

How can UX requirements be part of the acceptance criteria specification? Findings from a case study with startups

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Abstract

User experience (UX) is a topic widely discussed in the software industry. The elaboration of UX requirements is an activity that practitioners face difficulties during the software specification. On the other hand, user stories (US) are a well-known artifacts to describe software requirements. Frequently, acceptance criteria (AC) complement the US specification by giving more details about the requirement scope, functionality, and quality requirements of the software. Taking into account US/AC relevance, ACUX (Acceptance Criteria of User eXperience) guide was proposed to support software teams to the writing of UX requirements during the elaboration of AC. In this paper, a case study carried out with software teams from two startups investigated the use of ACUX. The study aims to observe the changes that the guide adoption employed in the teams' routine concerned on UX requirements elaboration. The findings revealed that ACUX improved team communication and played the role of a reminder for the developers memory about the relevant aspects of UX to be considered in the requirement specification.

Keywords: user experience, UX, UX requirements, user stories writing, case study.

1 Introduction

Recently, software product development has requested that companies integrate User Experience (UX) into the process of design and evolution of their products. UX refers to the experience delivered to users by a product during its use [1]. The literature has highlighted the importance and challenges of addressing UX requirements in the industrial setting [2, 3, 4]. Moreover, there is an acknowledged need for continuous improvement of UX to align with user expectations [2]. The definition of UX requirements involves not only understanding users' expectations, but also considering users' actions with the product [1].

Although the relevance of specifying UX requirements is recognized, studies show that user needs are often handled informally or neglected [2, 3]. This issue arises from the challenges that numerous software teams face in defining UX-related requirements [2]. Such challenges might originate from the absence of a dedicated specialist to facilitate understanding of the details of UX [5]. Beyond the lack of UX experts, software teams also struggle to discern which UX details are essential to specify in the requirements [3, 4].

In startup organizations, the difficulty of handling requirements specification can become even greater. Professionals in these organizations usually have little experience and perform multiple roles. Often, agile development approaches are the most used in startups (e.g. Scrum, Kanban), and software teams in startups are responsible for specifying product requirements [5]. In this context, user story (US) emerges as a valuable artifact for agile teams to specify requirements and manage team tasks [6,7].

US provides a concise textual description of the functionalities that a software should have from the user's perspective. Although there is no standard for writing US, the grammar proposed by Cohn [8] is the most used by agile teams [7, 8]. The grammar consists of a template that includes placeholders in which the text should be filled according to the requirement that is specifying: "as a << type of user >>, I want << some objective >> so that <<

some reason >>". The elements outlined are the spaces where the team indicates the user who will use that functionality, their needs, and the reason for having such a need, respectively [8].

As US provides a short description of the functionalities, it is complemented by *acceptance criteria* (AC). AC describe requirements and critical points that the software team must take into account when implementing that US [8]. In addition to providing details that impact implementation, AC also support software developers during the testing phase [8]. Similar to US, there is not a prescriptive format for crafting AC; nevertheless, North [9] suggests a grammar for formulating AC, consisting of three elements: "*Given* << *interaction context* >> *when* << *event or action occurs* >> *then* << *expected results* >>".

Considering that there is a demand for supporting the writing of UX requirements and that US/AC constitute a valuable artifact for software teams, a guide called ACUX (*Acceptance Criteria of User eXperience*) was created. ACUX offers a set of guidelines to assist software teams in documenting UX requirements using AC format, enhancing the US specifications. This paper aims to present a case study to explore the use of ACUX for aiding the writing of UX requirements. Two software teams from different startups participated in the case study. From a qualitative perspective, individual interviews with the participants indicated that ACUX enabled the startup professionals to develop an initial understanding of important UX requirements. Furthermore, the analysis conducted on the artifacts developed by the teams showed that the use of ACUX helped include UX requirements in AC. As a contribution, this paper presents a discussion about the impacts that the ACUX use introduced on the teams' work routine and the learning that the guide provided for the professionals involved.

The remainder of the paper is organized as follows: Section 2 presents the related work to US and AC writing; a brief presentation of ACUX is found in Section 3; Section 4 describes the case study (startups' configuration, participant profiles, data collection procedures and data analysis); the findings obtained from the qualitative analysis of the interviews are discussed in Section 5; and Section 6 summarizes the findings and discussed their relation with the literature; finally, Section 7 presents the final considerations of this work.

2 Related work

The literature has highlighted both the advantages and obstacles of incorporating UX practices in agile approaches. It has especially pinpointed the challenge of drafting UX requirements [2, 5]. Interviews with software experts reveal that *user stories* are commonly used in agile environments [5,10]. However, challenges are observed in both the writing and understanding of *user stories* [10]. Furthermore, the team members agreement concerned requirements while developing USs poses challenges [2, 11]. Zaina, Sharp, & Barroca [4] suggest that guidelines can instruct the writing of US, especially for structuring UX information in software projects. Furthermore, software developers agree that employing guidelines in US elaboration influence beneficially the requirements engineering overall [6].

Considering the quality of writing US, Lucassen et. al [6] propose the Quality User Story (QUS) framework, which aims to evaluate the textual structure of US. Wautelet [12] compared the US created with the QUS framework [6] with the US developed using a free format. The authors identified that the framework helped the understanding of the problem that is handled in the software scope during the US creation. Although most works on UX and requirements highlight the importance of the writing of UX requirements, few works address both topics. Recently, Amna & Poels [13] conducted a literature mapping to explore the state-of-the-art about *user story* research. The results show studies from different areas; however, there is no discussion of UX requirements specification.

Based on case studies, Pereira et al. [14] propose a set of design patterns for organizing UX information in online tools that are commonly used by agile teams (e.g., Jira). One of the patterns guides developers to include UX information in AC; however, the pattern does not give details on the type of information that can be used. Moreno & Yague [15] introduce a set of usability mechanisms to be specified in AC that detail methods of providing user feedback. In another work, Choma et al. [16] propose UserX Story, a grammar that supports the US writing, which incorporates Personas [17] and Nielsen Heuristics [18] in the development of AC. Lopes et al. [19] investigate how UX artifacts assist agile teams in writing US/AC; the results showed that Nielsen's heuristics and personas were the techniques most used for elaborating US and AC. Marques et al. [20] propose USARP (*USAbility Requirements with Personas and user stories*), a method that combines personas, user stories, and usability guidelines to support the elicitation and specification of usability requirements in agile projects.

In a previous work, we conducted a study on the utilization of ACUX [21]. This previous paper includes details on ACUX and its guidelines conception. A qualitative study was carried out in a research and development center specializing in mobile app development. The study involved 10 teams composed by trainees and it was focused on exploring the artifacts contained the US/AC specification. The US/AC artifacts produced by the teams were evaluated to determine the guidelines that were most applied to the writing of the UX requirements. Finally, the results indicated that ACUX provided a good support for the teams which wrote requirements that covered details about the user's interaction with the product. Unlike that paper, the current study investigates the influence of ACUX on the work routine of the two startup teams.

3 ACUX Guide

To construct ACUX, we followed a method that includes a literature review and an exploratory study that investigated the elaboration and writing of AC on UX in US [22, 23]. The complete description of ACUX conception can be found in [21]. However, the next paragraphs provides a concise description of the ACUX construction for a better understand of the guide.

Initially, a systematic review identified 26 primary studies that focused on documentating UX requirements in US/AC from which best practices of US/AC writing were extracted. In addition, an exploratory study analyzed 261 AC from 79 US elaborated by 30 developers in a controlled setting. The aim was to identify prevalent mistakes in the descriptions of UX requirements in AC. The framework *Elements of UX* proposed by Garrett [1] was subsequently utilized to categorize the guidelines into their different purposes. This framework is structured into five layers: *strategy*, *scope*, *structure*, *skeleton*, and *surface*, ranging from the most abstract, *strategy* - which addresses the application domain, to the most tangible, *surface* - which involves elements facilitating user interaction. Each layer has elements of UX that characterize what should be addressed in each layer. To build ACUX, the three framework upper layers (i.e., *structure*, *skeleton* and *surface*) were considered, as they have elements that directly interfere with the user's interaction with the product. Upon examining the elements of UX from the three layers, ACUX guidelines were incorporated into two categories: *Interaction Design* (ID) - encompassing elements from the *structure* and *skeleton* layers; and *Visual Elements* (VE), including those from the *surface* layers. From these distinct groups, ACUX offers more clarity of the guidelines' meanings.

After elaborating the guidelines, an interactive online version of ACUX was developed¹ by using Figma platform. The ACUX components that includes: (i) guidelines categorized into two sections - 6 *Interaction Design* (ID) guidelines, and 9 *Visual Elements* (VE) guidelines; (ii) examples with the application of each guideline; and (iii) tips on *Usual Mistakes* that alert developers about what should be avoided in UX requirements description. Fig. 1 illustrates the components of ACUX mentioned previously. All examples utilize Cohn's [8] syntax for writing US and North's [9] method for crafting AC. ACUX also includes suggestions of artifacts (e.g., personas, storyboards) that can provide insights for the wrinting of UX requirements in AC.

¹ACUX guidelines available in Portuguese: <https://www.figma.com/proto/EPjh6WCoZsrLHAE0Y170mn/ACUX-Guidelines?scaling=min-zoom&page-id=0%3A1&node-id=370%3A0>

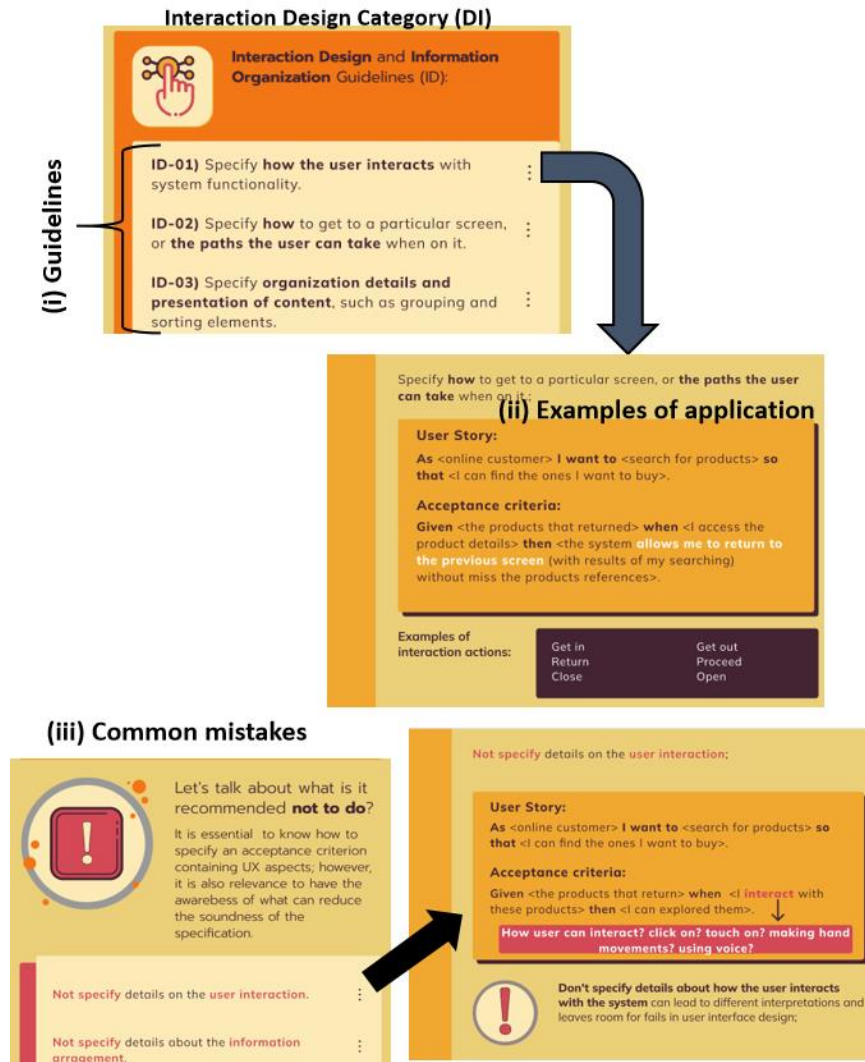


Figure 1. ACUX components - translated from the original ACUX.

4 Case study

The case study was conducted following the guidelines of Runerson & Höst [24]. The study was approved by the Human Research Ethics Committee of the Federal University of São Carlos, São Paulo, Brazil². Using the network contacts of the research group, the first action was to establish contact with a startup *hub*³ located in Minas Gerais, Brazil; as a result, two startups agreed to participate in the case study, henceforth referred to as Startup 01 and Startup 02. Startups were selected as the case of the study due to the fact that these organizations mostly work with agile approaches, and therefore, their teams often adopt US/AC. Thus, ACUX could be useful for these companies teams. Startup 01 was founded in 2017, operated in the *Agrofintech* sector, had 10 employees, and 5000+ customers. Startup 02, founded in 2020, operated in the *Fintech* area, had 5 employees and 900+ customers. Both startups adopted Scrum, and the US/AC was written by the teams with the support of the scrum master. Startup 01 used the kanban board in physical format and Startup 02 in virtual format from Trello tool.

In an initial meeting, the CTO (*Chief Technology Officer*), the same for both startups, reported that the software requirements were discussed first with investors, and after that the teams received those to be used in US/AC elaboration. In other words, the writing of the US/AC and the requirements elicitation were not carried out by the same professional. Consequently, a great amount of user requirements details could be overlooked. At that same meeting, the ACUX was presented covering its purpose. CTO mentioned that the startups have to rework the user

²CAAE number: 40135020.8.0000.5504.

³Hub is physical or virtual workspace that motivate a network construction between the organizations; besides, it facilitates the access to investors, mentors and suppliers.

interfaces due to the fact that they frequently did not meet the user expectations. From the CTO point of view, the adoption of ACUX could avoid the constant need of redesigning the user interface. During this meeting, two software teams, one of each startup, were nominee as case study participant. Startup 01 team used ACUX to "*restructure an application with the aim of enhancing product design*", while the Startup 02 team applied the guide to "*develop new features*" in an application. The team members of the startups answered a profile questionnaire from Google Forms (see the professionals profile in Table 1). In Table 1, we see that most of the teams' members were young individuals and novice developers. All professionals declared that they often participated in some way in the elaboration of US/AC or used them in the software testing phase.

Table 1. Profile of the participants by startup.

ID	Age	Educational Background	Course	Role	Professional Experience	Experience in startups	AP Exp.
ST01-P1	38	Master's degree	CC	CTO	10+ years	6-10 years	6-10 years
ST01-P2	22	Graduated	SI	Dev	3-5 years	1-2 years	1-2 years
ST01-P3	19	Undergraduate	SI	Dev	1-2 years	1-2 years	1-2 years
ST01-P4	26	Graduated	SI	Dev	3-5 years	3-5 years	3-5 years
ST02-P1	20	Undergraduate	SI	Dev	1-2 years	1-2 years	1-2 years
ST02-P2	25	Graduated	SI	Dev	1-2 years	1-2 years	1-2 years
ST02-P3	31	Graduated	SI	Dev	10+ years	1-2 years	3-5 years
Legend: CC - Computer Science; SI - Information Systems; Dev - Software developer ST in ID column identifies the startup the professional worked AP Exp: Agile Practices Experience							

A training to leverage the teams about the study objective was carried out with the two startups teams (~30 minutes). First, the project presentation, and US/AC and UX fundamentals were delivered to the participants; subsequently, ACUX was explained and a warm-up of how-to-use the guide was performed using Trello. Finally, the participants were instructed to use the guide for a two-week *sprint* (i.e., agile development cycle); they also were informed that an individual interview to collect their feedback about ACUX would be conducted afterward. In addition to using ACUX, the participants were asked to make notes on their difficulties and point out the guidelines they used to prepare the AC. The participants were asked to provide the US/AC developed with the support of ACUX. The teams were informed that they could contact the researchers at any time for clarification of doubts.

After two weeks, interviews were conducted with each participant individually (~10 minutes/participant). All interviews were recorded, resulting in 1 hour and 10 minutes of audio recordings. The questions asked during the interviews were about: (i) the primary assistance offered by the guide to the participant and whether ACUX introduced any obstacles to its utilization; (ii) the changes in the team's workflow caused by the use of the guide; (iii) the main lessons learned got from the use of ACUX; (iv) the knowledge acquisition on how to consider UX in AC; and (v) the general participant opinion about the guide, modifications suggested and the use of ACUX for other purposes.

All interviews were transcribed into text, and organized by participants and questions asked. The answers were read and interpreted by the researchers to identify positive and negative feedback from the participants. The chunks of text considered positive (in terms of the guide acceptance) were marked in green, and those that presented some negative mentions were marked in red. Next, we continued with the extraction of findings per question by summarizing the perceptions reported by the interviewees. The participants' statements that justified the findings mentioned in the previous step were then extracted. Finally, all the individual findings of each participants were compiled to produce general findings per question.

After the interviews, the collection of US and AC developed by the teams was conducted. In total, 05 US containing 80 AC were created by Startup 01 team; and Startup 02 team produced 03 US containing 18 AC.

ACUX presents guidelines in two groups: interaction design (ID), and visual elements (VE). In the analysis of the US, we verified if the guidelines were used by identifying words or phrases that reported UX requirements and determining which group and guideline they belonged to. The identification of UX requirements in the AC was carried out using colors, orange for ID and green for VE. Each identified UX requirement was color-coded according to the related group and transcribed into specific columns of the spreadsheet. The codes of ACUX guidelines that contributed to each UX requirement were recorded.

5 Results

The next sections present the main results obtained from the interviews analysis and the artifacts. Considering the qualitative nature of this study [24], the main findings are highlighted in bold and excerpts from the participants' statements illustrate these findings.

5.1 The guide use

From the interviews analysis emerged three groups of results that addressed: the use of ACUX, the support offered by the guide to developers, and the barriers introduced by the guide itself on its use.

Startup 01 members reported that the *use of ACUX* motivated the team to **anticipate the discussion of product issues and interface problems** that were previously discussed in later stages, as seen in ST01-P1's statement: "we used the [ACUX] to think about new features before their development, yeah... So right at the beginning before making a prototype... with the guide we discussed some problems in advance that would only arise later in development". Furthermore, the guide **assisted the team in the planning and elaboration of user interfaces**, as reported by ST01-P3 and ST01-P4, respectively: "planning the interfaces from the *user stories*, I found it was very useful"; "in the user interfaces creation, it was interesting to define consistence on the screens together with the marketing team". Startup 02 participants pointed out that ACUX aided in the US/AC writing and also **make more visible the important points for the elaboration** of US/AC, as highlighted by participant ST02-P2: "I elaborated the *user story*, and thus I was developing it to see the result, [...] I want to check the level of specification I had to do, or if it was missing something, then I looked to the guide and say, 'oh, this was missing, that was missing'..."

The data analysis revealed evidence about the *support provide by ACUX* to the participants for the US/AC elaboration. Participants from both Startup 01 and Startup 02 stated that the guidelines encouraged them to question themselves on forms of improving the UX of the product. Participant ST01-P2 pointed out that "in the case of arranging the ideas...I thought about issues that could better satisfy the user". ST02-P1 said that the guide "widely aids in understanding the significance of completing a more comprehensive [client/user] request", and that "the guide helps us to realize the factors and elements that should be considered, which are often overlooked due to urgency or the desire of delivering the product. However, ACUX illustrates how the connection of these elements enhances the product usability and become it more attractive".

The participants also reported about the presence of *barriers* that hindered the use of the guide. They pointed out that ACUX introduced **more work requests to the team**, but they recognized that the time dedicated to using the guide can avoid future rework on the product. The participants stated that **document requirements is not a culture in the company** and that the use of the guide raised doubts about the documentation. ST01-P1 stated that "we realized that the time we spend documenting will be saved in the future because, as I said, several... several aspects that we didn't think about, we were able to predict in advance" and added "we don't have a culture of producing comprehensive documentation, as this startup is a small company... thus [we don't like] spending a bit of time planning and then developing". The issue about culture was also pointed out by ST02-P3 "occasionally, it [ACUX use] became a little extensive... we are small here, and as consequence... my role is not limited to doing this [US/AC elaboration] and we ended up taking a little time away from other activities". ST01-P2 reported that ACUX "...helped a lot...the format of presenting the guidelines was very clear [about what to do]", but the participant complemented that the use of ACUX also raised doubts, "I thought the guidelines and my specification were not consistent [...] the contrast aspect [screen contrast] I had a little doubt to use it [...] there was no way I could better manage it [the contrast aspect] due to the context I was employing it".

5.2 Team workflow

The results revealed changes in the teams' work routine as a consequence of the adoption of ACUX. These changes impacted communication between team members.

The modification on the *teams workflow* was noticed for both startups, especially with regard of **changing the order that activities was performed**. Before using ACUX, the teams first design prototypes of the solution without discussing issues related to UX, or even having conversations about user needs. According to ST01-P3, the introduction of ACUX allowed them to prepare US/AC contained more details which consequently avoided the need of reworking the prototypes designed: "in part of the development [...] [the use of ACUX] helped a lot to turn the implementation phase faster"; and for ST01-P4 the writing of US/AC "improved the consistence of the user interfaces". The professionals from Startup 02 noticed that the use of the guide encouraged the team discussion during the *sprint meetings* which did not happen before; the team dialogued more on the details to be included in the US/AC. This new workflow caused a perception of **improvement in the team's performance** as the US/AC provided a more assertive description about the user interface requirements that should be prototype, as highlighted by ST02-P2: "if all the requirements are provided in details, then we can get the *user story* and implement it accordingly, and we can obtain a more assertive feedback from users avoiding the need of many iterations with the clients/users to evaluate the prototype". ST02-P3 reinforced that the guide reduce the team rework: "in the review phase, we often identified that a lot of rework should be done [before the adoption of ACUX], we observed that the solution was not fulfilling the requirements and then we asked to the team re-coding some parts", "I think that many times [...] in my head [...] it was clear what we had to do but I didn't transcribe it to the team, I kept having to rework, so the guide introduced more agility to the user interface design".

The changes into the team workflow had an *impact on team's communication*. Both startups recognize that the use of ACUX **motivated the communication between team members** because they started to discuss frequently their ideas on user interfaces. For ST02-P2 the impact was positive “because we can align each other's ideas, and also have a space for questioning”. ST02-P2 argues that “sometimes, [...] whether something is not specified, we thought 'oh, what's up? what should I have to do? Ah, I'm going to ask for my colleague[...] that s/he will explain what I should do and then I added the new details in the US/AC in the user story', so the communication between us was really improved”. Startup 02 complemented that in addition to improve the team internal communication, ACUX **enhanced the communication with external members**, i.e., with the marketing team that took part of the software design, as we can see in the ST02-P3's statement: “I believe that mainly in relation to... the team that together with the people who design the screens, which today are our marketing department, I think that [the guide] also streamlined this communication.”.

5.3 Lessons learned

As *lessons learned from using the guide*, both startups concluded that the guide acted as a reminder for **the developers' memory** of what should be considered in terms of UX during the application's specifications. For Startup 01, the guide highlighted points that the team neglected about UX previously; the guidelines **make evident the end-users' perspective of the product**.

Furthermore, ACUX supported **team members who do not have advanced knowledge** about UX design to identify which UX elements they should consider. ST01-P1, ST01-P3, ST01-P4 and ST02-P2 statements, respectively, report their lessons learned: “the guide brings us the point of view that US/AC contains not only functional specifications, [i.e.,] the user's action, but also the aspects that are related to this action, as such as the position of elements on the screen, font types and size, we used to write these details in a very vague way and now we have learned a way of remembering and thinking about it”; “when we considered the usability [of the application] [...] normally I return many times [...] I mean I started the coding and then I return to redefine something, then, now, these returns usually happen much less. If any doubt arises, we just go back, [and see what] we have already agreed”; “software developers have no idea of [UX] design, with the [guide] ‘telling us’ what we have to code [...] in a simple way, we can reach the final result, which is the development of user interfaces easy of using”; and it complemented that “I learned a lot about [requirements] specification... I have difficulties in specifying, I know what it is, but transcribing [to the writing] [...] for someone read and then use it, I have a little difficulty, and this [ACUX] helped me, [...] I looked at the guide, and I could found an example”.

Another lesson learned pointed out by Startup 02 was that the guide revealed the importance of **elaborating US/AC in details and with completeness** and that this approach of specification avoids rework, according to ST02-P1's statement: “the major learning was to understand the importance of writing the requirements in full detail... I found it [the guide] very important, it provided me with a great learning experience, because it makes me want to write [US/AC] in more detail to aid my colleagues, or even for myself, to have everything more explained, so that there are no more communication mistakes or lack of information”.

5.4 Acquired knowledge

For Startup 01, the ACUX examples improved their **learning on how to specify the solution** and motivated the questioning about the relevant points to be informed in US/AC. According to ST01-P1, the guide aided to “acquire knowledge on ways of describing UX requirements in acceptance criteria... it [ACUX] opened our eyes, for example, to create different user interfaces for each type of managing password checking so that when user interface requests a numeric password, users only see a numeric keypad, for example”.

For Startup 02 otherwise, ACUX was more relevant for conducting the team to the writing of the US/AC. They expect that the continuous use of the guide could internalize into the team work the guidelines, and consequently **the dependency of consulting the guide reduce soon**, as ST02-P1 reports: “some stuff is on the top of our head [...] without the need of checking the guidelines, as we apply [the guidelines] the more we will learn, so I believe that our knowledge acquisition [about UX] will increase overtime”.

5.5 ACUX Acceptance Overview

The teams in both startups reported a good acceptance of ACUX. According to team members, the **examples established an important support for understanding** both the guidelines application and the recommendations per se.

Nevertheless, the Startup 02 team stated that the **inclusion of more examples** in the guide certainly motivate the ACUX adoption. Furthermore, the Startup 01 team mentioned that ACUX presents a **potential to be adopted in other software development phases** in addition to the US/AC writing step. For instance, ACUX could be used in conversations with the customer. ST01-P4 pointed out that the guide “could support them to make the client engaged

and aware to the demands from the real context of product use, so that they could say ‘according to the user's usability good practices we can do it this way’ to the client”.

5.6 Analysis of the Artifacts

The analysis of the artifacts was conducted by startup; that is, the US and AC developed by ST01 were analyzed first, followed by the artifacts developed by ST02. Subsequently, the results obtained from the two startups are compared and described. The main findings are highlighted within the text. The complete analysis is available in Portuguese at the link⁴.

5.6.1 Startup 01 Artifacts

Observing the artifacts developed by ST01, it is evident that a broader AC was created for the story, along with 15 more specific AC. The teams aimed to develop an AC for each guideline of the ACUX, including the reference code of the desired guideline in each AC. Although the ACUX does not require the inclusion of an AC for each guideline, doing so can enhance the precision of incorporating UX requirements into the AC.

The team developed one AC for each US following the grammar suggested by the ACUX, as well as 15 additional AC written in free form. This same pattern was applied across all US of ST01. It was observed that **UX requirements were taken into account in the developed AC**; out of the 80 analyzed AC, 72 included UX requirements in their descriptions. Although this evaluation did not focus on quantitative measures, among these 72 AC, 6 presented some type of issue regarding the information from the ACUX, in addition to the UX requirements.

Observing the misuse of the ACUX, it is first noted that in several AC, Guideline ID-01 (“Specify how the user interacts with the system functionality”) was not considered, while simultaneously adhering to the first topic presented under “what not to do” (“Do not specify details about user interaction”). In other words, **five AC failed to clearly present how the user's interaction with the system occurs** (e.g., “interacting with the button”; what does the interaction entail? click? touch?). A second issue identified in the descriptions of the AC pertains to subjectivity. The following descriptions were identified in some AC: “simple and direct visual elements”; “data should be presented in an easy manner”; and “simple form.” Thus, in these AC, the last point raised by the ACUX regarding “what not to do” (“Specify details based on personal perceptions”) was not considered, allowing for different interpretations.

Another misuse of the ACUX that occurred in more than one AC is related to Guideline ID-06 (“Specify the sequence in which the information should be presented to facilitate interaction”), in which the participants provided a sequence of information but did not clearly specify what the sequence entails. It is understood that these details may possibly be clear to the team during that sprint, however, considering the proposal presented by the ACUX, **it is important to clearly specify all details to avoid leaving any point implied**.

An important point to consider is that the AC encompassed both groups related to UX present in the ACUX, addressing aspects of interaction design and information organization as well as those related to visual elements.

5.6.2 Startup 02 Artifacts

Upon examining the artifacts developed by the ST02 team, it is noted that one US followed the same structure adopted by the ST01 team, specifically, a single US with 16 AC, comprising one broader, more general AC (adhering to the grammar suggested in the ACUX), while the other AC were more specific, lacking an established grammar but **aiming to meet the guidelines proposed in the ACUX**. However, the other two US included only one AC each.

In ST02, **UX requirements were also considered in the AC** developed with the support of the ACUX. In quantitative terms, UX requirements were included in 17 of the 18 analyzed AC, representing approximately 94.4%. It is important to emphasize that a quantitative analysis was not the focus of this evaluation. Nevertheless, the number of AC that incorporated UX requirements through the utilization of the ACUX is **considerably representative**. Analyzing separately the US that presented only one AC per story, it is possible to identify that, despite presenting only one AC, these **encompassed more than one guideline** from the ACUX. This indicates that UX requirements at different levels can be considered within the same AC.

A misuse of the ACUX identified in the description of an AC, similar to that observed in ST01, is related to Guideline ID-06 (“Specify the sequence in which the information should be presented to facilitate interaction”). In this instance, the participant recorded the following AC: ‘Message, confirmation button, Profile menu, release of menus,’ yet **did not provide further details about the AC**, leaving the true meaning of this AC implied.

⁴ US/AC artifacts available in Portuguese:

https://docs.google.com/spreadsheets/d/1uMyGXuOrq3YtQEGct0xBCS1RZsulosoDEqwG_tA3Y3g/edit?gid=0#gid=0

5.6.3 Analysis of Startups Artifacts

The guideline that **most assisted the teams in including UX requirements** was 'VE-01' ('Specify the most appropriate visual elements for the user to perform their tasks'). The content of this guideline was identified in 37 AC, with 25 AC from ST01 and 12 from ST02.

In ST01, **all guidelines were utilized**, meaning that at least one UX requirement suggested by each of the ACUX guidelines was identified. In contrast, in ST02, two guidelines were not used, specifically (ID-04 and VE-04). However, it should be noted that this does not indicate a problem with the use of the ACUX, as the goal of the ACUX is to assist in the writing of UX requirements by presenting various guidelines, which should be applied according to the team's needs. Nonetheless, it can be considered that the **number of guidelines used as support in ST02 was also representative**, as only two of the 15 guidelines present in the ACUX were not utilized.

To analyse the most reported dimensions of UX, Table 2 was created. In this table, it is evident that both the guidelines related to "interaction design" and those related to "visual elements" were utilized by both startups. Comparing the two startups, it is observed that the **prevalence of the use of "visual elements"** was similar across both teams. This indicates that in both startups, the guidelines pertaining to the category of "visual elements" were the most frequently employed. However, it should be noted that the group of visual elements comprises three more guidelines than the interaction design group.

Table 2. Use of guideline groups.

UX Dimension	ST01	ST02	Total
Interaction Design	63	19	82
Visual Elements	82	26	108

The artifacts developed by the teams of the startups indicate that the **utilization of the ACUX was positive**. This is evidenced by the fact that all guidelines were employed at some point, and the **two dimensions of UX addressed by the ACUX** were incorporated into the artifacts of both startups.

6 Discussion

The case study findings confirmed that ACUX introduces advantageous for teams in managing the creation of AC with a focus on UX requirements as our first study has revealed [21]. Additionally, the results showed that the use of the guide enhanced the communication on UX within the team and with external stakeholders. Zaina, Sharp & Barroca [4] previously discussed issues on communication about UX in agile teams and reported that significant UX details are often hidden into the software engineering artifacts (e.g., user stories, prototypes).

Our results revealed that the ACUX use aided the teams to anticipate discussions about the significant aspects that affect the user interface design and consequently the the product user experience. ACUX also served as a method to systematize the specification of UX requirements through the AC writing. Although the advantages of employing the guide was evident in the study outcomes, it is worth noticing that the integration of ACUX into the teams' routine introduced a workload since they always consulted the guide before preparing the US/AC. Nevertheless, we got evidence that requirements' documentation was not a common practice in the startups, which could have influence the effectiveness of the guide adoption. The lack of UX documentation was previously highlighted in [4, 14]. However, the startups have an expectation that the continuous use of the guide enhances the teams' ability to specify requirements. According to Wautelet et al. [12], the use of guidelines improves US specification. The case study presented here demonstrates that better specifications significantly improve both internal team communication and with external with other organization sectors.

In addition, the team workflow changed with the inclusion of ACUX. The discussions on UX design was moved to before the prototyping phase. Besides, the dialogue about UX become more explicit and straightforward which contributed to improving team performance and reduced the need for coding and requirement specifications' revisions. The guide encouraged a requirement discussion more UX-focused supported by the concrete UX elements [1] which include interface components and user actions.

The findings showed that the guide serves as a reminder for developers' memory on the crucial aspects to define UX concerns. It assisted team members lacking UX expertise in the writing of US/AC contained more precise and thoroughness details. Lucassen et al. [6] had previously explored the importance of elaborating US/AC with completeness to keep a good communication about the software requirements.

Taking into account other proposals, ACUX presents guidelines for different purposed, i.e., writing UX requirements in US/AC. Besides, its format to provide the content and its structure makes the guidelines presentation more appropriate to its purpose. The Choma et al. [16], Lopes et al. [19] and Marques et al. [20] purposals cover the writing of AC; however, they request the utilization of UX artifacts to support the US/AC elaboration. Moreno &

Yague [15] address an approach with different purpose which is dedicated to defining in AC the incorporation of feedback messages to the users. Pereira et al. [14] propose patterns that facilitate the identification of UX requirements that can be described in AC; however, the patterns do not make clear the specificities of UX elements. Unlike these works, ACUX is not associated with any particular artifact or purpose, such as feedback messages, which gives it a broader applicability. Furthermore, ACUX takes into account the UX elements suggested by Garret [1] which provides guidelines with more concrete details on user interface.

Upon examining the artifacts developed with the support of the ACUX, it was possible to identify that the suggested structure for writing ACs was not entirely disregarded. In the vast majority of AC, the writing was freeform, lacking a defined grammatical standard, and yet UX requirements were present. This factor further differentiates this work from the approaches of Choma et al. [16], Lopes et al. [19] and Marques et al. [20], which focused on the write of AC.

Taking into account our previous work [21], this paper introduces a distinct perspective by evaluating the application of guidelines through a comprehensive approach. The prior paper focused on the implementation of guidelines in US/AC, identifying the most frequently used ones. In the current paper, we investigated the positive and negative aspects perceived by the teams on the use of guidelines as well as the effects of the guide adoption on the teams communication and on their daily operations.

The participation of only two startup software teams is a limitation in the investigation. However, the teams' configuration accurately reflects typical startup team structures. Generally, these professionals are novice developers, primarily engaged in development, possess minimal skills in defining requirements, and often have little knowledge on UX aspects. Therefore, this study results probably reflect the current work conditions in startups with similar team characteristics.

7 Conclusion

This paper presented a case study on the use of ACUX, an artifact that provides a set of guidelines to assist software teams in writing UX requirements into acceptance criteria. Two software teams from different startups participated in the case study that adopted the ACUX throughout a development cycle that followed agile practices. Feedback was collected from team members through individual interviews to evaluate the effectiveness of the guide use and its influence on the teams daily activities.

The findings indicated that the guide served as a reminder about relevant user experience aspect to be considered in the software specification. The guide adoption encouraged the teams to deliberate on the UX requirements prior to the prototyping phase. Consequently, the participants recognized that the guide helps prevent their rework of user interface design because the guide enriches the documentation on UX requirements. The teams also believed that their performance improved using the guide. Despite the guide initially introducing a workload, there is an acknowledgment that the guidelines will gradually become integrated into the requirements specification and their respective documentation.

In future work, we aim to replicate the study in startup teams with different levels of maturity to compare the results. This analysis will enhance our understanding of which guidelines were applied and how they vary across different maturity stages.

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