. Particular attention must be given to the design and evaluation of technological tools, in order for them to match to user needs and provide users with pleasure, satisfaction and performance. The concept of usability makes sense and appears to be inevitable in the consideration of human factors in the human-machine interaction [2], [3]. Usability is defined by ISO 9241-11 [4] as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". More broadly, usability refers to "learning agility" and the "ease of use" of a product or service. Current awareness of the difficulties of use emphasizes the need to make products easy to use: taking into account usability in tool development allows for providing products adapted to users. Usability is closely linked to user-centered design (UCD), an approach that considers the user and the task he has to do as the center of the design process [5], [6]. There are specific ISO standards dealing with UCD [7], [8] which emphasizes the advantages of this approach: "The benefits of a human-centered approach include increased operator satisfaction and productivity, better work quality, cost reductions for training and technical assistance and improving the well-being and health of the user". The UCD is divided into different phases, which are carried out in collaboration with end-users, involved in each step. These phases are interdependent and performed in an iterative manner (refer Fig. 1).

B. Usability Evaluation Methods

There are many methods and tools available for the implementation of a UCD approach. ISO 16982 [9] presents the main usability methods and determines two categories:

1) Methods involving the direct participation of end users:

- **User Testing**: This method consists of asking users to interact with an interface. This interaction can be free (the subject will not have specific goals) or scripted (the subject has to perform a specific task) [10], [11].
- **Card Sorting**: Card sorting consists of presenting to users a deck of "cards". They are asked to group them according to different categories that seem relevant for them. They are finally asked to name these categories [12].
- **Interviews**: The user can be subjected to different types of interviews: directing (the questions and their order are imposed on the user); semi-structured (the themes that the specialist wishes to address are defined, but the user is free to answer in the place of his choice and have the opportunity to introduce non-defined topics); non-directional: the main theme is imposed but the user is free to say what he wants in the order he wants [13].

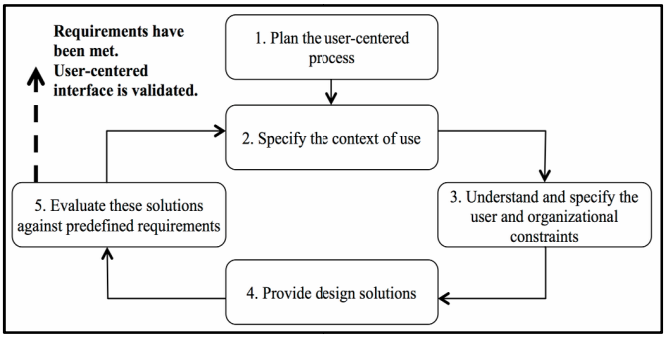

Figure 1. Interdependence of different UCD activities

- **Questionnaire**: Some standardized usability measurement questionnaires are available: WAMMI (Website Analysis Measurement Inventory), SUMI (Usability Measurement Inventory Software), etc. [14], [15].
- **Creativity Methods**: These methods are used for bringing out new ideas, new uses, etc. (brainstorming, use of associations of ideas, etc.) [16], [17].
- **Critical Incident**: A qualitative interview technique that aims to study significant events (incidents, processes or issues) identified by the person involved in these events. The user explains how these incidents are managed and what the consequences are. The objective is to better understand the incident from the point of view of the user, taking into account cognitive, affective and behavioral elements [18], [19].
- **Observation**: The user is in a natural situation (work or otherwise) and performs some usual activities. The specialist is present to observe these activities [20], [21].

2) Methods not involving the participation of end users:

- **Heuristic Analysis:** This method involves the inspection of an interface according to specific criteria in order to detect any positive/negative aspects in terms of usability. There are several available heuristics analyses: Heuristics Nielsen, The golden rules of Shneiderman, etc. [22], [23].
- **Cognitive Walkthrough**: This task-centered method consists in simulating user cognitive behavior. It occurs in 3 phases: 1) the definition of a scenario of use and the aims to achieve; 2) the evaluation phase in which questions are asked for each action performed; 3) the identification of usability problems from the analysis of the answers given to questions [24].
- **Personas**: This method consists of analyzing the profiles and needs of the target users in order to create fictional characters to which designers can refer when designing an interface [25], [26].
- **Automated Evaluation**: This method is based on algorithms devoted to automatic analysis of the usability criteria: automatic analysis of complex perceptual screens or of the quality of presentation, etc. [26], [27].
- **Evaluation by Expertise**: This method is to call in an expert, who thanks to his knowledge, skills and experience can identify the usability problems most frequently observed [26], [28].
- **Approaches Based on Models**: They rely on theoretical models of the user's behavior, or on formal models (Keystroke Level Model, GOMS rules, etc.), focused on the task to develop working hypotheses on the user's behavior in any given situation [31], [32].
- **Analysis of Documents and Report**: Document-based analysis allows an usability specialist to make his own judgment. These documents must be reliable and provided by a variety of sources (standards, expert reports, etc.) [28].
- **Creativity Methods:** Already defined above.

It has already been shown that the organizational, physical and environmental constraints of project have an impact on the choice of method [9]. It appears that a project conducted under important time and material constraints will tend to neglect (or remove) the direct involvement of users. However, this choice has real consequences for the project: it cannot claim to have a high standard in terms of quality, skill development and adaptability to different user profiles, etc. Some authors make recommendations concerning the use of these methods. According to Baccino, Bellino and Colombi [30], the use of different evaluation techniques depends on five main criteria: *type of data* (qualitative, which require interpretation; or quantitative (numerical data) which are easily usable for statistical tests); *time* (real: data reflect behavior when it occurs; or delayed: data are collected after the tests); *participants* (developers, ergonomists, users); *object*, in terms of perception (appreciation of the aesthetics of the interface) and understanding (cognitive processes involved); *cost* (low, medium and high). For instance, user testing provides access to quantitative and qualitative data in real time and offline; it is necessary to have access to end users to perform the test; the test may be conducted during the development and evaluation phase; the user is tested on his perception and understanding of the interface; the cost may be low, medium or high depending on the test. The heuristic evaluation produces qualitative data in delayed time. It is carried out by the ergonomist during phases of design and development. The cost is low.

C. Objectives

In France, despite the existence of theoretical framework for the use of usability evaluation methods, such as standards and recommendations, we do not have good visibility of the use made by professionals of all usability methods. Thus, we have developed a questionnaire aimed at evaluating the professionals aware of interface usability issues: designers with a user-centered approach, ergonomists, consultants in the field of interface evaluation, engineers in cognitics, engineers, researchers or teacher-researchers in the HMI field, HMI ergonomics, etc. The objective of our work is to identify professional practices in terms of the use of usability evaluation methods and to determine the factors influencing their use. This questionnaire will allow us to have an overview or tendency of the main profiles. This work constitutes the first step of our approach. After that, we wish to conduct interviews with people who responded to the questionnaire, in order to know their habits in more detail. One of our final objectives is to provide a support system to help designers choose the better association of usability methods according to all the contextual elements (environment, end-users' characteristics, project constraints, etc.). It is important for us to propose a support system based on current uses, to ensure it better meets the needs and expectations of users.

II. Methods: Development of the Questionnaire

A. Justification for the Choice of the Questionnaire Method

We chose the questionnaire method for this study because it is a proven method and particularly suitable for the study of habits in a professional context. This method should allow us to reach all targeted people, and report on their diversity both in terms of their training and their professional practices [31]. It is a method of collecting data, to comprehensively reach a group of subjects whose "profession includes a diverse range of tasks, carried out in multiple places and in variable conditions" [32]. Thus, the questionnaire allows for the collection of data from a large number of people, at relatively low cost. Furthermore, it also contributes to reliability, thanks to its uniformity (no variant in question, no possibility to influence the responses).

The relevance of this questionnaire is to identify the level of knowledge and use for each method. This questionnaire will allow us to draw up a panorama of professional practices. It is only when we conduct interviews that we could have access to information depending on the projects, such as: when they have used this method; different techniques according to the project stage; the influence of budget, etc.

B. Description of the Questionnaire

We have developed a questionnaire including 87 questions as following:

1) The first part describes methods for evaluating the usability of an interface. They are grouped into two categories, according to the definition of the ISO standard [4]: on the one hand, methods that require the participation of end-users: user testing, card sorting, interviews, questionnaires, creativity methods, critical incidents, and observation; on the other hand, methods that do not involve end-users: heuristic analysis, cognitive walkthrough, personas, automated assessment, assessment by expertise, approaches based on models, analysis of documents, creativity methods. For each method, the participant must indicate if he knows the method, if he uses it and in what context, and how he has heard about this method. We do not distinguish here “if he used” or “if he used it at this time” because the usage depends on the projects. We are interested here in the “general use” of a method.

2) A second part identifies the participant's profile: professional occupation; the sector in which the participant works and for how long; academic training and years of graduation; personal characteristics (sex, age).

C. Method of Communication

Sphinx software was used in order to produce and deliver our questionnaire to participants. The time taken to complete the questionnaire was approximately 15 minutes. The study was conducted over a 2-month period, during the last quarter of 2012.

D. Recruitment of Participants

We used social network and mailing lists specialized in ergonomics of Human-Machine Interaction to communicate with and recruit professionals (ErgoIHM, ergolist, some specialized groups from LinkedIn, etc.).

III. Results

A. Description of the Sample Group

The initial sample consists of 139 participants, including 7 who do not use methods for evaluating usability. Among the 132 participants using these methods, 106 have access to users. Among our global study of the professional practices of all usability methods (those involving end-users and those not involving them), we choose to present here only the results from professionals who used usability methods and have access to end-users. From the 106 of them left, we removed responses from 8 participants who did not answer all questions. The final sample consists of 98 participants; it is representative of the professionals sensitive to usability issues, it does not have to be wider for this study. In this final sample, 46 professionals are men (47%) and 52 women (53%). The average age of our sample is 33 years (from 22 years to 65 years). On average, professionals graduated 7 years ago. Among these professionals, 73% have received bachelor degrees. Half of them are consultants, entrepreneur or ergonomist, 20% are teacher-researchers or PhD students. They mainly represent the fields of consulting, ergonomics and service (27%) and the fields of software, web, video games and telecommunications (23%) (refer Table I).

B. Statistical Analysis

The aim of this study is to have an overview of professional practices concerning the use of interface usability evaluation methods. To obtain this objective, we first perform a factorial analysis to identify the profiles of professionals compared with the use of each method. Then, we determine whether there is a relationship between the variables that show the highest weight in the factor analysis. Finally, we evaluate the knowledge and use of each method by professionals.

TABLE I. DESCRIPTION OF THE ACADEMIC TRAINING, CURRENT OCCUPATION AND TYPE OF BUSINESS OF THE PARTICIPANT SAMPLE

Academic Training	Engineering school	24%
	Graduate degree	3%
	Bachelor degree	73%
Current Occupation	Project Leader, Responsible, Director	11%
	Consultant, Auto-Entrepreneur, Ergonomist	49%
	Teacher and Researcher, PhD Student	20%
	Computer Scientist, Engineer	13%
	Others (looking for a job, etc.)	7%
Type of Business	Sector 1- Bank, Insurance, Mutual, Medical, Health	15%
	Sector 2 - Consulting, Ergonomics, the Tertiary (Services) Sector	27%
	Sector 3 - Software, Web, Video Games, Telecoms	23%
	Sector 4 - University, Research Organization	17%
	Sector 5 - Transport, Industry, Energy	6%
	Others (Agriculture, etc.)	12%

1) Identification of professional profiles

a) Coding of data

In order to make our statistical analysis as thorough as possible, we used a response code for the year of the last degree obtained.

The year of the last degree obtained is transformed into a variable that can take two values. The median is 5 years. The two values are: *Low experience*, corresponding to low experience, i.e. the participant obtained their last degree less than 5 years ago; *Important experience* which corresponds to important professional experience, i.e. the participant obtained their last degree five years ago or more.

The analysis (Factorial Multiple Correspondence Analysis) is conducted using the following 19 nominal variables:

- Each individual method: user testing, card sorting, interviews, questionnaires, creativity method with users, critical incidents, observation, heuristic analysis, cognitive walkthrough, persona, automated evaluation, evaluation by expertise, approaches based on models, analysis of documents, creativity without users;
- For each method, we identify if it is known and used by the professionals, if it is only known but not used by the professionals; or if it is not known.

The identification variable:

- Sex with 2 categories: Man, Women;
- Academic background with 3 categories: graduate degree, bachelor's degree, engineering school;
- Type of business (sector) with 6 categories: sector 1- bank, insurance, health insurance, medical, healthcare; sector 2- consulting, ergonomics, the tertiary (services) sector; sector 3- software, web, video games, telecoms; sector 4- university, research organizations; sector 5- transport, industry, energy; sector 6- Others;
- Experience with 3 categories: low experience, important experience and unspecified experience.

b) Results of the MCA

The MCA results demonstrate that the principal plan accounts on its own for 56,9 % of the total variance (axis 1: 49.2% and axis 2: 7.7%). This is why we limit our interpretation of the first two axes. For each axis we only took into account the variables that have a significant contribution to the construction of the considered axis (5% threshold).

Axis 1 (49.2% of total variance)

The variables that have the largest contribution to axis 1 are:

- For the identification variable: "sector" (type of business) followed by "experience";
- All methods except observation (i.e. user testing, card sorting, interviews, questionnaire, creativity methods (with users), critical incident, heuristic analysis, cognitive walkthrough, persona, automated evaluation, evaluation by expertise, approach based on models, analysis of document, creativity methods without users).

Two main profiles have been highlighted:

1) Professionals working for several years (last degree obtained five or more years ago) in sector 2 (consulting, ergonomics, services) and sector 3 (software, web, video games, telecoms), use 11 of the 15 proposed methods (methods involving end-users or not). Two methods are not used in these sectors: critical incidents and automated evaluations.
2) In sectors 1 (bank, insurance, health insurance, medical, healthcare) and 4 (university and research organizations), the methods are not used, and are even unknown to young professionals (last degree obtained less than 5 years ago). 13 methods are unknown; two methods (user testing, heuristic analysis) are known but not used.

Axis 2 (7.7% of total variance)

The variables that have the largest contribution to axis 2 are:

- For the identification variable: "academic background", followed by "experience" and finally "sector" (type of business).
- For methods: card sorting, interview, questionnaire, critical incident, observation, heuristic analysis, cognitive walkthrough, persona, approaches based on models, analysis of document.

Two main profiles have been highlighted:

1) Professionals from an engineering background, who have been working in the field of research (sector 4: university, research organization) for less than 5 years:
   - Use significantly the interview method;
   - Know but do not use the following methods: card sorting, questionnaire, cognitive walkthrough, persona, theoretical model, analysis of documents;
   - Do not know the methods of critical incident and observation.
2) The professionals with bachelor's or graduate degrees, with important experience (last degree obtained 5 years ago or more):
   - Use significantly the following methods: questionnaire, critical incident, persona and analysis of document;
   - Do not know the following methods: interviews, card sorting, heuristic analysis, cognitive walkthrough and theoretical models.

Our preliminary results clearly show that the use of usability methods depends on experience, sector and academic training. People with important experience working in sector 2 (consulting, ergonomics, tertiary sector) and sector 3 (software, web videos games and telecoms) use usability evaluation methods (methods involving end-users or not). Nonetheless, novices who work in sector 1 (bank, insurance, mutual, medical, health) and sector 4 (university, research organization) do not use any methods and only know the methods of user testing and heuristic analysis. People from engineer training with low experience have a good overall knowledge of all the methods, but they do not use them.

However, professionals with a bachelor's or graduate degree have an overall lack of knowledge of methods.

2) Relationship between the different variables

Analysis of these factors allows us to determine the profiles of professionals compared to the use of each method. Then, we wished to determine if there were dependencies between the three identification variables with significant weight: expertise, academic training and type of business (sector). For this, we use a Khi2 test to cross (2*2) these three variables:

- The results of the Khi2 show independence between the "experience" and "academic training" variables (Khi2=8.472; p-value=0.076).
- The results of the Khi2 show independence between the "experience" and "sector" variables (Khi2=15.140; p-value=0.127).
- The results of the Khi2 show independence between the "academic training" and "sector" variables (Khi2=3.394; p-value=0.971).

3) Knowledge and use of methods

Henceforth, we want to identify to what extent professionals know and use each method. Fig. 2 shows, for each method, the percentage of professionals who know but do not use the method (K); those who know and use the method (KU); and those who do not know the method (NK). There clearly appears to be dependence between the knowledge and use level of methods and the type of method, for the methods involving end users (p-value <0.00001, Khi² = 162.71) or methods not involving end-users (p-value <0.0001, Khi² =197.22).

Concerning methods involving end users:

- The most widely used methods are user testing, observation and interview, which are respectively used by 93%, 81% and 78% of professionals.
- The most unrecognized methods are critical incidents (31%) and questionnaires (20%).

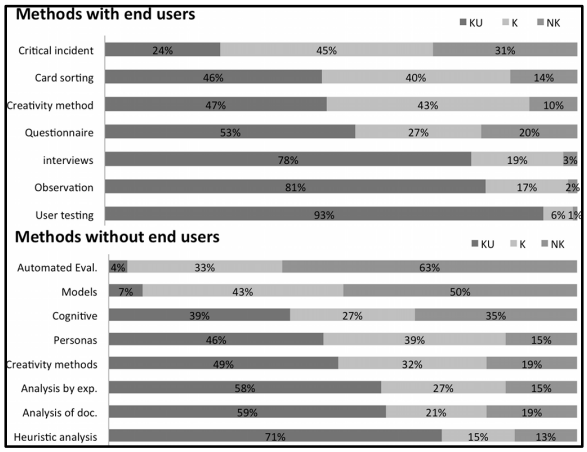

Figure 1. Percentage of professionals who know but do not use; who use; or not know each method

Concerning methods not involving end users:

- The most widely used methods are heuristic analysis and analysis of documents, used respectively by 71% and 59% of professionals.
- The best known but not used method is the approach based on theoretical models, 43% of professionals know this method.
- The most unrecognized methods are automated evaluation and approach based on theoretical models, 63% of professionals do not know about automated evaluation and 50% about approach based on theoretical models.

We note that methods involving end users are more used by professionals than methods not involving end-users, which is rather positive in the context of the implementation of a UCD approach.

IV. Discussion

The aim of this study is first to have an overview of current professional practices related to the use of usability evaluations and conception methods (questionnaire, user testing, etc.) of an HMI; and then, to determine the factors influencing their use.

In the literature, some authors such as Baccino, Bellino and Colombi [30] had already shown that the use of methods depended on factors such as the type of data, time, participant, phase of design, cost, etc. In this study, we widen the search field by analyzing the influence of data such as academic training of professionals, their expertise, the industry in which they work and their sex. The results of this study have shown that the use of methods (involving end-users or not) depends mainly on the first three variables mentioned above. It appears that it was only after a number of years working that people become aware of the existence of UCD methods. These methods seem to be ignored and not used by young professionals at the beginning of their careers. Coutaz and Balbo [33] had already demonstrated that the use of these methods depended in part on the level of expertise of individuals. Similarly, the results show that professionals from engineering school have a good overall knowledge of usability methods but do not use them much. In parallel, the professionals who have a bachelor's or graduate degree have generally poor knowledge of these methods. This information also appears in the study of Coutaz and Balbo [33], who emphasized that the use of methods depends on a minimum level of skills. Both of these results raise the question of the relevance of training content, particularly for bachelor's or graduate training. It would be interesting to expand this analysis by asking to what extent the content of current training is adapted (both from a conceptual and practical point of view) to provide future HMI designers with all the tools necessary for their work. The establishment of an observatory of professional practices would identify changes in terms of use of these methods, but also of the emergence of new methods and measures. For example, we note that the use of eye tracking has grown considerably recently; some companies even offer their expertise in this field.

The use of methods also varies depending on sectors. We have seen that in some sectors such as banking, insurance, health insurance, medical, healthcare and university research

organizations, methods are rarely used; and the use of some of them remains anecdotal. It would also be interesting to identify why in some areas as critical as the field of healthcare, UCD is so poorly taken into account. One may wonder to what extent the implementation of specific events, such as awareness campaigns, internal training and support could encourage these sectors to establish and develop UCD approaches.

V. Conclusion

A perspective of this study is to intervene at professionals' workplaces to introduce them to the consideration of usability evaluation methods. It would also be interesting to integrate emerging concepts that are developed in parallel to usability, such as user experience (UX). User-centered and based on the experience of interaction with a system, UX includes, in addition to functional aspects, less utilitarian dimensions, such as emotions, hedonism or aesthetics [36], [37].

Moreover, it would be interesting to identify what the practices are in other countries. The ISO standards being international, we might think that the practices are similar. Some studies have been conducted on usability professionals in other country [34], [35]. Another perspective of this work would be to determine what are the similarities and dissimilarities of professional practices between each country; and also to identify what the international usability professional community may learn from one another.

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