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Investigating UX work in Software Startups: A Survey about Attitudes, Methods, and Key Challenges

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Abstract User eXperience (UX) work within the software industry entails implementing user-centered practices and techniques to acquire and apply insights about users. Given their challenging context characterized by small teams and limited resources, this application can provide software startups with a competitive edge. Despite a growing interest in this field, the perspectives of startup professionals regarding UX work and the challenges they face remain largely unexplored. This paper seeks to explore the perceptions of startup professionals regarding the usefulness of methods and techniques used in UX work, as well as the moments during user interactions with the product or service when they are applied, alongside the challenges inherent in the startup environment. To achieve this, we conducted a survey involving 90 professionals from software startups in Brazil, employing descriptive and inferential statistical methods for data analysis. Our findings reveal that software startup professionals prioritize understanding user needs, capturing feedback, and conducting user tests in their UX work. Interviews are the most commonly utilized method, although usability testing, competitive analysis, and high-fidelity prototyping are also valued across various stages of startup maturity. Furthermore, UX data is primarily collected during user interactions with the product. Additionally, we identified that specific challenges may have a reciprocal relationship with UX attitudes. These findings underscore the perceived value of UX work among software startup professionals, although perspectives vary depending on the startup's stage.

Keywords: UX Work, Software Startups, Challenges, Long-Term UX, UX Methods, UX Attitudes

1 Introduction

User eXperience (UX) emerged as an umbrella term that includes all aspects of user interaction with services and products by combining situational and temporal elements related to technology use (Norman and Nielsen, 2020; Bargas-Avila and Hornbæk, 2011; Hassenzahl and Tractinsky, 2006). Over time, studies of Human-Computer Interaction (HCI) in the software industry have pointed out the need for professionals to pay attention to the experience that the product provides to the users (Vukovac *et al*., 2019; Kashfi *et al*., 2019; Kieffer *et al*., 2019; Saad *et al*., 2021; Choma *et al*., 2022). The literature has discussed that efforts employed to conduct user-centered activities, methods, and techniques, also called UX work, can provide benefits to software development (Zaina *et al*., 2023; Saad *et al*., 2021; Hokkanen and Väänänen-Vainio-Mattila, 2015). In addition, the UX work might benefit the business (e.g., increasing the number of users, identifying new market segments) (Hokkanen *et al*., 2016b), as well as maximize the product's value to the customer (Klotins *et al*., 2019b; Kuusinen *et al*., 2019). Software professionals also recognize that UX is relevant for determining whether or not users stay engaged with a product or service (Alhadreti, 2020), besides creating a competitive advantage (Hokkanen and Väänänen-Vainio-Mattila, 2015) and helping to move towards sustainable business creation (Unterkalmsteiner *et al*., 2016).

Difficulties in terms of collecting and using user feedback (Hokkanen and Leppänen, 2015), lack of teams' mindset or culture about UX work (Lindgren and Münch, 2016), lack of UX specialists or professionals dedicated to UX (Hokkanen and Väänänen-Vainio-Mattila, 2015), and balancing the customer value with minimal engineering effort (Klotins *et al*., 2019b) are challenges faced by software startups' professionals. However, software startup professionals have shown efforts in applying UX attitudes, methods, and techniques to research and evaluate user experience (Saad *et al*., 2021; Silveira *et al*., 2021; Guerino *et al*., 2022; Choma *et al*., 2022; Zaina *et al*., 2023). UX attitudes represent the practices, actions, and activities that are recurrent in the development of UX-oriented products and services (Meingast *et al*., 2013; Hokkanen and Väänänen-Vainio-Mattila, 2015; Kashfi *et al*., 2019; Kieffer *et al*., 2019; Hassenzahl, 2018) (e.g., user tests, developing prototypes, and artifacts to communicate UX) (Hokkanen *et al*., 2016b; Zaina *et al*., 2021; Silveira *et al*., 2021).

UX attitudes combined with different methods and techniques (e.g., interviews, card sorting, and usability testing) allow the companies to investigate the prolonged use of a product (Pohlmeyer, 2012), as well as discover the product's

value that can emerge over time (Marti and Iacono, 2016). At the same time that the longitudinal research about UX (i.e., Long-Term UX) is relevant for understanding users' behaviors, feelings, and emotions from different "pictures" about the use of a product or service (Varsaluoma and Sahar, 2014; Marti and Iacono, 2016), software startups professionals also struggle with the effective use of information collected about their users from UX data (i.e., user behavior, emotions, and satisfaction) (Hokkanen and Väänänen-Vainio-Mattila, 2015; Hokkanen and Leppänen, 2015). UX data is a valuable resource to influence routes to software development and generate knowledge usable by all professionals (Kunneman *et al*., 2022; Victorelli *et al*., 2020).

Unlike consolidated companies, software startups are characterized by operating with small software teams, using new technologies with little knowledge, working with high uncertainty about customers and market conditions, and having a high failure rate (Paternoster *et al*., 2014). Giardino *et al*. (2015) show some challenges software startups face in the early stages, which can be extended to startups in other stages (Wang *et al*., 2016). These challenges include managing multiple tasks, defining a viable minimum product, and delivering customer value (Giardino *et al*., 2015). Considering the characteristics of software startups and the challenges faced by software professionals in UX, we bring to the Brazilian HCI scientific community a discussion about the practice of UX work from the point of view of software startups' Brazilian professionals. By looking at the Brazilian Symposium on Human Factors in Computing Systems publications, we identified a few papers that explore UX topics from the perspective of a large number of software professionals, i.e., through surveys (Melo and Darin, 2019; Pichiliani and Pizzolato, 2019; Alves and Matos, 2019).

Therefore, this paper aims to investigate the perceived usefulness of software startups' Brazilian professionals about UX attitudes, methods, and techniques applied in UX work. Our paper still investigates in which moments of Long-Term UX, UX attitudes are performed during software development. Furthermore, we also investigate the key challenges perceived by professionals and the existence of these challenges in the different stages of Brazilian startups. To achieve these goals, we conducted a survey answered by 90 professionals from Brazilian software startups. In our study, we define three research questions (RQs): **RQ1)** *What is the perceived usefulness of UX attitudes, methods, and techniques according to the software startup professional?*; **RQ2)** *In which moments are the UX attitudes be performed to collect the UX data according to the software startup professional?*; **RQ3**) *Does the use of UX attitudes impact the challenges faced by software startups?*

Our study contributes by presenting results on UX attitudes that software professionals have applied in the context of startups. It also reports that the startup's maturity stage influences the adopted UX attitudes and the perceived usefulness of UX methods and techniques. Furthermore, our findings clarify that UX data is collected by software startup professionals at all moments of Long-Term UX, mainly when users utilize the product. We highlight that this paper is an extended version of a previously published paper (Guerino *et al*., 2024). The new contributions of this extended version are mainly linked to research question RQ3, which was exclusively added to this new version. Therefore, we highlight the findings of RQ3 that startups at different stages face diverse financial, team, and technological challenges; furthermore, we related the investigated UX attitudes to these challenges, for example, the relationship between team-oriented attitudes and team-related challenges, as well as financial challenges influenced by attitudes such as user testing and research or evaluation optimization.

Our paper is organized into the following main sections: Background (Section 2), Research Method (Section 3), Results (Section 4), Discussion and Threats to Validity (Section 5), Conclusion and Future Work (Section 6).

2 Background

In this section, we present the fundamentals that support our study (Section 2.1), besides related work with surveys applied (Section 2.2).

2.1 Fundamentals

The standard ISO 9241–210 defined UX as "user's perceptions and responses that result from the use and/or anticipated use of a system, product or service" (ISO, 2009). More recently, Hassenzahl (2018) advocates UX-oriented software development aiming to provide user "well-being" with pleasurable and meaningful experiences (*Wellbeing*), determine user needs and experiences (*Why*), fix product functionality to create valuable experiences (*What*), and generate the appropriate interaction elements for the desired experiences (*How*) (Hassenzahl, 2018). Our survey takes into account the Hassenzahl (2018)'s definition, considering that practical work toward good UX is rooted in a User-Centered Design (UCD) approach (ISO, 2009).

Our survey investigated some of the UX attitudes identified in a recent systematic review (Martinelli *et al*., 2022). Martinelli *et al*. (2022) identified 38 UX practices (i.e., UX attitudes) focused on UX research and evaluation that have been applied by the software industry (i.e., software startups and established companies), besides exploring how these attitudes are related to longitudinal research. Our survey considered the eight most frequently cited UX attitudes in this systematic review (Martinelli *et al*., 2022), and Table 1 describes these UX attitudes.

Table 1 shows that these UX attitudes are intended to leverage UX work. We use the concept of UX work to refer to the use of user-centered attitudes, methods, and techniques that aim to acquire and apply knowledge about the target audience (Hokkanen and Väänänen-Vainio-Mattila, 2015; Saad *et al*., 2021; Zaina *et al*., 2023). Taking into account that UX attitudes represent the practices, actions, and activities recurrent in the development of UX-oriented products and services (Meingast *et al*., 2013; Hokkanen and Väänänen-Vainio-Mattila, 2015; Saad *et al*., 2021), these UX attitudes are applied through methods and techniques which impose structure on the UX work (Kashfi *et al*., 2019; Rivero and Conte, 2017). We investigated some of the methods and techniques identified in another systematic mapping (Guerino

Table 1. UX attitudes investigated.

UX Attitudes	Description
Educate and train members in UX Research	Internal training and workshops among practitioners to develop research and evaluation skills. Educate development teams to create a culture of user research.
Strategies, attitudes and goals about UX	Define UX goals to help guide product development. Plan beforehand activities and strategies dedicated to UX work.
Understand user needs	Understand through research the pains, difficulties, and expectations of users. Design solutions based on the users' real needs to create value.
User feedback capture	Feedback is collected from surveys about a new feature or design, obtained in interviews, meetings, or by exchanging app messages. Feedback collected from users or customers.
User tests or evaluations	Develop tests and evaluations about the user experience when interacting with a service or product. Expert reviews and evaluations also help to minimize failures during product development.
Analyze data and generate useful insights for the product or service	Develop UX data analytics to generate meaningful insights that help make decisions about product design and development.
Artifacts to bring teams, users and insights together	Produce Personas, Storyboards, or wiki pages to materialize and share UX knowledge among practitioners from different teams.
Attitudes that optimize surveys or evaluations	Develop lean assessments and use simple techniques to generate designs and surveys with users quickly. Approaches such as Lean UX, Agile UX, and Design Thinking support this practice.

et al., 2022). Guerino *et al*. (2022) identified 36 methods and techniques that software startup professionals have applied during their UX work. We considered the eleven methods and techniques most frequently cited in this systematic mapping (Guerino *et al*., 2022): interviews, competitive analysis, high-fidelity prototype, usability testing, user flow map, personas, surveys, wireframe, benchmarking, storyboard, and card sorting.

We investigated these UX attitudes, methods, and techniques in relation to applying longitudinal research (i.e., Long-Term UX). Long-Term UX is defined by longitudinal research on UX that investigates user profile changes when using a product or service at various points in time (Roto *et al*., 2011; Kujala *et al*., 2013; Marti and Iacono, 2016). Roto *et al*. (2011) divides into four moments of use of a product: *Anticipated UX* when one expects to get a user's expectations before the first use or launch of a new product; *Momentary UX* to understand perceived changes during the user's interaction with the product, at the exact moment they occur; *Episodic UX* to evaluate a particular episode of product use after a broader interaction event; and *Cumulative UX* with the aim of to gather the results of previous research and user recollections after having used the product for some time. Collecting UX data with users in the Long-Term UX can be run sequentially, considering all moments usage or some of them (one or more moments usage) (Roto *et al*., 2011). Long-Term UX investigations analyze short-term (one day or one week) and long-term (weeks or months) interactions, considering pre and post-interaction experiences (Mkpojiogu *et al*., 2022; Kujala *et al*., 2013, 2011; Roto *et al*., 2011).

Software professionals recognize that UX data obtained from longitudinal research produces useful results for (i) comparing the results with previous knowledge, (ii) understanding the change in UX over time, (iii) helping to decide future work, (iv) designing and developing new products, and (v) updating current products (Varsaluoma and Sahar, 2014). UX data is user data captured through UX tracking, market trends, and user responses by interacting with a product or service, being these UX data associated with user behavior, emotions, culture, and satisfaction (Tullis and Albert, 2013; Kunneman *et al*., 2022). UX work that does not capture UX data only in a single user experience can minimize the professionals' difficulty in handling and utilizing user feedback (Hokkanen and Väänänen-Vainio-Mattila, 2015; Hokkanen *et al*., 2016a).

UX work can be challenging for companies such as software startups (Hokkanen and Väänänen-Vainio-Mattila, 2015; Hokkanen *et al*., 2016a; Saad *et al*., 2021). Particularly, software startups also face challenges respective to dimensions of the development team, product, financial, and market, which can impact the different development and learning stages (Giardino *et al*., 2015). Therefore, our survey investigated the ten challenges cited by Giardino *et al*. (2015) and Table 2 shows the challenges with their dimensions and a description of each one. It could be that these challenges have an impact on UX work in software startups. For example, the lack of resources such as time, people, and budget (Hokkanen and Leppänen, 2015), and finding the target users to collect meaningful feedback (Hokkanen and Väänänen-Vainio-Mattila, 2015) are challenges that directly interfere with UX work (Saad *et al*., 2021).

Table 2. Key challenges from Giardino *et al*. (2015) investigated

Challenge (Dimension)	Description
Technology uncertainty (Product)	Developing technologically innovative products, which require cutting-edge development tools and techniques.
Acquiring first paying customers (Market)	Persuading a customer to purchase the product, e.g. converting traffic into paying accounts.
Acquiring initial funding (Financial)	Acquiring the needed financial resources from angel investors or entrepreneurs' family and friends.
Building entrepreneurial teams (Team)	Building and motivating a team with entrepreneurial characteristics, such as the ability to evaluate and react to unforeseen events.
Delivering customer value (Market)	Defining an appropriate business strategy to deliver value.
Managing multiple tasks (Team)	Doing too much work in a relatively short time, e.g. duties from business to technical concerns.
Defining minimum viable product (Product)	Capturing and evaluating the riskiest assumptions that might fail the business concept.
Targeting a niche market (Market)	Focusing on specific needs of users willing to take risks on a new product, such as early-adopters and innovators.
Staying focused and disciplined (Team)	Not being particularly sensitive to influences from different stakeholders, such as customers, partners, investors and competitors (both actual and potential).
Reaching the break-even point (Financial)	Balancing losses with enough profits to continue working on the project.

Software startups are newly created companies that pro-

duce software products or make intense use of software to manage their activities (Giardino *et al*., 2014). Software startups can be classified into four stages to explain the maturity of product development and consolidated business (Klotins *et al*., 2019a; Associação Brasileira de Startups, 2020). Our survey comprises these four stages as follows: *Stage 1* is the *ideation phase*, which includes creating and refining the idea of a product or service to selling it to the first customer, working with a small team; *Stage 2* is the *operation phase*, in connection with the first sale until the validation of the product or service, generating more sales without major changes in the software development; *Stage 3* is the *traction phase*, where the product development process is stable, it will reach the entire market, and the growth rate will stabilize; and *Stage 4* is the *scale-up phase*, where the software startup has already reached its maturity, being the development process robust and well-established, with validated processes for creating new products (Klotins *et al*., 2019a; Associação Brasileira de Startups, 2020). These stages of software startups guided the analysis of the results obtained by our survey.

2.2 Related Work

We identified three surveys on UX in software startups (Hokkanen *et al*., 2016b; Salgado *et al*., 2016; Silveira *et al*., 2021). Hokkanen *et al*. (2016b) investigated what abilities software startup professionals have to conduct UX work, and what factors affect UX work. Collecting and using log data to support UX design, such as having a clear strategy for how to create the UX aimed are abilities hardest according to professionals. Besides, three factors affect UX work in software startups: i) Strategy, as strategic choices on resource allocation and product qualities that affect actions for creating good UX; ii) Team Qualities, as they can be improved by having UX expertise, domain knowledge, and UX mindset; and, iii) Interaction with Users, that focus on how involving users in their process of creating UX. This survey was applied between 2015 and 2016, including 21 professionals from five countries (the majority of Finland) (Hokkanen *et al*., 2016b).

Salgado *et al*. (2016) also surveyed 26 professionals from Brazilian small businesses (including software startups) about Usability and UX practices. This survey collected data during 2016, and their results pointed out the need to improve the professional mentality about UX in software development, as well as carry out UX practices more suitable to small businesses. In addition, the authors showed that professionals with low experience often apply the UX methods and techniques in the companies investigated, especially user interviews, low and high fidelity prototypes, contextual analysis, and usability tests (Salgado *et al*., 2016).

Silveira *et al*. (2021) present a survey conducted in 2020 with 88 Brazilian professionals. This survey investigated what are the reasons for using UX practices for these professionals and what challenges impact UX work. Creating value for the user, obtaining competitive advantages, and understanding how to sustain the long-term business model are reasons for using UX in software startups. Besides, six challenges in UX adoption were identified: i) matching UX work into agile practices, ii) making practices leaner for UX work, iii) adjusting the pace of UX work in a highly reactive environment, iv) aligning UX work with the business model, v) training and skills development about UX activities, and vi) conducting research with real users (Silveira *et al*., 2021).

We identified four other surveys in the literature applied in the software industry (which includes software startups), investigating UX partially or as a central topic (Giardino *et al*., 2015; Wang *et al*., 2016; Melo and Darin, 2019; Alhadreti, 2020). Giardino *et al*. (2015) collected 5389 responses by software startups' professionals from 90 countries, with the majority of participants being from the USA. The survey conducted between 2013 and 2014 identified ten challenges in software startups respective to four dimensions (see Table 2). It is noteworthy that this survey does not present results about UX, but there are software startup professionals' quotes on the lack of UX specialists in building products/features and performing user-based experiments (Giardino *et al*., 2015).

Wang *et al*. (2016) analyzed responses from 4100 different software startups, also collected between 2013 and 2014. Although this study is a continuation of Giardino *et al*. (2015), the authors restrict the data analysis to considering one response per startup and only responses from the most senior role (i.e., responses mentioned by CEOs, CTOs, and Engineers). Since the focus of the study is limited to early-stage software startups, the authors present seventeen challenges faced by startups. Some results presented that the biggest challenges are building products, customer acquisition, and funding. At the same time, leadership & team alignment, partnership, legal, and regulations are challenges of less impact or concern to software startups. Statistic tests confirmed that what software startups perceive as the biggest challenges vary across different learning as well as product development stages (Wang *et al*., 2016).

Melo and Darin (2019) analyzed how the Brazilian community (including academics and professionals) understands different definitions of UX. The survey of 2019 included 23 UX definitions about various topics, including the "Long-Term UX´´ term. One-third of the 216 participants are from the software industry, which includes software startup' professionals. The results indicate that the participants strongly agree with the definitions of *Anticipated UX* and *Cumulative UX*, but understanding *Momentary UX* and *Episodic UX* still is complex. 'Prior exposure to an artifact shapes subsequent user experience', and 'the imagined use of a product can result in real experiences' are statements to define *Anticipated UX* and received the most point (Melo and Darin, 2019).

Alhadreti (2020) collected 2020 answers from 75 professionals working in software development environments from Saudi Arabia. This survey explored professionals' perceptions of UX maturity, UX significance, UX methods, and the UX challenges in software development. Improving UX consistency, collaborating across departments, and collaborating between teams are UX challenges most frequently, while access to user participant panels, and prototypes to provide to participants are principal UX resources. Besides, high-fidelity prototypes, task analysis, personas & user profiles are some of the UX methods most used by professionals. One-third of the participants may be from software startups due to the size (number of employees) of their companies (Alhadreti, 2020). This survey identified challenges with UX and the use of UX methods similar to previous surveys (Sil-

veira *et al*., 2021; Hokkanen *et al*., 2016b).

Despite the interest in research involving UX and software startups, we have not identified any exploratory studies investigating the view of professionals from these companies. More precisely, our survey differs since it addresses the view of software startup professionals about Long-Term UX and bases our analysis on the opinion of these professionals about the usefulness of UX methods and techniques. Besides discussing the UX work currently performed at software startups, our survey presents the future perspectives that professionals have about UX attitudes, methods, techniques, and challenges that impact UX work.

3 Research Method

Our research method chosen was an online survey, and we followed the guidelines of Kitchenham and Pfleeger (2008) (detailed in the next sections). This research followed Resolution No. 014/2017-CEP[1] of the State University of Maringá, which regulates the internal activities of the Permanent Committee on Ethics in Research Involving Human Beings at that university.

3.1 Survey Design

We created a survey containing thirty-one questions, including demographics and questions about UX. Before these sections, an introductory section about the Informed Consent Form (ICF) was inserted, which presented information about the purpose of the survey, data confidentiality, and anonymity. To proceed with the survey, participants had to agree to the terms. Four researchers participated in the survey design: one Ph.D. and one Ph.D. student in Computer Science, with +6 years of research in HCI and UX, formulated the survey structure and questions; two senior researchers, with +8 years of experience in research and practice with software startups, reviewed and refined the survey.

For this paper, we used some specific questions to explore our RQs, aimed at (i) investigating the attitudes and perceived usefulness of UX methods and techniques (RQ1); (ii) exploring at what point in the Long-Term UX attitudes are used to collect data (RQ2); and (iii) investigating if UX attitudes impact the startup challenges shown in Table 2 (RQ3). We seek to answer these questions from the professionals' point of view at the startups. Table 3 presents the demographic questions (Q1 to Q6), the questions analyzed to answer each RQ (Q7 to Q13), and the type of response used for each question. All questions were available in Portuguese.

Before reaching the final version of the questions, we evolved and refined the survey. The researchers performed several meetings to review terminology, structure, and questions. In addition, the survey was made available to two software startup professionals for pilot testing. From the pilot results, we refined the questions by inserting more answers to cover different options and reorganized the survey questions. It is important to note that the data collected from the pilot study was not considered in the final sample.

[1] `http://www.ppg.uem.br/images/downloads/copep/Resolucao-014-2017-CEP-UEM.pdf`

Table 3. Survey questions

#	Questions	RQ	Type
Q1	What is your educational background?	-	MC
Q2	What is your position or role in the startup?	-	MC
Q3	How many employees does the startup have?	-	MC
Q4	What year was the startup founded?	-	FT
Q5	In what segment does the startup operate?	-	MC
Q6	What stage does the startup fit into?	-	MC
Q7	What UX attitudes are applied by startup professionals?	RQ1/RQ3	MC
Q8	What UX attitudes do you consider most important to develop in the future?	RQ1	LK
Q9	How useful was each UX method and technique listed below?	RQ1	LK
Q10	What motivated the startup to adopt UX methods and techniques?	RQ2	MC
Q11	Among the practices of user research and evaluation, how useful is the UX data collected from these methods?	RQ2	LK
Q12	When performing user research and evaluation, in which moments of the development do you or your team usually collect data from the user?	RQ2	MC
Q13	How difficult was to overcome each of the listed challenges?	RQ3	LK

Legend on Type: Multiple-Choice (MC), Free Text (FT), and Likert Scale (LK).

3.2 Data Collection

After refining the survey from the pilot test, we made it available online via Google Forms. Data collection took place between December/2021 and February/2022. Our data collection used convenience sampling, which considers the availability and interest of the participant in the study according to the time frame defined for the data collection (Kitchenham and Pfleeger, 2008). We contacted the participants through social networks (i.e., Facebook and LinkedIn), email, and WhatsApp. The participants' information was taken from the database of the ABStartups[2] and innovation programs.

3.3 Data Analysis

We had 90 participants who responded to our survey. In the first step, when reviewing the consistency and integrity of the data (Kitchenham and Pfleeger, 2008), we found no inconsistency, incomplete or duplicate responses. Thus, we obtained 90 valid responses that served as the basis for the next step of the analysis, aiming to answer our RQs.

To answer RQ1, we analyzed responses on (i) the UX attitudes that are commonly applied by startup professionals (Q7), (ii) the UX attitudes that respondents consider most important to develop in the future (Q8), and (iii) their perception of the usefulness of UX methods and techniques applied by startup professionals (Q9). To answer RQ2, we analyzed the responses on (i) the motivations that led startup professionals to adopt UX methods (Q10), (ii) the respondents' perception of the usefulness of the methods used to collect user data (Q11), and (iii) the moments of development in which startup professionals usually collect user data (Q12). Finally, to answer RQ3, we analyzed responses on the level of difficulty startups were to overcome each of the ten challenges showed in Table 2 (Q13) (see Table 3) to later cross-reference them

[2] https://abstartups.com.br/mapeamento-de-comunidades/

with the data related to UX attitudes collected in the Q7. For example, we investigated whether startups that have the attitude of *understanding user needs* have less difficulty with the challenge *targeting a niche market* or whether startups that carry out *user tests or evaluation* have less difficulty with the challenge *delivering costumer value.*

For data analysis, we divided the responses into four groups based on the stage of software startups reported by the participants (see Q6 in Table 3), defined according to the literature (see Section 2.1). After partitioning the responses into these groups, we analyzed quantitatively the data using descriptive and inferential statistics (Wohlin *et al*., 2012). We applied Kruskal Wallis tests (McCrum-Gardner, 2008) to compare the survey responses across startup maturity stages. The tests are conducted with a significance level of 0.05. Additionally, we used the *Dwass–Steele– Critchlow–Fligner* (DSCF) post hoc test (Douglas and Michael, 1991) to verify statistically significant differences between the four software startup stages and determine which groups were different in the pairwise comparisons in each one of the questions on usefulness, attitudes, and challenges (i.e., Q7 to Q13).

4 Results

This section presents our results. Section 4.1 presents a profile of respondents and information about the software startups. In sections 4.2, 4.3, and 4.4, we present the results of each research question.

4.1 Demographics

As mentioned in the data analysis (Section 3.3), we had a total of 90 valid responses from participants in our survey. Regarding the participants' educational background, we observed that the majority (53%, N = 48) are or have gone through a post-graduation course (i.e., continuous education, master or doctoral programs). In addition, 36% (N = 32) have an undergraduate degree, 9% (N = 8) are in undergraduate studies, and 2% (N = 2) have only completed high school. Regarding the participants' positions, we obtained a variety since the same participant could select more than one position. The most returned positions were CEO (62%, N = 56), user interface designer (14%, N = 13), and developer (14%, N = 13).

Taking into account the year the startups were founded, we observed that the startups were founded from 2000 to 2021. We realize that most software startups in our sample are young and have up to 4 years of operation, 21% (N = 19) were founded in 2019, 19% (N = 18) in 2020, and 14% (N = 13) in 2021. Furthermore, different answers were obtained about the segment in which these software startups operate. The highest returns on segments were marketing (11%, N = 10), finance (9%, N = 8), and retail (9%, N = 8).

When analyzing the 90 responses about the software startup stages (see Q6 from Table 3), we found that our sample was well distributed among the four stages: Stage 1 (i.e., Ideation) equivalent to 31.1% (N = 28), Stage 2 (i.e., Operation) relative to 26.7% (N = 24), Stage 3 (i.e., Traction) corresponding to 24.4% (N = 22), and Stage 4 (i.e., Scale-up) associate to 17.8% (N = 16). By analyzing the demographic data, we found that around 72% of the respondents (65 of 90) were from micro-enterprises with up to 10 employees, among which 65% (47 of 65) were less than 3 years old (see Tables 4 and 5 respectively). From responses, 58% of respondents were from startups that were in stage 1 (28 of 90) or stage 2 (24 of 90), where most of them were micro-sized startups (49 of 90) and up to 3 years old (38 of 90) (see Tables 4 and 5).

Table 4. Startups size

Startup size*	N	Stage 1	Stage 2	Stage 3	Stage 4	% of Total
Up to 5	51	25	16	10	0	56.7%
From 6 to 10	14	2	6	4	2	15.6%
From 11 to 20	13	1	2	4	6	14.4%
From 21 to 50	7	0	0	2	5	7.8%
More than 50	6	0	0	2	4	6.7%

*Number of employees

Table 5. Startups age

Startup age	N	Stage 1	Stage 2	Stage 3	Stage 4	% of Total
1 year	13	6	6	1	0	14.4%
2–3 years	37	12	14	10	1	41.1%
4–5 years	18	7	3	4	4	20.0%
6 years	22	3	1	7	11	24.4%

4.2 Perceptions on UX attitudes, methods, and techniques (RQ1)

UX-related attitudes applied. The four most common UX-related attitudes reported by respondents were *understand user needs* (84.4%), *user feedback capture* (76.7%), *user tests or evaluations* (61.1%), and *analyze data and generate useful insights for the product or service* (55.6%). We see in Table 6 the data from the perspective of startup stages. Although there are no significant differences between the groups of software startups, we find that *understand user needs* and *user feedback capture* are attitudes mentioned by a higher percentage of respondents from software startups in stage 2, and *user tests or evaluations* is most mentioned by respondents from software startups in stage 1. *Artifacts to bring teams, users and insights together*, *educate and train members in UX Research*, and *strategies, objectives, and responsibilities about UX Research* are the three least mentioned attitudes, mainly by respondents of software startups in the first two stages (see Table 6). In Table 6, we also see that these three attitudes show significant differences between the groups from stages 1 and 4 (see p-values column).

UX-related attitudes to develop in the future. As can be seen from Figure 1, startup professionals in stage 3 assigned greater value to the attitudes that they consider most important to develop in the future. However, we did not find significant differences between the groups (see Figure 1). In general, the three most important attitudes in the respondents' opinion are *understand user needs* ($\overline{x}$=4.52),

Table 6. UX-related attitudes applied by startup professionals.

UX-related attitudes applied	N	Stage 1 N=28	Stage 2 N=24	Stage 3 N=22	Stage 4 N=16	% of Total	p-value
Understand user needs	76	24 (85.7%)	21 (87.5%)	19 (86.4%)	12 (75.0%)	84.4%	0.717
User feedback capture	69	18 (64.3%)	21 (87.5%)	17 (77.3%)	13 (81.3%)	76.7%	0.244
User tests or evaluations	55	19 (67.9%)	15 (62.5%)	13 (59.1%)	8 (50.0%)	61.1%	0.700
Analyze data and generate useful insights for the product or service	50	16 (57.1%)	11 (45.8%)	13 (59.1%)	10 (62.5%)	55.6%	0.712
Attitudes that optimize surveys or evaluations	22	5 (17.9%)	5 (20.8%)	6 (27.3%)	6 (37.5%)	24.4%	0.494
Artifacts to bring teams, users and insights together	20	1 (3.6%)	5 (20.8%)	7 (31.8%)	7 (43.8%)	22.2%	0.011*
Educate and train members in UX Research	17	1 (3.6%)	2 (8.3%)	7 (31.8%)	7 (43.8%)	18.9%	0.002*
Strategies, objectives and responsibilities about UX Research	13	2 (7.1%)	2 (8.3%)	3 (13.6%)	6 (37.5%)	14.4%	0.032*

Colors represent the percentage of UX attitudes applied about the total per stage: 0% *100%*

user feedback capture ($\overline{x}$=4.38), and *user tests or evaluations* ($\overline{x}$= 4.36). The three attitudes considered least important were *artifacts to bring teams, users, and insights together* ($\overline{x}$=3.54), *attitudes that optimize surveys or evaluations* ($\overline{x}$=3.68), and *strategies, objectives, and responsibilities about UX Research* ($\overline{x}$=3.70). The averages on the importance of UX-related attitudes assigned per group are shown from black squads in Figure 1.

Perceived usefulness of UX methods and techniques used. From the results, we found that the five most used UX methods and techniques were *interviews* (83.3% - 75 of 90), *competitive analysis* (78.9% - 71 of 90), *high-fidelity prototype* (75.6% - 68 of 90), *usability testing* (75.6% - 68 of 90), and *user flow map* (73.3% - 66 of 90). *Card sorting* is the least used UX technique (60% - 54 of 90) and with the lowest degree of perceived usefulness according to respondents. As shown in Figure 2, respondents assigned a higher degree of usefulness to *usability testing* ($\overline{x}$=4.15) and to *competitive analysis* ($\overline{x}$=3.95), in startups of stage 1 and 2 respectively. On the other hand, *high-fidelity prototypes* are considered highly useful for professionals in startups of stage 3 $\overline{x}$=4.08) and stage 4 ($\overline{x}$=3.93). We found significant differences only regarding the *storyboard* technique between software startups in stages 2 and 3 (see Figure 2).

4.3 Long-Term UX (RQ2)

Motivation to adopt UX practices. The three most mentioned motivations for adopting UX practices among respondents were *to improve product/service quality* (61.1% - 55 of 90), *produce what the user wants to consume* (48.9% - 44 of 90), and *engage customers* (46.7% - 42 of 90). *To improve product/service quality* and *produce what the user wants to consume* were most often mentioned by software startup respondents in stage 4, while *engage customers* were most often mentioned by software startup respondents in stage 2 (see Table 7). Only 11% of respondents mentioned reasons such as *incentive of mentoring programs* or *the startup adopted UX practices due to market demand*, mainly from software startups in stages 1 and 2, respectively.

Usefulness of collected UX data. Nearly 65% of respondents (58 out of 90) stated that collecting *UX data is very useful in software development*, mainly in the opinion of respondents from software startups in stage 1. As shown in Table 8, *collecting user data* appears to be less useful, mainly in stage 3. Only 9% of the respondents (8 of 90) answered that collecting *UX data is not always useful in software development*.

Long-Term UX Moments. Taking into account the moments that software startup professionals usually collect UX data, we identified that 60% of them (54 of 90) collect UX data *while the user uses the product or service (Momentary UX)*; 54.4% (49 of 90) collect UX data *after the user uses the product or service (Episodic UX)*; 45.6% (41 of 90) collect UX data *before the user uses the product or service (Anticipated UX)*; and only 23.3% (21 of 90) collect *user memories or opinions after using the product or service for some time (Cumulative UX)*. In addition, we identified one or more moments of Long-Term UX to UX data collection, which is usually adopted by software startups' professionals. Table 9 shows 13 items listed from A to M (column ID). As shown in this table, only 8% of them match the four data collection moments (see item F). About 52% of the respondents (46 of 90) indicated a single collection moment (see items A, B, D, and G). The most common combination is *Anticipated UX, Momentary UX, and Episodic UX*, which was mentioned by 14% of respondents (13 of 90).

4.4 Challenges and the impact of UX attitudes (RQ3)

Key challenges: The findings for the key challenges faced by the startups are shown in Table 11. The results were arrived at by calculating the average of the responses from the startup professionals at each of the stages analyzed, with the closer to 10, the greater the difficulty related to the challenge.

Regardless of the stage of the startup, the main challenge faced is related to *reaching a financial break-even point*. Except for this challenge, for startups in stage 1, the most difficult challenges were *acquiring first-paying customers*, *building entrepreneurial teams*, and *acquiring initial funding*. On the other hand, the least complex challenges at this stage are *technological uncertainty* and *targeting a niche market*. The main challenges for startup professionals in stage 2 are focused on *managing multiple tasks* and *building entrepreneurial teams*. On the other hand, *targeting a niche market* and *technological uncertainty* are also characterized as less complex challenges at this stage.

For startup professionals in stage 3, in addition to *building entrepreneurial teams*, another challenge is *acquiring initial funding*. As with startups in stages 1 and 2, the least faced

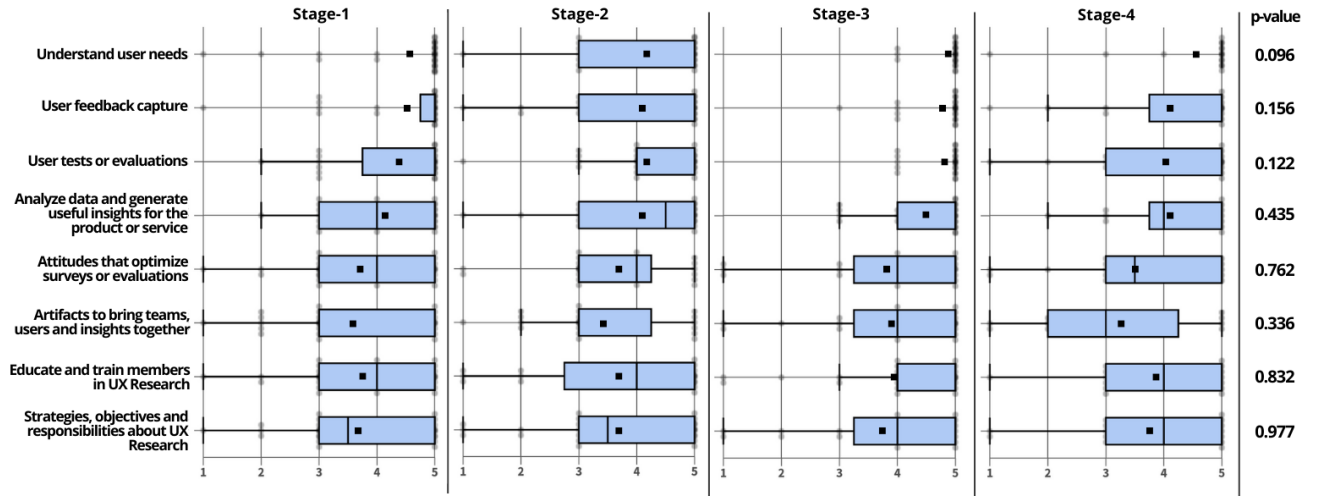

Figure 1. UX-related attitudes to develop in the future (per startup stage).

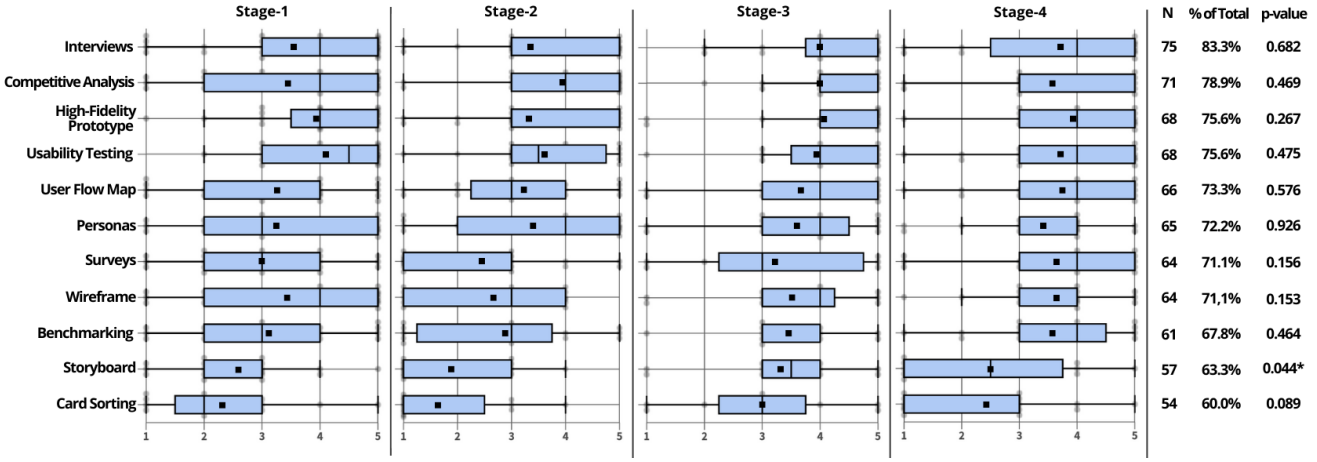

Figure 2. Perception of the usefulness of the UX methods and techniques used (per startup stage).

challenges are also related to *technological uncertainty* and *targeting a niche market*. In stage 4, startups also face the challenge of *building entrepreneurial teams* and *staying focused and disciplined*. The latter stood out in startups only at this stage. About the challenges least faced by startups in stage 4, we highlight *acquiring initial funding* and *technological uncertainty*.

Regardless of the stage, startups' leading challenge is *reaching the break-even point*. Other challenges that we can infer that occur regardless of the stage, according to our results, are *building entrepreneurial teams* and *managing multiple tasks*. The challenges of *acquiring first paying customers* and *acquiring initial funding* are generally concentrated in startups from stages 1 to 3 while *delivering customer value* and *staying focused and disciplined* appear with more significant difficulties in startups from stage 4. Furthermore, concerning the challenges investigated, we can infer that *technological uncertainty* tends to be faced less by startups at different stages.

Impact of UX attitudes: While the challenges were not originally extended to UX issues, we argue that many can impact UX work, for instance, when financial challenges make UX activities unfeasible to adopt formally and continuously (Kuusinen *et al*., 2019). On the other hand, we highlight that UX work can positively impact such challenges, as they can provide timely solutions to overcome them. To strengthen this analysis and verify the relationship between some UX attitudes and the challenges explored, we conducted a cross-analysis involving these concepts. Table 12 shows the average difficulty for each of the challenges investigated for startups that use or do not use each of the UX attitudes also explored in the survey.

When analyzing startups that do not *educate and train members in UX Research* or define *strategies, objectives, and responsibilities of UX Research* (see Table 12), we uncovered that most startups have more difficulty in *building entrepreneurial teams* and *managing multiple tasks*. Still, when analyzing the challenges that have a higher average difficulty for startups that do not implement these practices, we found the challenges *acquiring first paying customers*, *acquiring initial funding*, and *reaching the break-even point*.

Another connection investigated was to understand whether *user tests or evaluation* and *attitudes that optimize research or evaluation* had any relationship with financial challenges, such as *reaching the break-even point* and *obtaining initial funding*. Regarding user testing and evaluation, we noticed when analyzing Table 12 that there was not much difference in the average financial challenges for startups that apply and do not apply this attitude. As for attitudes that optimize research or evaluation, we noticed that startups without

Table 7. Motivations to adopt UX methods and techniques.

Motivation to adopting UX practices	N	Stage 1 N=28	Stage 2 N=24	Stage 3 N=22	Stage 4 N=16	% of Total	p-value
To improve product/service quality	55	19 (67.9%)	12 (50.0%)	13 (59.1%)	11 (68.8%)	61.1%	0.529
Produce what the user wants to consume	44	12 (42.9%)	11 (45.8%)	11 (50.0%)	10 (62.5%)	48.9%	0.638
Engage customers	42	15 (53.6%)	14 (58.3%)	8 (36.4%)	5 (31.3%)	46.7%	0.229
The startup was born thinking about UX practices	33	13 (46.4%)	8 (33.3%)	5 (22.7%)	7 (43.8%)	36.7%	0.327
Time savings in development	33	12 (42.9%)	7 (29.2%)	7 (31.8%)	7 (43.8%)	36.7%	0.657
The startup decided to adopt UX practices recently	11	1 (3.6%)	4 (16.7%)	2 (9.1%)	4 (25.0%)	12.2%	0.170
The startup adopted UX practices due to market demand	10	2 (7.1%)	4 (16.7%)	2 (9.1%)	2 (12.5%)	11.1%	0.725
Incentive of mentoring programs	10	6 (21.4%)	2 (8.3%)	1 (4.5%)	1 (6.3%)	11.1%	0.208

Colors represent the percentage of motivations about the total per stage: 0% 100%

Table 8. Usefulness of UX data for software startup professionals.

Perception of the usefulness of UX data	N	Stage 1 (N=28)	Stage 2 (N=24)	Stage 3 (N=22)	Stage 4 (N=16)	% of Total
UX data is very useful in software development	58	23 (82.1%)	13 (54.2%)	12 (54.5%)	10 (62.5%)	64.4%
UX data is useful in software development	23	3 (10.7%)	7 (29.2%)	9 (40.9%)	4 (25.0%)	25.6%
UX data is not always useful in software development	8	1 (3.6%)	4 (16.17%)	1 (4.5%)	2 (12.5%)	8.9%
UX data is not useful in software development	1	1 (3.6%)	0 (0%)	0 (0%)	0 (0%)	1.1%

Colors represent the percentage of usefulness UX data about the total per stage: 0% 100%

this attitude have higher average financial challenges.

Finally, we analyzed if *analyze data and generate useful insights for the product or service*, and *artifacts to bring teams, users, and insights together* are UX attitudes related to *defining minimum viable product*. According to Table 12, startups that apply *analyze data and generate useful insights for the product or service* are less concerned about the challenge of defining an MVP. The same happens for the other attitudes, increasing the average difficulty for this challenge by almost one point in startups that do not apply these attitudes.

5 Discussion

This section presents a discussion of the results obtained for each RQ. In addition, we also discuss threats to the study's validity.

5.1 UX attitudes, methods, and techniques (RQ1)

Considering our RQ1 (*What is the perceived usefulness of UX attitudes, methods, and techniques according to the software startup professional?*), it is possible to discuss the results from the following statements: i) the attitudes most used by professionals are those that motivate the use of UX methods, such as understanding the users' need and capturing feedback, while attitudes that need more significant efforts, such as educating and training members about UX research and artifacts to bring team, users, and insights together, are less used; ii) interview is the most used UX method, but it was not considered the most useful in any of the startups' phases; iii) usability testing is the UX method considered most useful for startups professionals in stage 1, competitive analysis for startups professionals in stage 2, and high fidelity prototyping for startups professionals in stages 3 and 4; iv) storyboarding and card sorting are the least used methods and also least useful for professionals.

Regarding the UX attitudes explored in RQ1, we noticed that the most used attitudes are frequently present when the software startup decides to invest efforts in applying UX methods. For example, attitudes such as *understand user needs* and *capture user feedback* are crucial when the company decides to have a user-centered design using the methods provided by the HCI area. The statistical results showed that these UX attitudes had no significant difference concerning the stages of the software startups (see Table 6 in Section 4.2). Our findings corroborate with the findings discussed in other studies (Hokkanen and Väänänen-Vainio-Mattila, 2015; Silveira *et al*., 2021; Salgado *et al*., 2016). We confirm that these practices are still the main UX attitudes developed in software startups. This result also suggests that these attitudes are performed by professionals from software startups at stage 1 to professionals in more consolidated software startups.

Concerning the UX attitudes that had significant differences (*artifacts to bring teams, users, and insights together*; *educate and train members in UX research*; *strategies, objectives, and responsibilities about UX research*; see Table 6 in Section 4.2), we realized that they are less common in UX work. The data showed that software startups in stage 1 generally do not adopt these attitudes, which may be linked to the fact that this stage is characterized by substantial challenges, such as a lack of resources, small teams, and professionals playing several roles. For example, the significant difference indicated that a software startup at stage 1 would not educate and train members about UX research; in the same sense, some works in the literature point out that early-stage software startups generally do not have employees specializing in UX (Hokkanen and Väänänen-Vainio-Mattila, 2015; Choma *et al*., 2022). Thus, our analysis revealed that software startups would likely take some UX attitudes at more advanced stages, i.e., closer to being established companies. This finding is similar to the results of Martinelli *et al*. (2022), which identified *artifacts to bring teams, users, and insights together*, *educate and train members in UX research*, and *strategies, objectives, and responsibilities about*

Table 9. Moments of UX data collection– (p-value = 0.314).

ID	*Anticipated UX**	*Momentary UX**	*Episodic UX**	*Cumulative UX**	N	Stage 1 N=28	Stage 2 N=24	Stage 3 N=22	Stage 4 N=16	% of Total
A	–	●	–	–	16	6 (21.4%)	5 (20.8%)	3 (13.6%)	2 (12.5%)	17.8%
B	–	–	●	–	14	5 (17.9%)	2 (8.3%)	4 (18.2%)	3 (18.8%)	15.6%
C	●	●	●	–	13	3 (10.7%)	3 (12.5%)	4 (18.2%)	3 (18.8%)	14.4%
D	●	–	–	–	10	3 (10.7%)	3 (12.5%)	2 (9.1%)	2 (12.5%)	11.1%
E	–	●	●	–	8	0 (0%)	5 (20.8%)	1 (4.5%)	2 (12.5%)	8.9%
F	●	●	●	●	7	1 (3.6%)	1 (4.2%)	3 (13.6%)	2 (12.5%)	7.8%
G	–	–	–	●	6	2 (7.1%)	3 (12.5%)	0 (0%)	1 (6.3%)	6.7%
H	●	●	–	–	5	4 (14.3%)	0 (0%)	1 (4.5%)	0 (0%)	5.6%
I	●	●	–	●	3	1 (3.6%)	2 (8.3%)	0 (0%)	0 (0%)	3.3%
J	●	–	●	–	3	1 (3.6%)	0 (0%)	2 (9.1%)	0 (0%)	3.3%
K	–	–	●	●	3	2 (7.1%)	0 (0%)	0 (0%)	1 (6.3%)	3.3%
L	–	●	●	●	1	0 (0%)	0 (0%)	1 (4.5%)	0 (0%)	1.1%
M	–	●	–	●	1	0 (0%)	0 (0%)	1 (4.5%)	0 (0%)	1.1%

Colors represent the percentage of Long-Term UX moments about the total per stage: 0% 100%
**User data collection moment: We highlight in circles the moments in the Long-Term UX when the UX data is collected.*

Table 10. Moments of UX data collection.

Long-term UX research moments	N	Stage 1 (N=28)	Stage 2 (N=24)	Stage 3 (N=22)	Stage 4 (N=16)	% of Total
Momentary UX	54	15 (53.6%)	16 (66.7%)	14 (63.6%)	9 (56.3%)	60.0%
Episodic UX	49	12 (42.9%)	11 (45.8%)	15 (68.2%)	11 (68.8%)	54.4%
Anticipated UX	41	13 (46.4%)	9 (37.5%)	12 (54.5%)	7 (43.8%)	45.6%
Cumulative UX	21	6 (21.4%)	6 (25.0%)	5 (22.7%)	4 (25.0%)	23.3%

Colors represent the percentage of Long-Term UX moments about the total per stage: 0% 100%

UX research as attitudes present in established companies. Examples of these UX attitudes are the bootcamps programs where novice professionals learn with the UX team to carry out field research with users (at Google) (Au *et al*., 2008), artifacts to communicate information about users with UX teams decentralized (at SAP) (Guo, 2016), and responsibilities about UX research to work with Long-Term UX (at Microsoft) (Kevic *et al*., 2017). Despite being more frequent in established companies, UX attitude of *educate and train members in UX research* (i.e., *UX training*) shows occurrences in software startups (Salgado *et al*., 2016), as we confirmed in our results (see Table 6).

Considering the future application of UX attitudes, there was no significant difference for the diverse startup stages. Therefore, we inferred that independently of the startup stage, there is the desire to apply all the attitudes listed, demonstrating the participants' concern with the UX work (see Table 6). Nevertheless, when we observed the averages of interest in the future application of each attitude, we found that those commonly used in UX work are the most used. The presence of these attitudes in the stages of software startups may be related to the importance of applying these attitudes that the participants perceived. However, we understood that all UX attitudes are essential and need to be developed in software startups and that more significant efforts are needed for this development. Moreover, this result can be found in previous surveys of software startups (Silveira *et al*., 2021; Alhadreti, 2020; Giardino *et al*., 2015; Hokkanen *et al*., 2016b; Salgado *et al*., 2016). These results encourage researchers to promote these attitudes in industrial settings.

About the usefulness of the UX methods, the interview was the method most used, corroborating with the literature that software startups frequently use this method (Salgado *et al*., 2016; Silveira *et al*., 2021). In contrast, our results show that interview was not considered the most useful method independent of the startups' phase. For stage 1, the most useful method was usability testing. Despite seeming surprising, the literature shows that software startups in the early stages are looking to consolidate themselves in the market and validate the business model (Giardino *et al*., 2015). Then, this result is related to the diversity of studies carried out by these software startups to test the Minimum Viable Product (MVP) with potential users. For stage 2, the competitive analysis appears as the most used. Software startups at this stage already have a defined product and are looking to validate it in the market. In this sense, competitive analysis is helpful for software startups to identify innovative points that the product will have and that will make it stand out from other competitors. Finally, the most useful method in stages 3 and 4 was the high-fidelity prototype, one of the most used methods by software startups, according to the literature (Salgado *et al*., 2016; Alhadreti, 2020; Silveira *et al*., 2021; Guerino *et al*., 2022, 2021). Thus, software startups in these phases already have well-defined and structured focuses and niches, and it is understood that the concern, at this moment, is with characteristics related to functionalities, visual design elements, and interaction flows, among others. In this sense, software startups can achieve these characteristics for their product through high-fidelity prototypes and realize the usefulness of this method. Some studies have highlighted the importance of prototyping in software startups and how these companies can overcome challenges using this method to generate competitive advantage (Bjarnason, 2021; Nguyen-Duc *et al*., 2017).

On the other hand, the least useful methods, storyboard, and card sorting, were also the least used, corroborating with

Table 11. Challenges faced by each startup stage (average).

Challenge	Stage 1 (N=28)	Stage 2 (N=24)	Stage 3 (N=22)	Stage 4 (N=16)	All (N=90)	p-value
Technological uncertainty	3.82	4.54	3.91	4.75	4.20	0.360
Acquiring first paying customers	6.25	6.00	5.36	4.94	5.73	0.436
Acquiring initial funding	5.75	5.83	6.05	4.38	5.60	0.320
Building entrepreneurial teams	6.18	6.46	6.09	6.75	6.33	0.871
Delivering customer value	5.04	5.67	4.68	6.00	5.29	0.377
Managing multiple tasks	5.18	6.46	5.45	5.88	5.71	0.340
Defining minimum viable product	5.18	5.42	4.64	5.69	5.20	0.654
Targeting a niche market	4.14	4.00	4.59	5.00	4.37	0.690
Staying focused and disciplined	5.11	5.88	5.41	6.38	5.61	0.514
Reaching the break-even point	6.54	7.04	6.91	7.19	6.88	0.764

Colors represent the averages of each challenge per stage based on the Likert scale: 1 10 (i.e., greatest difficulty).

Table 12. Degree of challenge difficulty in startups that use or do not use UX attitudes

Challenges	Understand user needs		User feedback capture		User tests or evaluations		Analyze data and generate useful insights for the product or service		Attitudes that optimize surveys or evaluations		Artifacts to bring teams, users and insights together		Educate and train members in UX Research		Strategies, objectives and responsibilities about UX Research	
	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no
Technological uncertainty	4.45	2.86	4.43	3.43	4.09	4.37	4.06	4.38	3.73	4.35	3.55	4.39	4.35	4.16	4.15	4.21
Acquiring first paying customers	5.92	4.71	5.68	5.90	5.60	5.94	4.96	6.70	4.50	6.13	4.35	6.13	4.29	6.07	4.38	5.96
Acquiring initial funding	5.91	3.93	5.58	5.67	5.64	5.54	5.16	6.15	4.91	5.82	4.85	5.81	4.35	5.89	4.08	5.86
Building entrepreneurial teams	6.55	5.14	6.25	6.62	6.35	6.31	6.04	6.70	5.41	6.63	5.90	6.46	6.35	6.33	6.00	6.39
Delivering customer value	5.63	3.43	5.54	4.48	5.31	5.26	5.16	5.45	4.86	5.43	5.05	5.36	5.65	5.21	5.85	5.19
Managing multiple tasks	5.92	4.57	5.80	5.43	5.76	5.63	5.34	6.17	5.27	5.85	5.45	5.79	5.71	5.71	5.77	5.70
Defining minimum viable product	5.42	4.00	5.33	4.76	5.00	5.51	4.66	5.88	4.41	5.46	4.80	5.31	5.24	5.19	5.46	5.16
Targeting a niche market	4.53	3.50	4.58	3.67	4.02	4.91	3.60	5.33	3.32	4.71	4.10	4.44	4.53	4.33	4.54	4.34
Staying focused and disciplined	5.89	4.07	5.64	5.52	5.49	5.80	4.92	6.47	4.91	5.84	4.75	5.86	5.00	5.75	5.00	5.71
Reaching the break-even point	7.21	5.07	7.03	6.38	7.02	6.66	6.42	7.45	5.95	7.18	5.75	7.20	6.12	7.05	5.62	7.09

Colors represent the averages of each challenge per response in the UX attitude based on the Likert scale: 1 10

related studies about this topic (Guerino *et al*., 2022; Silveira *et al*., 2021). The storyboard showed a significant difference between stages 2 and 3, presenting a very low average for stage 2 and a higher average for stage 3. From the analyses, we understand that storyboard and card sorting are costly methods to apply and have a specific intention. For example, the storyboard can represent a user story or requirement in comic book form. However, card sorting is a method that allows the creation of groups of information and functionalities, which will help in information architecture (de Jesús Álvarez Robles *et al*., 2019). In this sense, due to the low use of these methods and the low average utility obtained, we inferred that software startup professionals are not sufficiently familiar with these methods or prefer to use more traditional methods. Nevertheless, some studies suggest the usefulness of storyboard and card sorting for software development projects (Guo and Goh, 2016; de Jesús Álvarez Robles *et al*., 2019; de Quincey and Mitchell, 2022). Thus, more significant efforts are needed on how to approach these methods in software startups.

5.2 Long-Term UX and UX data (RQ2)

About our RQ2 (*In which moments are the UX attitudes be performed to collect the UX data according to the software startup professional?*), we answer considering three statements: i) software startups are applying UX attitudes to collect and evaluate UX data in all moments of Long-Term UX (with priority to *Momentary UX* and *Episodic UX*), being the UX attitudes carried out in more than one moment of Long-Term UX; ii) more than 60% software startups' professionals recognize that UX data collected is very useful in software development, but these professionals' views can be changed according to the stage of the software startups; and iii) improving product/service quality and producing what the user wants to consume are the main motivations of software startups' professionals to apply UX attitudes, but other motivations are considered from the stage of the software startups. Each statement is discussed below.

Whereas previous research studied the software industry's Long-Term UX understanding (Melo and Darin, 2019; Rivero and Conte, 2017; Bargas-Avila and Hornbæk, 2011), our survey provides insight into Long-Term UX moments

worked on by software startups' professionals. When comparing each moment of Long-Term UX, UX attitudes to collecting UX data while the user uses the product or service (*Momentary UX*) are more representative among professionals from software startups in stages 1 and 2. But UX attitudes to collecting UX data after the user uses the product or service (*Episodic UX*) have more responses of professionals from software startups in stages 3 and 4. Findings about *Episodic UX* are similar to the previous studies (Rivero and Conte, 2017; Bargas-Avila and Hornbæk, 2011; Marti and Iacono, 2016), but software startups' professionals suggest that collecting UX data in *Momentary UX* is more significant. This result is the opposite of what was found in the established companies (Melo and Darin, 2019; Rivero and Conte, 2017). We suppose that this result may be related to the UX methods and techniques used by software startups' professionals. For example, among the UX methods most useful are interviews and high-fidelity prototyping.

Therefore, software startups' professionals may perform UX attitudes such as *user feedback capture* or *understand user needs* to obtain UX data while the user is using a solution (through a high-fidelity prototype) by collecting user responses with interviews. This UX work in software startups has been identified in previous research (Saad *et al*., 2021; Hokkanen and Väänänen-Vainio-Mattila, 2015; Hokkanen and Leppänen, 2015), in which feedback is obtained in informal meetings and video calls. Similar to our findings, Martinelli *et al*. (2022) show which *user feedback capture* has a correlation with interventions of *Momentary UX*. Collecting UX data in *Anticipated UX* appears with fewer responses, either in the total percentage or even when combined with other moments of Long-Term UX (see Table 9 and 10). Our results confirm that as well as in previous studies (Bargas-Avila and Hornbæk, 2011; Rivero and Conte, 2017; Martinelli *et al*., 2022), evaluations applied before (*Anticipated UX*) the user uses a product are less frequently in a longitudinal research strategy, even though software professionals understand the existence of *Anticipated UX* (Melo and Darin, 2019). This result makes it difficult to compare data or ways to track the user over time. When UX data are collected repeatedly at the same moment of Long-Term UX, the comparison between data reports a more specific cut about the user, making it impossible to extract the profile change according to different moments of use (Martinelli *et al*., 2022; Rivero and Conte, 2017).

In the first statement of our response to RQ2, *Cumulative UX* has the lowest number of responses (see Table 10). Longitudinal interventions that collect UX data at multiple moments, i.e., *Cumulative UX* (see F, G, I, K, L, and M in Table 9) show low percentages and may not occur depending on the stage of software startups. Previous studies present different perspectives on this result. Rivero and Conte (2017) state that only 6% of analyzed papers describe actions to evaluate UX from prolonged use of a product, while Martinelli *et al*. (2022) presents that *Cumulative UX* is the most representative moment of Long-Term UX when related UX attitudes. Papers also highlight that *Cumulative UX* is typically characterized by summative evaluations focused in *Episodic UX* (Roto *et al*., 2011; Marti and Iacono, 2016; Varsaluoma and Sahar, 2014), but that in our study they are also reported by smaller percentages (see F, K and L in Table 9). We understand that the mentioned studies are not exclusive to software startups and, therefore, our results provide an understanding of how professionals at software startups view the practice of Long-Term UX in their daily work.

Assessing UX over time provides valuable UX data on product usage but has disadvantages: users may not be available for long-term evaluations (Rivero and Conte, 2017; Varsaluoma and Sahar, 2014; Mkpojiogu *et al*., 2022), and continuous data collection (daily, weekly, monthly) can be challenging (Salgado *et al*., 2016; Au *et al*., 2008; Kujala *et al*., 2013). Another aspect concerns the UX attitudes and methods applied by software startups' professionals. Due to the frequency of responses received in UX methods like interviews, high-fidelity prototypes, and usability testing (that also are cited frequency by other studies (Guerino *et al*., 2022; Silveira *et al*., 2021; Alhadreti, 2020)), we notice that *user feedback capture* and *user tests or evaluations* are UX attitudes supported by UX methods mentioned in the context of Long-Term UX research. This result is similar to studies that present the use of traditional UX methods (such as interviews, focus groups, and surveys) for longitudinal research purposes (Varsaluoma and Sahar, 2014; Mkpojiogu *et al*., 2022; Rivero and Conte, 2017). However, further research is needed to identify the factors hindering Long-Term UX in the view of software startups' professionals and the specific UX attitudes and methods applied at each moment. Our results clarify that software startups' professionals have tried to collect UX data at different moments of user interaction with the product (see Table 10). But, it is a work developed by a few professionals when considering more than one collection moment in Long-Term UX (see Table 9).

Regarding the usefulness of UX data, the professionals' software startups recognize that UX data is very useful in software development, especially for software startups in stage 1. Statements stating "UX data is very useful" and "UX data is useful" are the majority of the responses considering software startups of all stages. However, a minority of software startups' professionals say that UX data is not always useful (see Table 8). Hokkanen *et al*. (2016b) investigated software startups' ability to collect meaningful user information to support UX design. The highest averages reported that software startup professionals get user feedback that helps to improve the product, besides they are able to reach potential users to gain meaningful feedback (Hokkanen *et al*., 2016b). We understand that there is a proximity between these results because useful UX data can impact the development of software user-centered (Hokkanen and Väänänen-Vainio-Mattila, 2015; Kuusinen, 2015). Another result in Table 8 is the decrease in percentages as software startups move into more advanced stages. This result is even more evident in the "UX data is very useful" statement. This result may be related to the findings of Giardino *et al*. (2015), in clarifying that the frequency of evaluation problems and solutions in product development increases as software startups reach maturity about the products and services developed. Understanding the usefulness of UX data to software startups' professionals allows us to inquire which of these UX data contribute to software development. User behaviors (Hokkanen and Väänänen-Vainio-Mattila, 2015;

Chilana *et al*., 2012; Brewer *et al*., 2017), user context and environment (Teka *et al*., 2018; Kuusinen, 2015), user emotions and feelings (Chilana *et al*., 2012; Brewer *et al*., 2017), and user culture and habits (Hokkanen and Väänänen-Vainio-Mattila, 2015; Chilana *et al*., 2012; Teka *et al*., 2018) are examples of UX data collected from UX attitudes and methods.

Finally, the motivations that most influence the adoption of UX attitudes are to *improve product/service quality*, and *produce what the user wants to consume*. Silveira *et al*. (2021) applied this question in her survey, identifying the created value for the user and creating successful products such as central motivations to adopt UX practices. Our results are different because we expose diverse motivations of professionals concerning each stage of the software startups. The motivations discussed in these studies are similar to the interests pointed out by software professionals in understanding the concept of UX, focusing in to design better products, and making users satisfied (Melo and Darin, 2019). One aspect that we understand with these results is the adoption of UX practices recently by software startups' professionals, with higher percentages in software startups of stages 2 and 4. In addition, the encouragement of mentoring programs occurs primarily in software startups of stage 1.

5.3 Challenges and the impact of UX attitudes (RQ3)

Regarding our RQ3 (*Does the use of UX attitudes impact the challenges faced by software startups?*), we responded considering the following statements: i) attitudes related to team behavior and involvement can positively impact team-related challenges; ii) attitudes that optimize research or evaluation help with financial challenges; iii) startups that focus on data and product-related attitudes have less difficulty in the challenge of defining MVP.

Regarding the two UX attitudes related to teams (i.e., *educate and train members in UX Research* and *strategies, objectives, and responsibilities of UX Research*), we noticed that these practices are the least applied and valued by startup professionals (see Table 6 and Figure 1). Previous work revealed that training and developing skills in UX activities are still challenging for Brazilian software startup professionals (Silveira *et al*., 2021). Nevertheless, attention to the skills of the team is a factor that interferes with the UX work quality carried out by startups, which includes domain knowledge, collaboration between teams, and fostering a UX mindset among different professionals (Hokkanen *et al*., 2016b) (Alhadreti, 2020). In addition, Martinelli *et al*. (2022) pointed out that short time frames for software development pose challenges to startup teams in defining *strategies, objectives, and responsibilities of UX research*. However, we argue that when startups include UX work as an essential part of their planning, adopting such attitudes should help professionals overcome critical challenges in *building entrepreneurial teams* since a good UX design directly impacts customer satisfaction and validation of business opportunities (Hokkanen *et al*., 2016a).

Additionally, *attitudes that optimize research or evaluation* is a UX attitude that is related to the greater difficulty of software startups in facing financial challenges, such as *breaking even* and *obtaining initial funding*. Optimizing research or evaluation is applied in higher percentages as startups mature (see Table 6). Software startup professionals must balance user testing and evaluation costs while working on software development. Although software startups often use a variety of UX methods (such as interviews, usability testing, personas, and high-fidelity prototypes) (Alhadreti, 2020; Silveira *et al*., 2021), there are still challenges in executing strategic choices about resource allocation versus product qualities (Hokkanen *et al*., 2016a) and in ensuring appropriate UX budget or resources (Alhadreti, 2020) (which correspond to the financial challenges of Giardino *et al*. (2015)). Another challenge faced by software startups is the need to make leaner practices, methods, and techniques for UX work (Silveira *et al*., 2021), which can impact costs and finances (Giardino *et al*., 2015; Wang *et al*., 2016). The absence of a business plan and not having an angel investor also impact obtaining initial funding for software startups (Giardino *et al*., 2015). Therefore, Brazilian startup professionals must balance costs while seeking initial funding, carrying out *user testing and evaluations* during software development. On the other hand, startups that are not implementing *attitudes that optimize research or evaluations* (which represents the majority in our sample) point to a greater degree of complexity in financial challenges.

Finally, *analyze data and generate useful insights for the product or service*, and *artifacts to bring teams, users, and insights together* are UX attitudes related to the challenge *defining minimum viable product*. *Analyze data and generate useful insights for the product or service* maintained close percentages over the different stages, but *artifacts to bring teams, users, and insights together* is applied with greater emphasis on startups from stage 2 onwards. At the same time as software startups perform the analyzing data and generating useful insights for the product or service, this UX attitude can help them overcome problems in defining minimum viable product. On the other hand, artifacts to bring teams, users, and insights together can make it possible to analyze and communicate the UX data obtained from user research and, probably, minimize the difficulty of developing technologically innovative products. Focusing on how involving users in the process of creating UX (Hokkanen *et al*., 2016b) and applying technologies to collect specific information about a particular segment of the product (e.g., education, medical) (Giardino *et al*., 2015) are alternatives for creating competitive products and facilitating the development of MVP. Software startup professionals themselves classify that the primary skills to perform UX activities are know-how to interpret and collect feedback and user information (Silveira *et al*., 2021) - i.e., the same as ours *analyze data and generate useful insights for the product or service*. But our results show that startups need to make an effort to put *artifacts to bring teams, users, and insights together* into practice and minimize difficulties in developing the MVP.

5.4 Threats to Validity

The threats of our study followed those recommendations by Ghazi *et al*. (2019) and are divided into (i) target audience and sampling frame; (ii) survey instrument design, evalua-

tion, and execution; and (iii) data analysis and conclusions. Besides, strategies to mitigate each threat were also classified according to Ghazi *et al*. (2019).

Regarding the target audience and sampling frame, the identified threat was an insufficient sample size, which may affect the representativeness of the population (Ghazi *et al*., 2019). To mitigate this problem, we used convenience sampling, publicizing the survey through personal contacts and snowballing via social media, such as LinkedIn. In addition, we adopted other strategies, such as ensuring participant anonymity, balancing time and number of questions, and characterizing the sample with demographic questions. We highlight that our study sample is composed only of Brazilian software startups, which suggests the need for further similar studies with foreign startups to generalize the results.

In the survey instrument design, evaluation, and execution category, one identified threat related to the wording of ambiguous or poorly contextualized questions, which could lead to invalid responses (Ghazi *et al*., 2019). To mitigate this problem, we used different types of data collection responses: the multiple choice and Likert scale. We also conducted a pilot test with two professionals from software startups to improve the structure and writing of the survey. In addition, we made our e-mails available for possible doubts and guaranteed the participants' rights through ICF.

Regarding data analysis and conclusions, a threat identified was related to the possibility of duplicate responses (participants from the same startup), which could lead to erroneous conclusions. To mitigate this problem, we manually checked the presence of startups from the exact location with the same demographic characteristics. However, we caution that we do not automatically check using respondent IP address tracking or analyze section cookies.

Finally, since the analysis depends on the authors' perspectives, their individual biases could influence the outcomes. To mitigate this threat, data analysis was carried out by the first three authors of the article, who subsequently reviewed and discussed it with the other authors. Likewise, there is a risk that participants may have answered questions incorrectly due to misunderstandings of the questions or the response options provided. In this sense, we tried to be as clear as possible in the questions formulated in the survey, reviewing the terms several times and carrying out a pilot study (see section 3.1) to verify the adequacy of the sentences. In any case, these factors represent significant threats to the validity of our findings. They should be acknowledged as limitations of the study.

6 Conclusion and Future Work

This paper presented the results obtained through a survey answered by 90 professionals from Brazilian software startups about the UX work in these companies. More precisely, we investigated the UX attitudes and the perception of these professionals regarding the usefulness of UX methods and techniques (RQ1), the moments of Long-Term UX in which these attitudes are held for collecting and evaluating UX data (RQ2), and challenges regarding product, market, team, and the impact of UX attitudes on challenges faced by startups (RQ3).

From the quantitative descriptive and inferential analysis for RQ1, we found that although the most used method, the interview was not considered the most useful in any of the different phases. Usability testing was the most useful for professionals of software startups in stage 1, competitive analysis for professionals of startups in stage 2, and high-fidelity prototyping for professionals of software startups in stages 3 and 4. From this result, we conclude that the perceived usefulness of methods varies according to the stage of the software startup that the professional is inserted. This conclusion suggests caution when recommending or identifying methods to be used in these companies. On the other hand, the methods considered least useful, not surprisingly, are the least used: storyboard and card sorting.

Concerning the results of RQ2, we realized that software startups have been collecting and evaluating UX data in all moments of Long-Term UX. However, interventions that involve more than one moment of Long-Term UX to evaluate user interaction with the product or service received fewer responses. Unlike other literature, Momentary UX is the moment of Long-Term UX at which software startups most often collect and evaluate UX data. Regarding the usefulness of UX data, software startups rate the currently obtained UX data as very useful for software development. However, the amount of professionals who agree with this usefulness decreases according to the stage of the software startup. Finally, improving product/service quality and producing what the user wants to consume are the main motivations for software startups to adopt UX attitudes and methods. These motivations confirm recent findings in the literature on the same topic.

According to the results of RQ3, our study reveals that Brazilian software startups face challenges in applying UX research practices, particularly in team training and defining UX strategies. These challenges, supported by tight development schedules, impact the quality of UX work and ultimately affect customer satisfaction and business success. Financial challenges are also linked to optimizing research and evaluation processes, vital to balancing costs and improving product quality. Furthermore, while startups recognize the importance of analyzing data to generate insights, there is a need to better implement collaborative artifacts to expedite the development of minimum viable products (MVPs). By prioritizing UX as a core component of their strategic planning, startups can overcome these challenges, improve product development, and strengthen their market position.

Options for future works are visualized. From the knowledge of the importance of all UX attitudes, we emphasize that more significant efforts should be made to verify how to motivate and prepare professionals to use UX attitudes in these software startups, aiming to generate a competitive advantage. Our research also opens room to investigate why the interview is the most used UX method but not the most useful in any of the stages. We understand it is useful in future work to investigate which UX attitudes and methods software startups apply for each Long-Term UX moment. We believe it is important to understand what UX data is collected and evaluated by software startups (i.e., user behaviors, user context, or user emotions) and how useful each UX data is for soft-

ware development. These findings can guide the development of proposals that help software startups professionals to work with UX attitudes, methods, and Long-Term UX in an efficient and lean way.

Declarations

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Authors' Contributions

Guilherme Guerino: Conceptualization, Methodology, Investigation, Formal analysis, Writing - Original Draft. Suéllen Martinelli: Conceptualization, Methodology, Visualization, Writing - Original Draft. Joelma Choma: Formal analysis, Visualization, Writing - Review Editing. Gislaine Camila Leal: Supervision, Project administration, Writing - Review Editing. Renato Balancieri: Supervision, Writing - Review Editing. Luciana Zaina: Supervision, Writing - Review Editing.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The authors confirm that the data supporting the findings of this study are available within the article.

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