Exploring User Experience Factors for Mobile Devices in Textual Data from Questionnaires

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ABSTRACT

The evaluation of User Experience (UX) prior to product launch provides insights into end-user acceptance indicators and helps identify potential issues. Therefore, it is important to conduct studies that evaluate user group perceptions, supported by various methodological approaches. Among these, questionnaires may include questions addressing both quantitative and qualitative aspects of user perception. Textual data related to qualitative aspects can be systematically analyzed to identify UX characteristics that contribute to a broader understanding of user perception. This paper presents an experience report on the classification of UX factors based on textual data collected through questionnaires. The purpose of this practice is driven by the belief that a structured analysis of UX factors can deepen the understanding of such data. We analyzed questionnaire results from two mobile device projects involving a total of 92 users, who were the respondents of the questionnaires. For this classification, 26 practitioners analyzed the textual data reported in the questionnaires. The results indicate that UX factors can provide deeper insights into usability and user satisfaction across different components of the devices. Additionally, the practitioners considered this type of classification useful for understanding the overall quality of the projects through questionnaires.

KEYWORDS

Questionnaires, User Perception, UX Factors, Longitudinal Study.

1 Introduction

The growth of mobile devices can be justified by the number of features added to *smartphones* and *tablets* each year, ranging from the simplest and most affordable solutions to the most complex ones, including the diversity of options that encompass various user profiles [1]. Although professionals from different areas of expertise are involved in the development of mobile devices, concerns about their quality before market release are common. Understanding users' prior perception of these devices, through the evaluation of User Experience (UX), enables the identification of acceptance indicators. ISO/IEC 9241-11 defines UX as "*a person's perceptions and responses resulting from the use and/or anticipated use of a product.*" Providing a positive UX is crucial for product acceptance, with a growing number of organizations seeking UX professionals to help improve their products [14].

Regarding UX quality for products in general, Hassenzahl [7] suggests pragmatic and hedonic attributes. Pragmatic attributes are related to the effectiveness and efficiency of software use, while hedonic attributes are related to user stimulation and emotions when interacting with the software. Thus, UX is considered broader than usability, since the latter focuses only on pragmatic aspects.

To support UX evaluation, the literature presents various methods and techniques for collecting both quantitative and qualitative data [13], such as interviews, questionnaires, meetings, focus groups, among others. Analyzing user perception through these methods enables understanding of the main characteristics that define positive and negative acceptance. Concerning the different types of studies for UX evaluation, applying these methods and techniques in longitudinal studies allows researchers to identify more detailed findings compared to short-term studies [10].

Questionnaires may include open-ended questions to collect qualitative data that complement quantitative data. This method provides an efficient way to quantify users' perceived experience, which is fundamental for UX-related research [9].

In this context, Eldorado Research Institute has been contributing to the investigation of practices for improving UX through in longitudinal studies using the *dogfooding* approach. *Dogfooding* is an approach increasingly adopted to evaluate the UX quality of products launched by software development companies [6] [15], in which company employees use their own products and services before they are released to the market. Therefore, such employees act as users of their own products, providing early feedback on their experience. Regarding the UX methods used in this approach, one of the methods used is questionnaire. The questions used in the questionnaire are related to the main components and features of a mobile device, such as the battery, front and rear cameras, among others. The questions use a 5-point Likert scale to assess users' level of agreement with each perception. Open-ended questions are also included for users to provide *feedback* related to the evaluation items.

However, these data are more limited compared to quantitative data in the project's context. It is important to investigate whether such data can support the comprehension of other positive and negative user perspectives regarding software products. The motivation behind this investigation lies in the idea that supporting a systematic analysis of UX characteristics can enrich the understanding of such data.

This paper presents an experience report on the classification of textual data collected through questionnaires based on UX factors in the literature [11]. Practitioners involved in UX evaluations in longitudinal studies for mobile device projects at Eldorado Research Institute, 26 participants, performed this classification for a sample collected from two mobile device projects. The participants considered this type of classification useful for understanding the overall quality of the projects through questionnaires.

Our experience report aims to contribute by: (i) feasibility of applying UX factors in mobile devices through textual data collected

in questionnaires, and (ii) practitioners' perception regarding the use of UX factors in this data.

2 Background

This section presents the concepts related to this research, such as the Dogfooding approach and the UX factors employed.

2.1 Dogfooding

With the growing interest in the concept of UX in the scientific community, there has also been an increase in the number of studies proposing approaches and methods to evaluate and improve UX [8][9]. In this context, the Dogfooding (DF) approach refers to the idea of "*eating your own dog food before feeding it to others*," a metaphor that represents the act of using a product or service before delivering it to the end user [6]. This approach suggests that company employees use their own products or services in their daily routines, which allows for an understanding of their prior user experience. In doing so, companies can improve their products and services before making them available to end users due to the variety of scenarios explored—scenarios that may not be identified by development teams. The application of the DF approach also contributes to a company's marketing strategy, given that its own employees are using the product [16].

Regarding the DF approach for evaluating mobile devices, for example, Silva et al. [15] present the processes, tools, and roles responsible for executing DF programs on a global scale. The user groups selected for mobile device evaluations must reflect the target audience of the region where the product will be launched, which is why this population is spread across different locations around the world and includes diverse user profiles. In addition, the methods applied for UX evaluation of smartphones and the main lessons learned are discussed in the literature [3].

2.2 UX Factors in Mobile Devices

One of the challenges related to UX evaluation is the selection of appropriate measures to address the particularities of a given evaluation context. Thus, the identification of factors that characterize UX can be considered a key element for this purpose [12].

Nakamura et al. [11] present a systematic mapping of UX factors in user evaluations within app stores. The study identified a total of 31 distinct factors, grouped into three categories: *Application Factors, User Factors,* and *Contextual Factors*. Among these factors, one example is Attractiveness, which is defined as the user's experience and feeling toward a product in a specific situation, based on evaluative judgment. User reviews collected from the Google Play Store and Apple Store were analyzed using descriptive statistical methods and sentiment analysis. The results highlighted that certain factors were more prevalent in specific types of applications. The authors also observed opposing effects from some factors, such as negative evaluations regarding app cost and interface, which impacted overall ratings. Through the work of Nakamura et al. [11], it was possible to leverage prior investigations of UX factors in the mobile context and apply them in a new scenario. This research also contributes to the application of these UX factors to data collected through different evaluation methods.

In our previous work [4], we evaluated and adapted the UX factors for the context of mobile devices based on the work by Nakamura et al. [11], described below. This investigation classified UX characteristics based on problems or suggestions for improvement reported by users in their daily use. The results indicated the feasibility of applying such factors to user-reported perceptions, which supported a better understanding of perspectives from the point of view of phone usage and user satisfaction. In this paper, the factors are being explored for the analysis of textual data collected from questionnaires applied in UX evaluation of mobile devices.

- **Accuracy**: Closeness between the users' experienced aspects and the measured data values.
- **Attractiveness**: Positive and negative perceptions of a product. What attracts users to the product.
- **Comparison**: Comparison with other products or between different software versions of the same product.
- **Ease of Use**: Effort required to use a particular feature or functionality.

  Satisfaction: Praise and criticism regarding product characteristics.
- **Screen Interface**: Product appearance, font and color schemes, and icons.
- **Performance**: Product performance given its configuration.
- **Customization**: Customization of screen and features/functionality.
- **Bugs**: Features that have problems during product use.
- ***Crash:*** Number of crashes while using a feature or functionality.
- **Network**: Discrepancies related to cellular network performance.
- **Resource Overload**: Excessive consumption of product resources, such as memory and battery.
- **Operating System Update**: Updates, improvements, and changes to the operating system.
- **Hardware**: Hardware components deployed in different versions of the phone hardware.

3 Related Works

Regarding the use of questionnaires for data collection, researchers continue to investigate ways to support both the improvement of data collection and strategies for result analysis. Celino et al. [2], for instance, proposed a conversational survey tool to administer questionnaires through a chat web interface. According to the authors, the concept of a "conversational survey" is a questionnaire

disguised as a conversation, which proposes qualitative answer options that are automatically quantitatively coded for numerical analysis. Therefore, this work provides a set of tools to set up a quantitative questionnaire involving characteristics and advantages of qualitative research methods. The participants appreciate the conversational form and prefer it over a traditional approach. From a data collection point of view, the conversational method shows the same reliability and a higher response quality compared to a traditional questionnaire.

Concerning user perceptions of product quality in the software context, in addition to short and longitudinal studies, some works have also investigated data available in public repositories, such as user reviews. Weichbroth and Baj-Rogowska [17], for example, present a study on the content of online reviews for WhatsApp from the perspective of usability and UX. The authors applied sentiment analysis techniques with the aim of extracting relevant keywords from the data, highlighting the main usability attributes and related UX dimensions. This type of evaluation provides an opportunity to better understand user perceptions, contributing to corrections and improvements in future versions.

With respect to the use of questionnaires, it is important to understand complementary forms of analysis from a qualitative perspective for quantitative data. For this reason, in our paper we aim to evaluate whether UX factors can also be used to characterize such experiences reported through questionnaires. Although the data in this paper were not explored in the context of user reviews, we consider it similar in the sense that users reported their perceptions about mobile devices, using questionnaires as a complementary tool for UX evaluation.

4 Methodology

The objective of this research is to conduct an investigation to evaluate the application of UX factors using textual data collected from questionnaires for mobile device evaluation, in the context of *dogfooding*. This investigation was conducted in two projects for the categorization of UX factors. Practitioners with experience in this type of evaluation conducted the analysis to provide feedback on the use of these factors.

4.1 Context

The case study was carried out in two mobile device projects at the Eldorado Research Institute in partnership with a leading company in mobile device development. Due to confidentiality reasons, we will refer to it as Company X. One of these projects was in its pre-launch phase, focusing on hardware and operating system evaluation. The other project involved an operating system update. A total of 92 users participated in the projects for their evaluation.

UX evaluation of mobile devices is conducted over a period of three to four months. The UX evaluation allows for an understanding of users' key perceptions during the evaluation period and their perspectives on the product as end users.

Users with different profiles, working in various areas in the companies are recruited. These users voluntarily agree to contribute their feedback for evaluating the quality of mobile devices. The methods adopted for collecting UX evaluation *feedback* are described as follow:

(i) use of **an app that enables daily reporting** of suggestions or perceived problems;

(ii) weekly remote **meetings for users to provide their *feedback*** and share questions and suggestions with other participants;

(iii) **questionnaires applied** at the beginning, during, and at the end of the evaluation period to understand user expectations.

4.2 Sample

Results from questionnaires applied at different stages of the two project evaluations were selected. Therefore, *feedback* from users was expected regarding the evolution of hardware and operating system versions, with a total of 25 comments from the open-ended questions.

We acknowledge that textual responses in questionnaires within this type of evaluation in our projects have limitations. Nonetheless, we found that the qualitative data provided by participants complemented their quantitative responses regarding the features of the phones.

Below are the user feedbacks with their respective codes (F#1, F#2, etc.), which will be discussed in Section 4. Only F#3 and F#16 are positive feedback; the others are negative.

F#1 - *Issues with call audio and the other party being able to hear me clearly.*

F#2 - *This might be a learning curve, but I seem to have difficulty interacting with the external screen.*

F#3 - *Is there a way to customize the home panel to have the clock in a different format or display something else like a small image?*

F#4 - *Overall, the external display UI is clunky, confusing, and inconsistent. On some panels, you swipe up to go one direction; on others, you swipe left to go another.*

F#5 - *I don't find the external display very useful for camera, calls, and photos. It works well for audio and is good for notifications and contacts. Fonts and icons are small for my large hands.*

F#6 - *With my typical use, the battery runs out after 10 hours.*

F#7 - *I noticed the phone heats up when using Android Auto and the battery drains faster.*

F#8 - *When gesture navigation is enabled, I noticed strange touch behaviors.*

F#9 - *Slow transition between apps and sometimes I need to clear all open apps to improve stability.*

F#10 - *Using WhatsApp; the front camera sharpness is not good.*

F#11 - *In portrait mode while trying to focus on an object, there is a lot of flickering of surrounding items.*

F#12 - *Sometimes, certain apps do not respond/do not open when trying to launch them.*

F#13 - *Sometimes my phone unlocks when I don't want it to because the power button is close to the fingerprint sensor.*

F#14 - *Bluetooth randomly disconnects my headset and I have to tap it to reconnect. I use headphones 6 to 8 hours a day for work and this happens 4 to 5 times daily.*

F#15 - *The stylus would feel better in hand if it were slightly thicker and easier to eject from the top-right corner.*

F#16 - *I prefer smaller phones that I can hold comfortably and securely with one hand and reach all on-screen buttons. I hate having one hand full and having to "juggle" the phone.*

Table 1: Study Participants

Role	Total
Analyst UX	9
Triage	4
Developer	5
Program Leads	6
Manager	2

F#17 - *The game icon is movable, but you can't easily delete it. I want to configure it and not leave it on the screen.*

F#18 - *The camera app is slow and with gestures enabled it performs poorly. The device also feels hotter when using the camera and video calls.*

F#19 - *Sometimes media apps take a long time to load.*

F#20 - *The maximum volume is a bit low.*

F#21 - *The macro zoom feature is hard to find. There was no option to choose the focus point on screen.*

F#22 - *I disabled the adaptive brightness feature because it was reducing brightness to undesired levels.* **F#23** - *Gesture navigation and split screen don't work together as they did on the previous phone.*

F#24 - *Charging speed is a bit slower than I expected.*

F#25 - *Sometimes the device performance drops, especially with third-party apps or multitasking.*

4.3 UX Factors Analysis by Practitioners

The application of the factors was planned as follows: (1) each user feedback item, described in Subsection 4.1, was added to a *Google Forms* questionnaire to be categorized according to the most appropriate factor, with the factor descriptions also included in the form; (2) the categorization was conducted by study participants, totaling 26 practitioners who work in the context of mobile device evaluation, whose roles are presented in Table 1; and (3) a post-study form was created to understand participants' perceptions regarding the use of UX factors.

Regarding the sample collected for UX factor analysis, the involved researchers conducted a prior assessment of each related factor. This was planned to evaluate the proposed descriptions and understand potential difficulties that participants might face with this type of analysis.

The investigation was conducted over a five-day period. After submitting their analysis, each participant received the post-study questionnaire.

5 Results

Table 2 presents a summary of user feedback collected from the questionnaires regarding the categorization of UX factors by practitioners, namely: Accuracy (Ac), Attractiveness (At), Comparison (Comp), Ease of Use (EU), Satisfaction (Sat), Screen Interface (Int), Performance (Perf), Personalization (Per), Bugs (B), Crash (Cr), Exceeded Resources (ER), Network (N), Operating System Update (OS), and Hardware (Hw). The highest number of occurrences for problem classifications are highlighted in gray. The IDs related to user feedback are also highlighted in green for positive and red for negative.

It was noted that most participants considered in their analysis that each reported feedback involves more than one classification from the perspective of UX factors, such as feedback #1 "**Problems with audio during calls and the other party being able to hear me clearly**," which is related to user satisfaction, bug, and mobile network. However, for feedback #17, it was observed that 13 participants considered the UX factor to be the interface. In this case, though, we considered the main aspect to be the user's preference for personalization.

In the analysis of the obtained results, regarding feedback #23 "**Gesture navigation and split screen do not work together as they did on my previous phone**," we understand that this is also related to the ways users interact with the interface; therefore, it would be interesting to have a factor that describes this aspect. Concerning the use of the factors to characterize pragmatic and hedonic attributes, in addition to the perspective of practitioners who work in UX evaluation for feedback analysis in questionnaires, the next subsections indicate some findings.

5.1 Hedonic and Pragmatic Aspects

Regarding UX in mobile devices, the application of UX factors can support the comprehension of pragmatic and hedonic aspects. However, this depends on the amount of information reported by users in their comments. For example, feedback #4 "**Overall, the external display UI is clumsy, confusing, and disconnected. On some panels, you swipe up to go one way, on others you swipe left to go another**" allows us to understand that aspects related to interface options may affect the users' ease of use and, consequently, their satisfaction with the product. On the other hand, with feedback #3 "**Is there a way to customize the home panel to have the clock in a different format or display something else like a small picture?**" it was not possible to characterize which pragmatic aspect might be related, such as satisfaction or attractiveness.

Regarding the list of evaluated problems, since most are related to disagreements with phone quality aspects, we noticed a trend of user dissatisfaction followed by difficulties in using the evaluated phones, such as issues related to display and performance.

5.2 Practitioners' Perception on the Use of UX Factors

Regarding the participants' perception, referred to in the text as P1, P2, etc., one of the observed points with this type of analysis was the difficulty in applying the factors. The difficulties are related to the **lack of necessary information in user comments**; P4 stated that "*some comments did not have enough detail and multiple factors applied to them*," and P6 said, "*for the most part, the factors seemed clear and sufficient to categorize user feedback. However, I think a few comments did not fully fit into any of them.*"

The **definition of the factors** was also not easily understood, as indicated by P10 in "*in the glossary, the meaning of some items is not obvious, for example, 'Accuracy.' Some items require additional knowledge, such as 'Performance' (knowing whether it's a low-tier device or not) and 'Hardware Component' (knowing whether it has changed or not). 'Attractiveness' does not seem like a good criterion to me, not all users include such statements in their descriptions.*"

Table 2: Analysis of UX Factors for Textual Data from Questionnaires

#	Ac	At	Comp	FU	Sat	Int	Perf	Per	B	Cr	R	RE	SO	Hw
F#1	3	1	1	1	13	0	7	0	12	1	10	1	0	3
F#2	3	6	1	21	5	14	0	0	1	0	0	1	0	1
F#3	0	1	1	9	5	13	0	22	0	0	0	0	0	0
F#4	1	6	1	24	15	19	0	3	0	0	0	1	0	0
F#5	1	5	2	18	20	19	0	4	0	0	0	1	0	0
F#6	5	0	1	0	11	0	9	0	1	0	0	14	0	2
F#7	3	0	3	0	7	0	11	0	2	1	0	18	0	1
F#8	6	1	0	6	6	8	6	0	18	0	0	0	0	2
F#9	1	0	0	0	4	2	24	1	5	2	0	5	1	0
F#10	3	6	2	0	21	2	5	0	2	0	0	1	0	3
F#11	2	1	1	2	6	2	10	0	17	0	0	0	0	2
F#12	0	0	0	2	1	1	23	0	12	7	0	4	0	0
F#13	2	3	0	8	17	1	1	0	6	0	0	0	0	12
F#14	1	0	0	5	10	0	8	0	23	1	4	0	1	3
F#15	2	7	1	11	13	2	0	0	0	0	0	0	0	19
F#16	1	13	10	12	16	0	0	0	0	0	0	0	0	9
F#17	0	0	0	24	7	13	0	5	1	0	0	0	1	0
F#18	2	1	0	2	6	0	24	0	5	0	0	7	1	3
F#19	0	1	1	0	2	0	25	0	3	1	2	3	0	1
F#20	5	4	3	1	21	0	2	0	2	0	0	0	1	6
F#21	2	5	1	19	12	8	0	1	0	0	0	0	1	1
F#22	5	4	1	2	18	6	1	4	7	0	0	1	0	2
F#23	1	1	19	9	12	11	2	0	6	0	0	1	0	1
F#24	6	6	4	0	14	0	9	0	2	0	0	4	0	4
F#25	0	1	2	0	6	0	25	0	4	0	0	4	0	2

However, other participants stated that they had no difficulty with the description of the factors: "*The UX factors were clearly recognized in most comments.*"

Regarding the usefulness of these factors in UX evaluation, participants believe that they facilitate the **comprehension of pragmatic and hedonic attributes of phones** for their improvement prior to market launch, as mentioned by P10: "*Factors are important for product quality as they help identify problems related to the device's usability, whether it has any defect, be it software or hardware. This information is useful during the bug-fixing phase or even in a future version of the device (if it is identified, for example, that something is bothering most users).*" The factors also facilitate the understanding of **UX aspects of different phone models**, promoting continuous improvement: "*In my view, they are very useful as they define important concepts and allow for standardized categorization of user comments. I believe this would be useful for project managers who could use the result of this process to compare different aspects of the products*" (P11) and "*the factors clearly reflect the strengths and weaknesses of each product and can be used to define areas for improvement*" (P18).

6 Lessons Learned

The analysis of UX factors for textual data supports the understanding of key aspects related to user perception. From the data collected through questionnaires without the use of factors, it is possible to identify positive and negative aspects of phone components such as the camera, battery, etc. With the use of factors, however, one can understand, for example, that the user experienced difficulty using the phone and dissatisfaction with features related to the screen interface, as in the case of feedback F#4. Therefore, the factors facilitate comprehension of both pragmatic and hedonic attributes. Nonetheless, a limitation of this type of analysis is related to the lack of necessary information, which mainly affects the understanding of hedonic aspects. Thus, it was observed that textual data in this context may be limited in capturing users' motivations for using a specific device, including their frustrations. These findings indicate that:

> It is possible to comprehend usability and UX aspects indicated through the analysis of feedback collected via questionnaires. However, limitations may arise due to missing information reported by participants in this type of feedback collection

Regarding user feedback, it is observed that most users submit negative feedback compared to positive feedback. This indicates users' concerns and their engagement in contributing to the improvement and refinement of mobile devices through UX evaluation. However, it is also important that positive feedback be encouraged and submitted. From the perspective of practitioners involved in the UX evaluation context, they considered that the analysis of user feedback supported by UX factors contributes to the shared understanding among all project stakeholders regarding mobile device quality. These results indicate that:

> Categorization facilitates the understanding of UX aspects of different device models by various project stakeholders, improving communication and supporting continuous improvement.

In the practitioners' analysis of the list of user feedback, it was noticed that one item not previously included in the list of UX factors, related to gesture navigation, was added to our list. This feature enables the use of functionalities available in smartphones. However, issues with this interaction can be observed, as reported in F#8 and F#18. Therefore, we considered proposing this factor with the following definition:

> *Navigability*: The ease with which users can locate and use functionalities during their interaction with the device.

Regarding the limitations of this practice within the context of mobile device quality evaluation, the experience described was carried out in two projects. We acknowledge that textual responses in questionnaires within this type of evaluation in our projects have limitations. Nonetheless, we found that the qualitative data provided by users complemented their quantitative responses regarding the features of the phones. Moreover, questionnaires complement other evaluation methods employed, since some users describe perceptions that had not been previously reported. It is not possible to claim that these results represent all types of questionnaire-based analysis in this context. Our findings serve as initial evidence of the usefulness of this type of analysis in this context.

7 Final Remarks and Future Works

This paper presented an experience report within the context of mobile device projects regarding the classification of UX factors based on textual data reported in questionnaires. Such a method has been employed in the UX evaluation of mobile devices at the Eldorado Research Institute, where the results provide both quantitative data and textual data to support the understanding of user perception. Regarding user feedback, it is provided to support the reporting of both positive and negative perceptions of mobile devices. However, the motivation behind this investigation lies in the idea that supporting a systematic analysis of UX characteristics can enrich the comprehension of such data.

The results obtained from the study indicate the feasibility of employing UX factors in the analysis of mobile devices using textual data. Moreover, the understanding of pragmatic and hedonic attributes is also feasible, making it possible to identify which aspects of the device may cause positive or negative experiences—motivating user satisfaction in acquiring the device. One observed limitation may be related to the amount and content of information reported by participants about the components of the evaluated phone. Our findings demonstrate the potential of this type of investigation in the context of questionnaire-based analysis.

The practitioners who participated in the study as respondents considered that the classification of user feedback facilitates comprehension, among project stakeholders, of the UX factors that influence the quality of the phones. This can promote continuous improvement across different device models.

Based on the insights from this case, future work intends to apply *Large Language Models* (LLMs) to support the analysis of user review comments by following the concept of UX factors. Furthermore, we also aim to explore uncategorized data to assess whether additional factors can be created and explored within this type of evaluation. Conducting such practice may enhance the application of UX factors using textual data.

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