Discovering Accessible Financial Systems Resources for Emergent Users

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Abstract: The widespread use of mobile phones in Brazil has significantly altered information access and communication, impacting the financial sector as institutions increasingly use mobile apps. However, ensuring accessibility for all users remains challenging, particularly for riverside people who lack exposure to formal education, urban environments, and digital technologies. This study examined the accessibility and communicability barriers this population faces in mobile banking applications, especially in instant payment features. After reviewing best practices and applying the Semiotic Inspection Method (SIM), the study developed and tested an instant payment prototype with riverside people in the Amazon region. Interviews and the Communicability Evaluation Method (CEM) were used to measure communication effectiveness and inform design improvements for Pix interfaces. Afterward, a workshop with computing students was conducted, and they showed interest in inclusive systems but needed more practical knowledge. The workshop also highlighted the necessity of providing audio resources, more security, and illustrations and text that are easy to understand in financial conversation systems for emergent users. This research supports digital inclusion by exploring resources to improve accessibility in interactive systems for emergent users.

Keywords: Accessibility, Emergent Users, Financial Services, Conversational Systems

1 Introduction

The widespread use of mobile devices has fundamentally transformed how people access information and communication [IBGE, 2021]. In Brazil, for instance, cell phones surpassed all other devices for internet access between 2018 and 2019, with a staggering 98% of the population using them for web browsing [IBGE, 2021]. This digital revolution has also impacted the financial sector, where institutions are increasingly leveraging mobile technologies to enhance customer relationships [Kazi and Mannan, 2013].

Financial inclusion, however, remains a challenge. As the Central Bank of Brazil (Bacen) supervises over 946 financial institutions offering diverse services [Central Bank of Brazil, 2024], ensuring accessibility for all users is paramount. Interactive systems designed with good practices become essential in this context to meet users' information and communication needs [Guimarães and Tavares, 2014].

Accessibility in software engineering refers to the creation of interfaces usable by everyone, regardless of ability [Barbosa *et al*., 2021]. It eliminates barriers that might hinder user interaction with a system. Communicability is a particularly important aspect of accessibility, focusing on clear and culturally-appropriate messaging within the user interface [Prates *et al*., 2000]. Effective communication allows designers to craft interfaces that empower users to complete tasks successfully [Prates *et al*., 2000].

Prior research has documented similar accessibility gaps in digital services for emergent users [Modesto and Ferreira, 2013; Thies, 2015; Capra *et al*., 2021; Srivastava *et al*., 2021]. These studies propose design solutions to improve

access to Digital Information and Communication Technologies (DICTs) for this population.

Building on this foundation, this research addresses the lack of accessible financial interactive systems for emergent users. We aim to understand the challenges faced by emergent users, those who have faced challenges in their education, are in a distance of urban zones, and have limited digital literacy [Devanuj and Joshi, 2013], to improve their interaction with financial interactive systems. We explore the communication barriers the emergent users face when using Brazilian Instant Payment, in Portuguese "Pagamento Instantâneo Brasileiro" or just "Pix".

To achieve the objectives, we employed a multifaceted approach. We conducted a literature review about guidelines and inclusion for emergent users, an inspection of communicability in a proposal for mobile banking, and a case study with riverside people of the Amazon region, where we assessed the communicability and accessibility of Pix for these people. Based on the evidence obtained from the case study, we conducted a workshop with undergraduate and postgraduate IT students to collaboratively discuss how to develop conversational financial systems accessible to emergent users.

We focused the workshop on improving conversational financial systems because, in the case study, the riverside community indicated that they use messaging apps to communicate with friends and family. Conversational interfaces, which engage in dialogues with humans [Candello and Pinhanez, 2016], have been investigated in several aspects, such as governmental chatbots' usability [Monteiro *et al*., 2023], and present an opportunity for emergent users to use them for transactions such as paying, receiving aid, or receiving

money [Melo *et al*., 2024a].

This article is an extended version of the paper in Portuguese entitled "A Case Study with a Riverside Community to Improve Apps Instant Payments Access", published in the Proceedings of the XXII Brazilian Symposium on Human Factors in Computing Systems [Teran *et al*., 2024b]. In the previous study [Teran *et al*., 2024b], we observed that riverside people face barriers to accessing interactive systems due to educational issues, internet connection, or little experience with digital technologies. In this extended version, the workshop supported the discussion and collaboration on the interaction resource set necessary to improve financial services, specifically the Pix, in the context of conversational systems and to meet the emergent users' socio-digital characteristics.

The paper is divided as follows: Sections 2 and 3 present the theoretical background and related work to the research. Section 4 describes the research method and ethical aspects. Sections 5 and 6 present the specific methods and results, divided, respectively, into a case study with riverside people and a workshop with computing students. Finally, Sections 7, 8, and 9 describe the discussion, threats to validity, and final considerations.

2   Theoretical Background

The subsections below highlight the important knowledge that are basis for this research, like digital accessibility and emergent users inclusion (subsection 2.1), communicability (subsection 2.2), financial services for the real-time payment (subsection 2.3), and conversational systems and Chatbots (subsection 2.4).

2.1   Digital Accessibility and Emergent Users Inclusion

Accessibility is a property used in planning, implementing, and evaluating any products and services, whether interactive financial systems or not. Thus, products and services are inclusive if they do not generate access barriers for users during the interaction process and, specifically, provide interfaces that meet people's information access and communication needs [Barbosa *et al*., 2021].

People with disabilities and those living in rural areas or developing countries benefit from accessibility [W3C, 2018]. Similarly, people with low literacy have characteristics that must be considered when accessing software to enjoy these services autonomously and safely. People with low literacy have, historically, faced exclusion in formal education. As a result, these users potentially face challenges in holistic thinking and interface reading [Tulaskar, 2020; Nedungadi *et al*., 2020].

Some authors [Devanuj and Joshi, 2013; Dhaygude and Chakraborty, 2021] have grouped the interaction characteristics of people with low literacy in a specific group called "emergent users". Emergent users are people who, during their social experiences, face barriers to accessing formal education, have lower wage values, live in locations far from urban areas, and have specific cultural and socio-environmental expressions [Devanuj and Joshi, 2013; Dhaygude and Chakraborty, 2021].

The lack of previous contact with DICTs, and social experiences, affected these users' understanding of interfaces of current interactive systems [Devanuj and Joshi, 2013]. There are five experiences by users, as well lived by emergent users, in the use of DICTs [Devanuj and Joshi, 2013; Dhaygude and Chakraborty, 2021]: (i) inexperience stage, (ii) initial stage, (iii) mechanical learning stage, (iv) fluent stage, (v) and wisdom stage.

The dissemination of Internet platforms has allowed the acquisition of income and management of social benefits for a low-income population. Despite that, the lack of accessibility in applications linked to these services and familiarity with DICTs generated interaction barriers for these users [Marins *et al*., 2021].

Governments and Institutions, such as Brazil and the World Wide Web Consortium (W3C), have provided support artifacts for developing accessible software and Internet services [Oliveira *et al*., 2021]. In Brazil, a widely used tool is the eMAG. Its role is to guide developers in creating accessible federal government websites and portals, ensuring compliance with WCAG guidelines [Brasil, 2014]. Through the eMAG, it is also possible to develop new tools that cater to the inclusion of emergent users.

2.2   Communicability

Communicability can also improve user interaction, being a quality criterion based on the precepts of Semiotic Engineering (SemEng) theory. This is defined as the possibility of the designer transmitting a message to the user through the software without interruptions in communication [de Souza, 2005].

More specifically, SemEng studies the communication between designers, users, and systems. The investigation can take place at two levels: the direct communication between the user and the system and the metacommunication from the designer to the user mediated by the system through the interface [de Souza, 2005]. SemEng encompasses essential concepts such as meaning processes involving signs, semiosis, and communication processes involving intention, content, and expression [Barbosa *et al*., 2021].

Research carried out by designers is essential for understanding the environments and tasks of potential users of a system [Barbosa *et al*., 2021]. Therefore, system users are expected to decode the metamessages provided by interfaces [Barbosa *et al*., 2021]. In Semiotic Engineering, metamessages are intended to be easily interpretable by users and perform their tasks clearly through interactive systems. Therefore, joining accessibility and communicability is essential in the development process of an interactive system. This research is considering that the application of Semiotic Engineering can strengthen the *design* of Instant Payment Systems (IPS) that meets the communication and access of emergent users.

2.3 Financial Services for the Real-time Payment

Digital and traditional banks provide access to their various financial services through devices with Internet access, such as smartphones [Ribeiro, 2020]. Thus, customers who carry out bank transactions benefit from financial autonomy and practicality in their personal and professional activities.

Real-time payment methods have become popular in several countries, such as Faster Payments in the United Kingdom, Zelle in the United States, Immediate Payment Service (IMPS) in India, and China's Internet Banking Payment System (IBPS). In Brazil, Pix began in 2020 and is a fast payment method that is used for electronic transfer by users from different banks, strengthening the financial accessibility of the population [Central Bank of Brazil, 2022b].

In 2022, 38% of the Brazilian population were Internet users and, in addition, 66% of these people used Pix as one of their payment methods. This shows the predominant use of Pix among Brazilians despite the short time since this financial service was implemented.

Global initiatives, like Sustainable Development Goals (SDG), of ONU [2015], present plans for social, financial, and digital inclusion for populations of diverse countries. Concerning accessibility and development of new digital technology, the SDG about decent work and economic growth, industry, innovation, infrastructure, and reduced inequalities (respectively, eighth, ninth, and tenth SDGs) must be thought and implemented in all spheres of society, including the software industry. The absence of SDGs in development scenarios can lead to greater social and digital exclusion for emergent users, affecting their ability to communicate with interactive systems for income generation and financial inclusion.

Therefore, offering accessible digital financial services has become a competitive advantage among financial institutions, especially considering that the economic system is increasingly related to DICTs. In addition, the Covid-19 pandemic influenced the migration of these services to digital ways, directly impacting the relationship between customers and suppliers for remote assistance [Junior *et al.*, 2022].

2.4 Conversational Systems and Chatbots

Candello and Pinhanez [2016] define conversational interfaces as intelligent artificial systems capable of engaging in dialogues with humans, categorizing them into four types:

- Speech-based – known as voice assistants, such as Siri, Cortana, Watson, and Alexa, these systems lack human form and incorporate a component that recognizes and translates user speech, delivering an audio response.
- Text-based – these conversational agents engage in text dialogues with users, allowing interactions involving clicks, images, and videos as well. Chatbots are a prime example of these agents, which have become popular and are now employed by various companies.
- Interactive Virtual Agents (IVA) – these conversational agents take on characters, avatars, that mimic human behavior and aim to establish humanized dialogues.

- Conversational Robots – these are conversational machines housed within physical bodies and exhibit behavior similar to humans, such as the Connie robot from the Hilton hotel chain.

Initially, in the development of conversational systems, a differentiation is made based on who leads the conversation: user-initiative, system-initiative, or mixed-initiative.

However, regardless of where the initiative comes from, most systems are built with an intent-action approach, where a series of system and user statements are predefined, and then how they should interact with each other is determined. The difference lies in how this grouping and linking is done, for example, a user-initiative system, such as "Q&A" systems, postulating a single system response for different possible user questions — in some cases, also for some variations of that response. The same applies, but in reverse, for system-initiative systems [Candello and Pinhanez, 2016].

This process called intent-matching, can be done through various technologies and platforms, such as template-based systems (where a model is created in which the user's text intention is determined by a previously defined group of words, manually) through intent recognizers based on machine learning (which use classifiers such as Bayesian networks, Support Vector Machines, deep neural networks); or, still experimentally, it can be done through learning from real conversations, which would teach conversational systems how to behave in dialogues, thus eliminating the need to link an intention to an action [Candello and Pinhanez, 2016].

The BOT-Checklist tool was also utilized to present some features of each Chatbot to the participants during the workshop. This tool was developed by Borsci *et al.* [2022] to assist designers in performing quality control in developing Chatbots. The BOT-Checklist was designed to accompany the Bot Usability Scale (BUS-15), created to evaluate the quality of user interaction with Chatbots consistently, providing designers with references to compare their products during conversational system development. The BOT-Checklist (or BOT-Check) consists of seventeen attributes, divided into two modules: one with fifteen attributes focused on short-term interactions and another with only two attributes focused on long-term interactions, complementing the first module.

However, since further investigation is still needed to confirm the effectiveness of BUS-15, and because — according to Borsci *et al.* [2022] — only the BOT-Check can currently be used as a means to verify the quality of conversational system design before testing it with end users, it was decided to employ only the latter. This decision aimed to give the workshop audience an overview of the Chatbot's functionality. In this scenario, the version of BOT-Check intended for short-term interactions was employed, considering that the dialogue between users and banking Chatbots is generally not conducted over a long period [Borsci *et al.*, 2022].

3 Related Work

The following subsections present related work about recommendations of interactive system design and evaluations for

emergent users (subsection 3.1) and workshops for the accessible interactive systems development (subsection 3.2). These works provide important results for the Human-Computer Interaction (HCI) area due to the digital inclusion of diverse users.

3.1 Recommendations of Interactive System Design and Evaluations for Emergent Users

Modesto and Ferreira [2013] conducted two case studies with emergent users to identify their experiences with search engines. First, participants carry out searches with different levels of difficulty and objectives. In the second stage, five new participants used filters and advanced search. As a result, they presented 13 design recommendations for accessible search engines for emergent users.

Chaudry *et al*. [2012] conducted two studies with emergent users with chronic kidney disease. First, involving 17 participants, a high-level prototype was developed to collect the number of clicks and assist in determining the most suitable sizes and types of elements for a nutritional health support tool. Second, they searched for the most appropriate navigation structure, thus, involving 19 participants who tested three high-fidelity prototypes. The results showed that the participants preferred interfaces with large widgets and linear navigation, where they did not find barriers to starting or restarting activities in specific places on the prototype screens. They presented seven design recommendations for mobile apps with touch interfaces for emergent users as a final contribution.

Capra *et al*. [2011] provided recommendations for research in Human-Computer Interaction (HCI) aimed at users with functional illiteracy. The research was divided into five methodological stages: selecting the target audience, conducting ethnographic research with students of the Brazilian teaching program for young people and adults (EJA in Portuguese), evaluating accessibility with users with and without functional illiteracy, and defining methods for accessibility assessment. This research generated nine recommendations to support HCI scholars in studying low-literacy users.

Capra *et al*. [2021] systematically mapped the literature, collecting studies in Scopus, ACM, and IEEE between 2000 and 2019. They identify research contributions to the accessibility of emergent users in accessing available information services on the Internet. The results present six aspects of interaction that must be considered in developing accessible systems for people with low literacy, specifically caregivers of older adults.

Thies [2015] discuss the challenges faced by emergent users when using interactive systems. They present a set of user interfaces designed to help emergent users access various services mediated by DICTs. Additionally, they identify trends in user interfaces that can eliminate access barriers for these individuals, such as instructional videos, paginated navigation, and voice user interface features.

Srivastava *et al*. [2021] systematically reviewed the literature, intending to propose general interface recommendations for emergent users. They also correlated literature stud-

ies with recommendations from organizations between 2013 and 2020, such as IDEO, Bill and Melinda Gates Foundation, Google, Unesco, MicrosoSave, CGAP, and Unesco. As a result, they created the SARAL Framework, which contains 13 accessibility recommendations for people with low literacy, categorized into five themes.

Studies in HCI are essential for both academia and industry, as they can generate benefits for end users. The works presented in this section aim to improve the design of interfaces available to emergent users, enhancing their experience with DICTs in everyday tasks, including work environments. Table 1 summarizes the countries, themes, and authors of the related studies. This case study contributes to the HCI field by presenting design assumptions to improve emergent users' access to IPS.

Table 1. Related Work Summary

Country	Research focus	Study
USA	Nutritional Health	Chaudry *et al*. [2012]
India	UI general recommendations	Thies [2015]; Srivastava *et al*. [2021]
Brazil	HCI research recommendations, Information Platforms, Search engines	Capra *et al*. [2011]; Modesto and Ferreira [2013]; Capra *et al*. [2021]
	IPS design considerations in the Inclue Platform	Our

The literature has focused on improving interfaces based on usability and accessibility quality criteria. This case study advocates for an approach to interface design that prioritizes communicability alongside accessibility and the SemEng to enhance Pix communication with riverside people. Our case study demonstrates how these individuals access traditional services, work, and interact with DICTs. Thus, we aim to strengthen the digital and financial inclusion of riverside people in the Amazon.

The results obtained in this case study provide a partial theoretical base for developing a platform, the Inclue Platform[1], that can be used by design and development professionals to include emergent users in digital technologies. The platform aims to consider the socio-digital characteristics of emergent users in interactive systems, which includes IPS, by presenting the necessary interface resources to include these people and providing examples of their conditions through the Persona concept.

3.2 Workshops for the Digital Inclusion and Accessible Interactive Systems Development

Ferrari *et al*. [2020] conducted a collaborative workshop to produce a systemic and socially responsible understanding of a game to support children in speech therapy exercises. The workshop focused on human and technical aspects, possible solutions, and their implications. The article's authors used artifacts and techniques from Socially Aware Design and Or-

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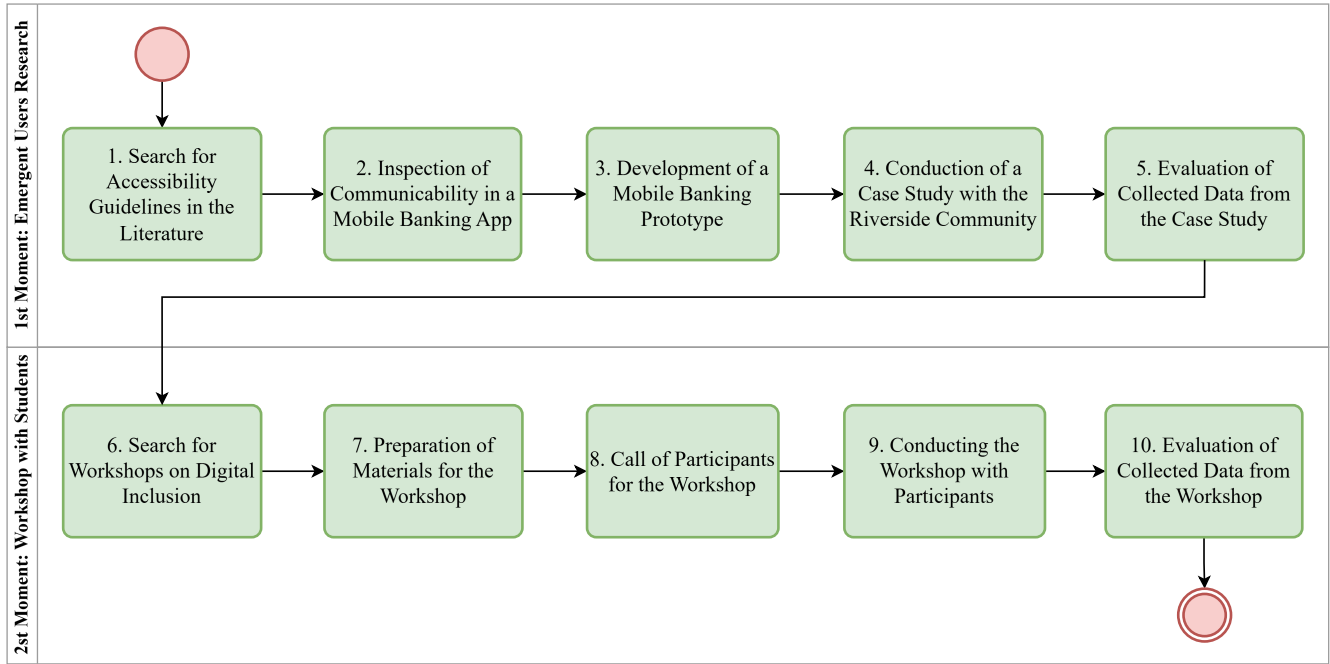[1]Inclue Plataform: https://inclue.vercel.app/

Figure 1. Steps carried out in the research conduction

ganizational Semiotics to identify interested parties and arrive at sociotechnical requirements that a solution prototype must contemplate.

Among the contributions of the work, Ferrari *et al.* [2020] highlight a set of lessons learned that we consider important for the planning and execution of our workshop:

1. Thinking critically about the problem domain and how a proposed solution affects stakeholders directly or indirectly is essential. Although we did not use Socially Aware Design artifacts in our workshop, we used the Personas technique on the Inclue platform to raise awareness among workshop participants about the issues and challenges affecting diverse emergent user profiles.

2. The presence of an expert in the theoretical framework of the artifacts used and also a mediator to document the discussions raised during the session. The first author of this work played the role of expert during the workshop, while another researcher played the role of mediator.

3. The Braindrawing technique can be used to generate low-fidelity prototypes.

4. Right after the end of the workshop, it is important to transfer all the information filled in physical artifacts to the digital medium so that no information is lost.

In [Ortiz *et al.*, 2022], the authors report the experience of conducting a series of workshops to practice Computational Thinking skills with the Youth and Adult Education (YAE) audience. The main contribution of the work that we consider relevant to our workshop is in the details that the authors give of the YAE audience and the context in which they are inserted, being people who were unable to continue their formal studies due to a series of factors, such as family and cultural issues, for example. We used the case study results detailed in the article to support the creation of Personas included in the Inclue platform.

These works are of great importance to the proposed scenarios, as they discuss digital technologies to support speech therapy and education for young people and adults. In discussing inclusion for a broad audience, our work brings emergent users to the forefront of financial services. In this way, the need to think about inclusive conversational systems for instant payment contributes to the construction of accessible resources; in supporting global social inclusion plans, such as the 2030 Agenda; and raising awareness among professionals about socio-digital aspects of people who have been far from computational advances and need digital technologies to acquire and share income.

4   Research Method

We used the qualitative and empirical research method through a case study in March 2022 in a riverside community in the Legal Amazon[2] region and a workshop conducted in April 2024 with future software development professionals. Our team is specialized in HCI, collaborative systems, and informatics in education and has various academic levels: Ph.D., master's, and undergraduate.

A set of ten steps was necessary to carry out this research (Figure 1). For this, two different moments were carried out: a case study with a riverside community, from steps 1 to 5, and a workshop conducted with future software development professionals (students), from steps 6 to 10.

The first moment was based in the research question "*how do emergent users of interactive systems communicate with DICTs, and what resources are needed to improve their access to IPS?*". To answer this research question, we conducted the following steps: (1) a search for accessibility

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[2]Legal Amazon: a political term created in Law No. 5.173/1966, representing an area in the Amazon composed, partially or wholly, of nine states of Brazil. Thus, the term purpose is to provide sustainable development and preservation of the Amazon region.

recommendations for emergent users; (2) a communicability inspection of a bank proposal; (3) the construction of the prototype with improvements identified in the previous steps (1 and 2); (4) a case study with riverside people from the Legal Amazon, in which we recorded the participants' voices and interactions via video screen capture with the prototype; (5) analysis of collected data, divided into socioeconomic and digital aspects. These steps were essential to understanding how emergent users interact with DICTs, recognizing the barriers they face, specifically those of the riverside people, and responding to how to make digital real-time payment systems more inclusive and equitable.

As a result, it was noticed that participants predominantly use conversational systems as a source of communication and information due to a few factors, such as Internet consumption. In this way, in the second moment, the research question was: "*how can we develop financial conversational systems to improve emergent users' access to digital payment methods?*".

To respond to the second research question, we conducted the following steps: (6) search for scientific research that used workshops as a collaborative method for digital inclusion and development of accessible software; (7) preparation of theoretical and didactic materials for the workshop, in addition to documentation for conducting the workshop; (8) definition of volunteers and call for students at a computer faculty; (9) implementation of the workshop, in which theoretical presentations were carried, alongside dynamics of inclusion of emergent users and development of accessible conversational systems; (10) finally, the data collected before, during and after the workshop was analyzed. These steps were essential to sharing the theme of digital inclusion for emergent users and collaboratively developing new proposals for interactive systems that strengthen their socioeconomic development.

More details on the methods and results of the case study with the riverside community are presented in Section 5, and those of the workshop are presented in Section 6. The materials used in the case study and workshop are available in a GitHub repository[3] for open science and knowledge sharing.

4.1 Ethical Issues

The Research Ethics Committee of the Federal University of Pará approved the research[4]. In the case study with riverside people, the Informed Consent Form (TCLE) was delivered one week before data collection for reading by the participants or people they trust. Prior to data collection, we reiterated the details of the TCLE and confirmed the participants' willingness to continue as volunteers.

Regarding the workshop, participants agreed to volunteer for the study and highlighted their interest by signing the TCLE. These terms were included in the first section of the form made available before the workshop. It is essential to highlight that the form was sent to participants five days before the workshop.

5 Case Study with Riverside People

This section presents the methods used to carry out the case study with riverside people, highlighting the context of use, the target audience, and the method of collecting and analyzing the case study data. Also, we present the results obtained from the case study with the emergent users.

5.1 Context of Use

With the launch of the Pix in 2020, it became possible to transfer monetary values at any time to several financial institutions available in Brazil. The Bacen designed Pix to promote the financial inclusion of the country's population. Its principle is to provide secure, low-cost payment services with adequate interaction experience [Central Bank of Brazil, 2022b], in conformity with the minimum requirements manual for the user experience [Central Bank of Brazil, 2022c] and for the use of the brand name [Central Bank of Brazil, 2022a].

We partnered with a Brazilian financial institution, a provider of the Pix service, to bring the case study closer to the target audience's reality. Thus, we inspected a mobile banking proposal using the SIM presented by the author de Souza *et al*. [2006].

Second, we developed an IPS, taking into account the recommendations introduced in the literature [Modesto and Ferreira, 2013; Thies, 2015; Capra *et al*., 2021], the user experience manual presented by the Central Bank of Brazil [2022c], and the SIM report prepared by the researchers. These documents were used as a theoretical basis for building the prototype interfaces to meet the needs of emergent users using IPS. The IPS prototype was initially developed with Figma[5] but was migrated to Adobe XD[6] due to the necessity of offline interactions. We performed pilot studies with three computing students with a minimum of one year of experience in HCI research. The studies were conducted individually, and the prototype was adjusted.

The IPS prototype included the following interfaces: a minimalist form and linear navigation to reduce the amount of information presented by the system; instructions limited to a maximum of 50 characters to indicate system functions or tasks; key data entry and instruction fields with bold keywords; a combination of text and illustrations for system actions; a payment receipt with real-world representation; and text and icons using green for success and received money, red for errors or money spent, and yellow for warnings and future transactions.

The purpose of the Bacen user experience manual [Central Bank of Brazil, 2022c] is to present requirements that banks must follow to improve the user experience in using Pix. The document is updated periodically. The prototype design and evaluation of interactions involved the use of document version 6.1. Two master's students in computer science inspected this document to identify Pix accessible requirements for emergent users, even if the requirements were not presented that way. Finally, a meeting was held to consolidate the requirements.

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[3]GitHub repository: https://github.com/human-interaction-with-tecno logies/open-science-case-study-riverside-and-Workshop
[4]CAAE Number: 54848021.8.0000.0018

[5]Figma: https://www.figma.com/
[6]Adobe XD: https://www.adobe.com/xd

5.2   Target Audience

The riverside people are part of one of the traditional Brazilian communities, mainly in the Amazon region. Their way of life is directly linked to rivers and water, in which artisanal fishing is one of the main activities of these peoples, along with the extraction of natural resources such as açaí, which guarantee their survival.

The traditional Brazilian people have had their social rights guaranteed since 2007 through Decree No 6040. It instituted the National Policy for the Sustainable Development of Traditional Peoples and Communities (PNPCT). In its 3rd article, the policy indicates that these groups have unique cultures, recognized among their members and specific forms of social organization. People use nature with respect for survival and cultural, social, religious, ancestral, and economic reproduction. In addition, their traditions provide knowledge, innovation, and technological practices [Brasil, 2007].

Riverside people live in an intrinsic relationship with nature. It is where natural cycles, such as tides and floods, regulate their daily lives and influence their economy, work, and housing. The Figure 2 shows the houses of the riverside people, which are predominantly on stilts suspended from the wood above the banks of the rivers. This architectural pattern connects riverside people to nature and ensures their survival, providing housing close to their source of income [Marçal dos Santos Menezes and de Almeida Viana Perdigão, 2021].

Figure 2. Example of a riverside house [Liotto *et al.*, 2018]

The highlighted concepts show the relevance of applying studies that improve riverside people's social, financial, and digital inclusion. Therefore, UI and UX professionals must consider social and technological experiences to develop accessible interactive systems.

During the case study, 12 riverside people of a community located in the legal Amazon participated. We chose this target audience because riverside people face longitudinal barriers to accessing several services, such as digital infrastructure, educational, and financial services. Due to a lack of educational and digital infrastructure services during their lives, the riverside people are considered emergent users because they face challenges in using digital technologies and, consequently, interactive systems.

5.3   Planning and Data Analysis

The data collected with the participants was carried out in three phases. The first phase lasted between 15 and 30 minutes, the second between 3 and 20 minutes, and the third between 3 and 11 minutes. The coding process was used in the data collected in the first and second phases. The participants' reports were transcribed, and the most relevant information for each question was filtered.

In the first phase, social information was collected from the participants, such as education, economy, and access to information technology. In this phase, we also showed a paper of interview script with a set of illustrations to the participants so that they indicate their significance. These illustrations are commonly used in interactive systems and IPS. This data collection allowed us to observe the process of semiosis, in which signs are associated with chains of meanings according to the social and cultural aspects livened by the people who interpret and adopt them [Barbosa *et al.*, 2021].

After the participants analyzed the signs on the paper, it began the second phase of the case study. During this phase, they could interact with an IPS prototype with instant payment functionality. They utilized a task script to guide their interaction with the IPS. The script included accessing an account, using a Pix key, and sending and receiving a Pix. Lastly, during the third phase, they highlighted the challenges of accessing the prototype. For this, we used a task script post-test to guide possible questions about barriers faced and opportunities to improve access.

We chose the Communicability Evaluation Method (CEM) to conduct the interaction case study with the participants [de Souza and Leitão, 2009]. We carried out planning, collection, and analysis during the CEM application. We analyzed communication breakdowns for each participant and generalized by resources used in the interaction process to identify common communicability problems and violation levels and, finally, to generate the semiotic profile. The CEM results have been organized in a report.

The following subsections present the results of the case study with riverside people, divided into (i) access to social, DICT, and financial services; (ii) semiosis of the signs used in the prototype; (iii) communicability disruptions faced in the prototype; finally, (iv) report of participants on the challenges to access the prototype resources.

5.4   Social Aspects

Twelve riverside people (coded from P1 to P12) volunteered in our case study (Figure 3), nine women and three men, among them: four between 26 and 33 years old, four between 34 and 41 years old, one between 50 and 57, two people between 58 and 66 years old and one person between 67 and 74 years old. Their sources of income are extraction of *açaí*[7] (P1, P9, and P11), retirement (P2 and P5), fishing (P4), private lessons (P7), nursing (P6), cooking (P8 and P12), housekeeping (P10), and pension payments (P3).

To access information, they use television, radio, and smartphones to connect to the internet. Computers are used at home (P7, P11, and P12), in Internet Cafe (P4 and P10), or at work (P6). P8 and P9 also use family computers. Mobile data is used to internet access, but participants are limited by

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[7]Açaí: a popular fruit of sphere shape format located in the Amazon forest. It is consumed after scraping pulp off the external layer and separating its lump.

Figure 3. Participants age group and gender

the amount of credit available from their telecom operator (P5 and P7). Instant messaging services are used for work and communication with family members.

Participants aged between 26 and 34 years had incomplete high school (P1) or had completed either a technical course (P6) or graduation (P7). Participants with technical course and graduation were also included in this case study, as they belong to a community where mobile data mainly provide access to digital communication technologies (DICT), and they face barriers in accessing the internet due to telecom limitations. Participants aged between 35 and 41 years had incomplete high school (P11) or had completed high school (P8, P9, P12). P4, aged between 50 and 57 years old; P5 and P2, aged between 58 and 66 years old; and P3, aged between 67 and 74 years old, had completed either the first, third, fourth, or fifth grade of fundamental school.

The participants have or had a bank account to receive their retirement benefits, pensions, or aid from public authorities, such as the Bolsa Família[8], to which all, except P8, had access. Participants have access to bank and lottery agencies in the nearest city. P5 reported that her daughter used the bank application to facilitate payments but canceled the access key when she moved to another town to prevent violations in the account. P8 had problems receiving monetary aid during the pandemic, and her daughter helped her. Participants used television or cell phones to stay informed about the aid or communicate with family and friends to get information.

Participants answered how they found out the account balance. Only the P8 and P12 use applications to check balances and pay bills, with or without Pix. We noticed that participants between 26 and 41 years old monitored the balance of their accounts through banking applications. Participants aged between 50 and 74 knew the withdrawal day through proof of previous payments. P3 reported knowing the available balance when inquiring with family members or contacting the nearest agency. Participants between 50 and 74 years old had difficulties using mobile applications and said they faced barriers in accessing banking applications.

5.5 Symbol Analysis

We showed illustrations to the participants to indicate their representativeness. The participants indicated the meanings of these illustrations of financial services and the prototype.

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[8]Bolsa Família: brazilian federal program for direct and indirect transferring of render to aid families in poor situations to improve the population's social aspects.

This case study used the illustration of Iconify [2022] for symbol analysis. All participants understand the key sign (Figure 4). However, P12 indicated that the illustration could represent a "Pix key", and P6 said the sign presented a "security key". For the sign representing money (Figure 5), the participants indicated they could be "Camera", "photographic camera" or "playing card". The other participants (P1, P2, P4, and P5) did not know the meaning of the illustration.

Figure 4. Meaning of Key

Figure 5. Meaning of Money

For the sign that represented addition (Figure 6), P3 did not recognize its meaning, and P4 identified that it represented a cross. The other participants stated that the symbol represented a plus sign, conceptually related to addition. Regarding the editing sign (Figure 7), participants cited different meanings, such as "Pencil", indicated by P1, P3, P4, P10, P11 and P12; the "Pen", indicated by P2, P5 and P7; and the "Annotation", interpreted by P6, P10, P11. The "Pencil" was the closest semiosis to the sign.

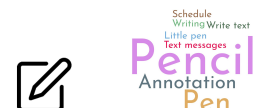
Figure 6. Meaning of Plus

Figure 7. Meaning of Edit

P4 and P5, aged 50 to 57 and 58 to 66, indicated that they did not know the help sign (Figure 8). P3, aged between 67 and 74, had difficulties identifying the sign and, therefore, informed that it represented a Letter "Y". For the others, the sign represented an "interrogation signal". The question mark symbol can represent a doubt in texts and systems, being used for help actions. Participants with incomplete high school accept this sign more easily. P1, P2, P3, P4, and P5 had difficulties with the "document" sign (Figure 9). P8, P11, and P12 reported that the sign represented an "Identity" or "Document". The other participants, with smartphone experience, said they were a "Contact". Thus, the document sign can be used in interactive systems to represent the two contexts mentioned above.

Figure 8. Meaning of Help

Figure 9. Meaning of Doc

In analyzing the "at sign" representation, P1, P2, P3, P4, and P5 had difficulty identifying the symbol, as shown in Figure 10, commonly used to indicate email domains and users. These participants perceived the symbol as resembling letters of the alphabet, such as "a" and "c". Figure 11 shows the results of the "financial institution" sign in banking applications. Only P12 correctly identified the symbol representing a bank during the data collection. However, P1, P2, P3, P4, P5, P6, P7, P9, and P11 interpreted the sign as a "House". P8, who uses mobile banking, does not remember where he had seen one. P10 reported not knowing the symbol at all.

Figure 10. Meaning of At sign   **Figure 11.** Meaning of Bank

5.6 Communicative Breakdowns

We extracted communicative breakdowns from the screen and voice recordings of the 12 participating riverside individuals. We evaluated each participant's interactions individually. They were categorized according to the resource used in the tests: Get Started, Sign up, App security, Central area, Create Pix key, Receive and Pay with Pix. 61 tags related to breaches of communicability were registered. Finally, all communicative Breakdowns were generalized based on the resources tested and the main challenges faced by riverside people to access the prototype. Next, we present the Communicative Breakdowns identified in the case study analysis.

5.6.1 Get Started

Participants needed help understanding the changes provided in the texts and were unable to interact with the continue buttons. This occurred when a participant pressed the button instead of tapping or when the participant tapped the progress bar to switch the button.

Tags: What happened? (P2); Why doesn't it? (P2); I give up. (P3); What now? (P4, P5).

5.6.2 Sign up

Participants needed help with text fields and actions to register the Brazilian Individual Tax ID Number (CPF in Portuguese) and password. The entry interface could have been cut easier, creating barriers to access. There were disruptions similar to interaction with the Get Started feature: tapping the progress bar, difficulty enabling the continue button, and repeating actions. These disruptions were temporary, as participants recovered after seeking information.

Tags: What now? (P1, P2, P8); Where am I? (P2, P4, P5, P9, P10); What happened? (P7); Why doesn't it? (P9).

5.6.3 App security

In the reliability cellphone, some participants had difficulty entering data and following instructions to complete cell phone registration at an ATM. They repeatedly tapped the disabled "continue" button and both email and phone fields during confirmation.

Tags: What now? (P2, P5); Looks fine to me. (P2); Where am I? (P4, P9); Why doesn't it? (P8); What happened? (P10, P12).

5.6.4 Principal Area

The main area has options frequently used by a given user, notifications of account activities or activities to be carried out, a menu simulating all the prototype's options, and a panel with marketing information about the bank's services. Participants had difficulties viewing the button that redirected them to the Pix Area. So it took them a while to find an option, saying "Where is it?", or they did not inspect the main screen and hit the "more services" button.

Tags: Thanks, but no. (P5, P6, P10).

5.6.5 Create Pix key

The participants needed help understanding their possible actions to create a Pix key. They analyzed the interfaces provided on the screen. In other cases, they tapped to fill in the Pix key field before indicating its type. Another difficulty faced was identifying the action that generated the Pix key.

Tags: Oops! (P1, P11); What is this? (P2); What now? (P1, P2, P4, P9); Where am I? (P1, P2); Looks fine to me. (P7); What happened? (P1).

5.6.6 Receive with Pix

The main flaws identified in the "Receive with Pix" activity were related to the responses provided by the prototype. Participants needed help perceiving the progress of the receipt registration process and understanding the meaning of the various receipt fields, which they could fill out to facilitate payment identification (such as identifier and message).

Tags: What now? (P2, P5); What is this? (P10); What happened? (P1).

5.6.7 Pay with Pix

Participants needed help understanding the Pix payment interfaces, as they were similar to other features, such as receiving or creating a Pix key. They needed to learn Pix's payment stage and clarify some data entry fields. For example, they tapped "continue" or the field title instead of filling in the correct text field. There needed to be a better understanding regarding the balance and sending value, with some participants thinking that the account balance was an example of the data field (placeholder).

Tags: What happened? (P1, P4); What now? (P1, P9); Oops! (P2, P5, P11); I can't do it this way. (P2); Why doesn't it? (P5); What is this? (P10).

5.7 Users Interaction Reporting

The participants were asked about the challenges faced in accessing the Prototype. About the ease of access to the application, opinions were divided between completely agree (P6, P7, P10, and P11), agree (P1, P3, and P11), neither agree nor disagree (P5), disagree (P2, P8, and P9) and I strongly disagree (P4). Participants who strongly disagreed or only disagreed reported barriers to accessing the Prototype due to a lack of previous experience with instant payment apps. Although P3 said that the Prototype was easy to access, she had difficulties accessing it because she could not use the buttons on the welcome screen, as mentioned in the section 5.6.

P4 reported difficulties understanding the interface features but overcame them in the initial interaction. P8 said that the metalinguistic signs helped complete the tasks of the forms. P10 said the examples in the text fields helped enter the correct information.

P1 and P5 indicated that the main screen had many interactive options, making it challenging to find the button that redirected them to the Pix area. They also said they had yet to gain experience with mobile banking apps. Thus, the amount

of information made it difficult to interpret which action they should take for a given Pix feature. P4, P7, P8, P10, and P11 reported finding the Pix area quickly. For P4, P7, and P10, it was easier to inspect the screen for the word "Pix" and thus perform the correct action. P8 discovered the correct method of accessing the Pix by looking at the resource's illustration.

P9 did not know the Pix symbol before and had difficulty finding the area with the Pix. However, with the familiarity of the symbol, he could find it more easily. In another context, P11 used text and illustration to ensure that a button would be responsible for the correct action to access the Pix area. P11 indicated that the location of the action to access the Pix area was adequate and, consequently, facilitated their autonomy to interact with the Prototype.

Participants were also asked about the experiences they had with three specific features of Pix, presented below.

5.7.1   Creating Pix key

Some participants needed help understanding the actions to create a Pix key in the Pix area. P1 and P2 faced challenges but could navigate with signs. P7 could create a Pix key easily due to its prior familiarity with an app. P5, P6, and P10 demonstrated that using a key symbol in the illustration proved effective, resulting in an easy creation of a Pix key. P8 had the facility to interpret the signals presented during Pix key creation.

5.7.2   Paying with Pix

P2 had difficulty locating the Pix payment button. P6 mentioned that the payment was slow due to the numerous steps required by forms, which differ from other banking applications they already used. P5 had difficulties in providing the correct amount in the simulated payment due to confusion between the available balance and the example text in the amount field.

P8 emphasized the importance of metalinguistic signs, being the instructions for each step of the form. P4 and P10 had facilities to simulate payment with Pix, thanks to personalized instructions in the steps of the form. They said that: "*[...] Read the text, click there and do things.*" and "*[...] I find it easy to read the instructions there.*". P7 reported that sending a Pix was easy but suggested the inclusion of additional illustrations to facilitate the understanding of users with low literacy levels and indicated that having someone to help users perform instant payments is essential.

5.7.3   Receiving with Pix

P1 found it easy to use the feature to receive with Pix due to its similarity to the feature to pay with Pix. P9 became familiar with the illustration used to represent the resource. P4 received a Pix quickly but needed help using the resource. For P6, receiving a Pix is more superficial than paying with a Pix due to the fewer steps. P8 reported previous experiences with a banking application that did not provide an option to review entered data, requiring the user to go back through all the steps to correct errors. P8 also emphasized the importance of having visual interfaces that make it easy to identify a specific user.

5.8   Receiver's Point-of-View Metamessage Reconstruction

Knowing user expectations is crucial before defining design considerations. SemEng is important in developing interactive systems, and its application in this case study led to accessible and communicable interfaces for individuals with low literacy, limited internet access, and new users. Thus, is presented the semiotic profile generation [de Souza, 2005] that must be considered when designing and evaluating instant payment services for this target audience: "*You are a participant who uses your cell phone in activities that are compatible with your telecommunication infrastructure, mainly in instant messaging applications to obtain general information. I understand you faced difficulties getting started getting started, creating Pix keys, paying with Pix, and receiving with Pix. Here, therefore, is the ideal system to meet your demands, which should provide audio resources and animated guidelines that help you understand a particular task, descriptive texts and button icons related to your daily life, alert messages that facilitate filling out of text fields, intelligent system responses provided after idle time in a given step.*"

6   A Workshop about Developing Financial Conversational Systems for Emergent Users

We held a workshop to apply design and evaluation considerations in an interactive system collaborative development scenario. Thus, the workshop stimulated discussions of these considerations for building conversational financial systems for emergent users.

We divided the workshop into two presentations by the organizers and four practical activities. On the one hand, regarding the presentation made by the organizers, the essential concepts and methods used to conduct the workshop stand out. On the other hand, concerning the activities carried out in a practical way by the participants, it is worth highlighting the awareness of the target audience "emergent users", the use of design and evaluation considerations in existing conversational systems, construction of a prototype in a collaborative manner and presentation of prototypes by groups of participants.

6.1   Concepts Presented

The workshop presented some basic concepts for building accessible interactive systems and the digital inclusion of emergent users. The presentation of concepts lasted approximately 30 minutes and was responsible for leveling the participants' knowledge about the thematic axis of the study.

The 2030 agenda was the first concept presented by the organizers. The 2030 Agenda is a ONU [2015] action plan aimed at people, the planet, and the prosperity of society. In other words, it is a document that strengthens sustainable development, brings universal peace, and eradicates social problems as its principles.

The workshop highlighted some sustainable development objectives of the 2030 Agenda, including decent work and economic development (8), industry, innovation, and infrastructure (9), and reduction of social inequalities (10). In the context of the Global South, these objectives, aligned with the development of interactive financial systems, generate more opportunities for acquiring income and digital inclusion for population groups on the margins of social inequalities.

Digital accessibility and emergent users were presented in the second conceptualization stage of the workshop. To do this, we used some definitions [Barbosa *et al*., 2021; Devanuj and Joshi, 2013; W3C, 2018] presented in the theoretical background of this article (section 2).

The definitions of instant payment systems and Pix were used in the third conceptualization stage of the workshop. To this end, discussions and definitions by Junior *et al*. [2022]; Central Bank of Brazil [2022b] were highlighted, presenting the impacts of Pix on the Brazilian population, the financial and digital scenario.

Finally, the fourth and final concept presented was about conversational systems to highlight the ease of these digital services to include emergent users. We used the work of Candello and Pinhanez [2016] as a theoretical basis and presented some real examples as evidence of resources that generate inclusion or exclusion for the workshop's target audience.

6.2   Target Audience

Nine computing undergraduate and graduate students participated in the workshop, working in different research subareas in Human-Computer Interaction (HCI). Despite the participants' differences in educational levels and HCI thematic areas, our goal was to promote an enriched collaboration of experiences about accessibility in the student's academic and professional environments.

Another goal was for the participants to learn about emergent users and financial systems. The workshop aimed to shift their recognition, guiding them to consider innovation systems and user interfaces as conversational systems, and to align their thinking with the 2030 agenda.

6.3   Materials Used

We used some materials during the workshop dynamics, such as cards, printouts of conversational systems, and a platform that supports designers and developers in developing accessible software to emergent users.

We used the Inclue platform[9] during some workshop activities. This platform was developed by some workshop members based on the results obtained in a set of studies [Teran and Mota, 2024; Teran *et al*., 2024b; Melo *et al*., 2024b]. It has, as abbreviated in its acronym in the Brazilian Portuguese language, the objective of:

- **Include** – **I**nclude Emergent Users to interactive systems;

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[9]Inclue Plataform: https://inclue.vercel.app/

- **Guide** – Guide, in portuguese "**N**ortear", designers on user interaction characteristics;
- **Connect** – **C**onnect Instant Payment Systems as a financial management alternative for Emergent Users;
- **Legitimate** – **L**egitimate Emergent Users as protagonists of digital services and sustainable development.

The Inclue platform has a total of five sections:

- **Home** – briefly presents the platform and its content;
- **Design and Evaluation Considerations**: provides a quick reference guide on implementing accessibility features in inclusive interactive systems for emergent users.
- **Personas** – presents some consolidations of the interaction characteristics of emergent users.
- **Quiz** – presents questions and answers a review of the content presented on design considerations and characteristics of emergent users.
- **About** – presents the platform's source documents and the team involved in Inclue's development.

During the workshop, the Design and Evaluation Considerations and Personas sections of the Inclue Platform were used, which supported group dynamics. In other words, this tool helped participants discuss the inclusion of emergent users and the development of conversational systems that meet their socio-digital characteristics.

The design and evaluation considerations of the Inclue Platform encompass the recommendations presented in the source article [Teran *et al*., 2024b]. However, it was validated and evolved based on a study with emergent users [Teran and Mota, 2024] and a set of inspections carried out on Brazilian banking applications [Melo *et al*., 2024b]. Therefore, the Inclue Platform was chosen due to the level of refinement of design and evaluation considerations [Teran *et al*., 2024a], in addition to the greater ease of interaction for participants.

We created paper cards to draw Personas and Design and Evaluation Considerations that participants needed to work on during the workshop dynamics. These cards were created based on information from the Inclue Platform to share the content worked on by the participants, given that it would only be possible to apply some of the content available on the platform due to time.

Finally, we printed two types of screenshots and gave to participants during the dynamics. The first type of capture was related to conversational systems on the market for using Pix, with the aim of participants identifying accessibility barriers. The other type of screenshot was a cell phone with the WhatsApp application open, which was used for participants to design proposals for resources accessible to emergent users.

6.4   Dynamics Conducted

Four dynamics were explored in the workshop. To accomplish these dynamics, we built three teams in which participants collaborated throughout the workshop. From these

teams, participants designed and evaluated the interactive capabilities of inclusive financial conversational systems for emergent users.

The first dynamic of the workshop was to raise awareness about emergent users, in which participants used the Inclue platform for this learning. In the Personas section of the Inclue platform, participants read the characteristics of an emergent user, defined by the draw cards, and then discussed in their groups how this particular person interacts with interactive systems.

Subsequently, in the second dynamic, the groups of participants described the selected personas, presenting them in the room to the other groups. Furthermore, they indicated what they learned about the socio-digital characteristics of these emergent users. In this dynamic, the organizers asked the participants some questions, such as: *"what other socio-digital conditions are characteristic of these users?"* and *"Have you, at any other time and place, observed any barriers faced by these people?"*.

In the third dynamic, the groups evaluated the barriers of a conversational system, supported by some design considerations and evaluation of the Include platform. Thus, we gave some sheets of paper to the teams with examples of screenshots of conversational systems that have some access barriers for emergent users in resources of creating Pix key and to pay with Pix.

We carried out a filter on the design and evaluation considerations that could be applied in developing conversational systems [Teran *et al.*, 2024a]. Of the 33 considerations available on the Inclue platform, 18 remained. Thus, based on the draw cards, six considerations were allocated to each group.

Participants read the six considerations and chose, as a group, at least 3 of them that were not implemented in the proposed conversational system. The design and evaluation considerations (considerations of number, respectively, 2, 7, 8, 10, 12, 14, 16, 17, 18, 19, 20, 21, 24, 26, 27, 32 and 33) distributed among the teams were:

- Trigger voice commands via buttons or by pronouncing activation keywords
- Present animated illustrations that are easy for the user to understand
- Show receipts that simulate the physical document
- Provide titles and captions in large fonts, with few characters and highlighted keywords throughout the application
- Provide voice feedback to indicate alerts or errors about user-reported data
- Present icons that are easy to understand for the user
- Provide an audio description of data previously entered by users
- Provide a graph that makes it easier to view your balance when sending or receiving a Pix
- Present a list of user favorites Pix keys
- Allow the user to favorite the recipient's Pix key in the process of paying with Pix
- When performing form-filling tasks, display a single task at a time on the screen
- Provide the option to edit the data entered before completing the task

- Define clear orders on forms to reduce errors
- Avoid back buttons on task completion screens
- Strengthen user authentication via voice command with non-sensitive personal data
- The voice assistant must ask if the user is in a safe environment before providing personal information
- Instructions should be brief and highlight keywords in specific actions
- Use voice assistants and animations to help users with their tasks

After identifying the barriers of conversational systems through design considerations and evaluation of selected ones, the participants presented the given system and its accessibility challenges to the other teams, as well as why the considerations are not applied to its resources.

In the fourth dynamic, the Braindrawing technique was used to collaboratively build a proposal for a conversational real-time payment system that included emergent users. As a result, each participant was given a page containing a cell phone capture using the WhatsApp application. Participants used this paper to design features that improve the accessibility of conversational systems for emergent users.

Participants were directed to design a payment conversation proposal via Pix or create a Pix key. The dynamic lasted 3 minutes for each participant, after which they would change roles, and the next participant would continue the drawing. The participants considered how emergent users would communicate with the conversational system and the response resources provided by this service. For example, participants designed possible text or audio conversations to be reported by emergent users, and then conversational assistants provided audio or illustration resources to assist and facilitate understanding for these people.

The Braindrawing cycle ended when the paper was returned to the original participant. Afterward, participants were given 15 minutes to discuss their prototypes and build a payment proposal with Pix using the experiences obtained in Braindrawing. Finally, the participants presented the consolidated prototypes to the other groups.

6.5   Planning and Data Analysis

We collected data before, during, and after the workshop. Before starting the workshop, participants were sent a form with questions related to knowledge about conversational systems, instant payment methods, accessibility, and emergent users. The form was sent days before the workshop to determine the participants' involvement in the topics covered.

During the workshop, we recorded audio and took photographs of the materials developed by the participants, including paper prototypes. This collection was essential to assess the extent to which design and evaluation considerations were implemented in conversational systems to develop accessible instant payment methods and the degree of participants' awareness of emergent users.

After the workshop, we provided a form to observe the participants' final understanding of the concepts presented and their satisfaction with the dynamics and materials used.

The following subsection presents the results obtained in the workshop. The subsection 6.6 highlights participants' previous knowledge about the thematic and target audience of the workshop. The subsection 6.7 presents the workshop conduction results. Finally, the subsection 6.8 presents the acceptability and viability results of the workshop.

6.6 Conversational System, Financial and Digital Accessibility Knowledgement

Nine undergraduate and graduate computer science students participated. The genders indicated by the participants were three cisgender men, four cisgender women, one non-binary person, and one who preferred not to answer. The age range of participants varies between four participants aged 23 to 27, two people aged 18 to 22, one person aged 28 to 32, one person aged 33 to 37, and one person approximately 58 to 62 years old.

Of the nine participants, four were undergraduates, and five were graduate students in computer science. The undergraduate courses mentioned by the participants were computer science (2), computer engineering (1), and information systems (1). Regarding graduate studies, four participants were master's students, and one was a PhD student in computer science. On a Likert scale of 1 to 5, participants were asked how interested they were in working with the development of accessible interactive systems. Seven of the nine participants indicated they were very interested, and two were reasonably interested.

In addition, participants indicated how knowledgeable they consider themselves to be about accessible software development. Four participants indicated that they were knowledgeable, two indicated that they were reasonably knowledgeable, and three indicated that they were not knowledgeable about software accessibility. Next, participants were asked whether they used theoretical or practical tools to develop accessible software. Most participants (5) indicated they do not use accessibility tools. On the other hand, participants cited Google Chrome's LightHouse and Devtols tools (1), WCAG and EMAG (1), and Linters for code accessibility (1).

Participants were also asked whether they had previously worked with inclusive systems for emergent users, that is, older people, low literacy, riverside, or traditional communities. For this answer, all participants indicated that they did not work on software development projects that considered the interaction characteristics of this target audience.

Regarding the workshop scenarios, the degree of conversational and instant payment systems use was asked. The question aimed to understand how knowledgeable the participants were about these interactive systems. For conversational systems, 4 participants indicated that they use it, 2 participants use it a lot, 2 participants do not use it, and 1 participant reported that they reasonably use this type of system. Regarding instant payment systems, 8 participants highlighted that they use them a lot, and 1 participant reported that they use this type of system.

Finally, participants were asked if they had contact with other workshops in the last six months. Most participants (5) had no contact with workshops in the last six months. The other participants indicated they worked in workshops on developing adaptable (2) and accessible (2) games.

6.7 Workshop Conduction

The following subsections present the results obtained during the workshop. We highlight the activities to raise awareness about the emergent users, the discussions on design and evaluation considerations, the accessibility evaluations in interactive financial chat systems, and, finally, about the design of accessible financial chat systems to include emergent users.

6.7.1 Awareness about Emergent User

Initially, three groups of 3 people were formed for the workshop activities. In the first activity, two cards with the name of the Personas were randomly given. Thus, participants accessed the Inclue platform and read about these personas. Table 2 presents the name of the personas and the intended group. Remember that personas are fictional actors constructed to present the characteristics and stories of a real person. Therefore, the names were created randomly to represent these people.

The participants discussed among themselves the stories and socio-digital characteristics of the Personas. Finally, they evaluated the Personas and their perceptions of the other groups.

Group 1 presented the Personas João Santana and Maria Nazaré. The group reported that the main difference between the Personas was related to age, help or not from trusted people, and the disparity in access to internet infrastructure due to the inhabited area. Thus, one participant's speech was "*[...] Maria, she won the smartphone, right? While João had to acquire an entire smartphone and antenna infrastructure to be able to access the internet.*".

Group 1 reported that these Personas have something similar: the relationship with access to DICTs, such as the use of interaction resources on smartphones and the internet, and the motivation to use this type of technology. Thus, a participant said that "*[...] we identified that they are both interested in using technology, although João's objective is more to pay bills and reduce distance, and Maria to obtain income, is it not? She is the one who has to use it to make money; right, it is about getting paid.*".

Group 2 presented Personas José Silva and Karina Oliveira. The two participants have something in common: the need to use banking applications to acquire income. However, a participant in the group hypothesized that Persona José's difficulty may be related to little contact with smartphone resources and the barriers faced in a financial aid application widely used by the Brazilian population during the Covid-19 pandemic. Therefore, his lines were "*[...] he uses for basic operations. Call, send a message, an SMS in this case, and send audio, probably via WhatsApp.*" and "*[...] it was an application that was created very quickly to help these people. It was probably an application that had several usability flaws.*".

According to participants in group 2, the needs experienced by the Personas in the workplace and in formal education can influence smartphone use. Therefore, although these

Table 2. Personas Sorted by Group

Group	Persona Name	Persona Story
Group 1	João Santana	*João, aged 38 and with two children, works in agriculture in Fontes Verdes. Two years ago, he used fuel to power his daily tasks due to the lack of electricity in the region. Last year, his eldest son moved to the urban area 247 kilometers away. João bought a smartphone and a long-range internet antenna to keep in touch. Because of the distance, convenience, and security reasons, he opened an account with a digital bank to pay bills and provide financial support for his son. Initially, João faced difficulties with the banking app, but his youngest son's assistance has reduced these obstacles.*
	Maria Nazaré	*She is a 64-year-old businesswoman who lives on the island of Sabiá and works in açaí extraction with her family. She recently received a smartphone as a Christmas present from her brother, her first device with this type of technology. She is eager to learn how to use Pix to make it easier for customers to pay at the Ver-o-Peso market. However, she indicated that she is afraid of using the application because she does not understand how to use the keyboard functions, buttons, and other traditional smartphone features.*
Group 2	José Silva	*José is 50 years old and works as a cook in Itapiri city. Born in the country's northeast region, he moved to the southeast region at the age of 25, at the invitation of a friend, to open a typical food restaurant. In 2020, José's work environment was affected by the Covid-19 pandemic, leading him to receive emergency aid to help with his family income and business. Despite this, he mentioned using his smartphone to send audio to his children and answer calls from his restaurant's customers. Therefore, he requested support from his children to learn how to use financial aid and instant payment applications.*
	Karina Oliveira	*Karina, at 43 years old, is a bagger. Last month, during classes at the School for Youth and Adults, she received entrepreneurship and financial education instructions. Therefore, she has been looking for alternatives to innovate in her daily sales. With the rise of Pix, she opened an account and is committed to learning about the app. However, Karina states she has little smartphone experience, with approximately one year of contact. Soon, she opened a bank account but felt the application did not provide usage tips. Therefore, she needed help entering data into text fields and understanding the illustrations.*
Group 3	Fernanda Duarte	*At 43 years old, Fernanda is a mother of four children and works as a day laborer. Due to the Covid-19 pandemic, she became the beneficiary of aid provided by the public authorities. However, she did not receive the benefit in the first few months because she faced difficulties accessing the social registration application. With the help of a trusted friend, Fernanda overcame these barriers, registered, and was approved to receive the aid. However, she expressed to her friend her desire to receive some lessons on the application, as she faces difficulties filling out forms and understanding icons and texts.*
	Keila Souza	*Keila is 52 years old and works as a waste picker in the metropolitan region of Belém. She studied until the fifth grade of elementary school, at 11, due to the need to help her mother, who worked in the rural area, to raise her siblings. Her brothers are grateful for her efforts and recently presented her with a house close to an elementary and high school. This year, Keila started studying at school, and the teachers encouraged her to use Pix to increase her income. Thus, she has learned how to use Pix, and whenever she has questions, she turns to her Portuguese and IT teachers, Joana and Carol.*

personas have difficulty using financial applications, some interactions, such as sending audio or messages, are easier to carry out. In this sense, a group participant's report highlights this thought: "*[...] Both the issue of scholarity and cell phone use. He can send audio and text messages and everything else. Not her, right? She has less contact time with her smartphone. There is still the issue of her education, which influences her to have more difficulty than him.*".

Group 3 presented Personas Keila Souza and Fernanda Duarte. Participants reported that the two Personas face barriers in accessing Pix, understanding icons and texts, interacting with forms, and seeking help from trusted people to understand how they can interact with payment resources. For example, Persona Keila gets around her difficulties by asking teachers for help to use Pix.

Group 3 highlights that Persona Fernanda is not an older person and, despite this, faces barriers in accessing Pix services due to digital literacy issues. In this sense, the participants indicated "*We assumed that she is a type of person who is not very familiar with the smartphone, [...] but she would not fit into an elderly person, and we also assumed that She might have a slightly higher level of education than Keila, but she is not at all familiar with mobile applications, and because of this, she needs some help in this part of registering forms, to be able to receive help correctly.*".

Finally, another point highlighted by group 2 was the need to use financial aid applications, which, however, create difficulties in acquiring income due to the exclusion of digital and financial literacy. Thus, they reported "*A key point we noticed was the issue of Covid [...]. We ended up here thinking*

that perhaps this difficulty that Fernanda had was precisely due to the lack of contact with these financial applications, that perhaps, it is also thought that many of the financial applications people will not have as much contact with if she has a low income. So perhaps it was her first contact with a banking application, and perhaps this resulted in her having difficulty accessing the resources that the application offers.

This stage of the dynamic made participants use the Personas of the Inclue Platform to discuss the socio-digital characteristics of emergent users, in addition to extending this reflection to other social, digital, and digital aspects that were not present on the platform but which exist in our society. Therefore, this discussion raises awareness about emergent users and how they should be considered in software development based on their educational, financial, geographic, and computational conditions.

6.7.2 Discussions about Design and Evaluate Considerations

In the second dynamic, each group received six cards that presented a QrCode and the title of a specific design and evaluation consideration. Participants used these cards to access the descriptions and examples presented in each consideration. After reading them and discussing the considerations, they chose three that they thought were important and excluded three others to implement in conversational systems. Table 3 presents these results.

For group 1, the three removed considerations referred to a feature suggested in their description that could not be im-

Table 3. Decisions of Considerations by Participants

Group	Included Considerations	Excluded Considerations
Group 1	2. Trigger voice commands via buttons or by pronouncing activation keywords	7. Present animated illustrations that are easy for the user to understand
	14. Provide an audio description of data previously entered by users	16. Provide a graph that makes it easier to view your balance when sending or receiving a Pix
	21. Define clear orders on forms to reduce errors	24. Avoid back buttons on task completion screens
Group 2	12. Provide voice feedback to indicate alerts or errors about user-reported data	20. Provide the option to edit the data entered before completing the task
	13. Present icons that are easy to understand for the user	32. Instructions should be brief and highlight keywords in specific actions
	19. When performing form-filling tasks, display a single task at a time on the screen	33. Use voice assistants and animations to help users with their tasks
Group 3	10. Provide titles and captions in large fonts, with few characters and highlighted keywords throughout the application	8. Show receipts that simulate the physical document
	17. Present a list of user favorites Pix keys	18. Allow the user to favorite the recipient's Pix key in the process of paying with Pix
	27. The voice assistant must ask if the user is in a safe environment before providing personal information	26. Strengthen user authentication via voice command with non-sensitive personal data

plemented in a Chatbot or the consideration specified or encompassed a specific feature of another consideration. So, for example, they reported "*Regarding Consideration 24: 'Avoid the back button on task completion screens', we took more consideration that a Chatbot usually takes place on our screen, right? So there's no way to delete the back button during the conversation because you know it kind of traps the user on the Chatbot screen, so we excluded this one.*".

Group 2 selected considerations 12, 13, and 19 and explained why they were more important than the others (considerations 20, 32, and 33). Participants in this group said two of the chosen considerations are important due to providing audiovisual resources that help users understand the data they have entered. Finally, the group indicated that consideration 19 is important because it facilitates the user in filling out the form through a single step at a time. As a result, their statement was "*We understand that this consideration is related to each activity. Being done once will make it easier for the user not to make mistakes when entering data.*".

Group 3 chose considerations 10, 17, and 27. Their reports said it is important to create easy texts for users to understand, given that some illustrations and icons can be difficult to understand. Thus, they indicated "*With the Personas presented, there are many difficulties in understanding icons and illustrations. So, it is important to have evident text for these people instead of using icons and other elements that replace the text.*".

Group 3 indicated the need to be concerned with the user's sensitive data, through the consideration of consulting via audio if the user is in a secure environment. With that, they said "*This information becomes important if there is a malicious person wanting to steal your data or benefit in some way that will harm the emergent user, then this information becomes important in this context.*".

Finally, participants in group 3 reported that consideration 17 is essential because it reduces the number of interactions on the data filled in by emergent users. In this way, they highlight that "*It becomes important to save the effort of emergent users who already have difficulty accessing this service, so it will facilitate sending a Pix in their context.*".

6.7.3 Accessibility Evaluations in Financial Conversational Interactive Systems

In the third dynamic, the workshop groups evaluated a conversational financial system based on the three design and evaluation criteria defined by their members. Each group received a printed screenshot of a conversational system named Yellow Bank, Red Bank, or Blue Bank, where a specific user interacted with features such as paying with Pix or creating a Pix key. The groups also used insights gained from persona dynamics to discuss the barriers that emergent users face when accessing these systems.

Table 4 presents the results from the groups' observations of the accessibility features implemented in conversational systems for the inclusion of emergent users. For the analysis, participants used the criteria selected in the previous stage and concluded that none of these accessibility features were implemented for accessing resources in conversational financial systems.

According to group 1, the Yellow Bank fails consideration number two by not providing voice output and not understanding voice input. In this context, they highlighted "*[...] when the person gives the number by voice command, it responds that it did not understand 'let's try again'. To send the Pix... when the person just says: 'I want to pay the Pix via audio', the screen is directed to the bank page with a list of recent Pix, but not via audio.*".

Regarding consideration 21, 'clear instructions in forms,' group 1 pointed out that this criterion is not met, as the system provides content beyond what is necessary at a given stage, potentially confusing the emergent user during their interaction. Therefore, they inform "*[...] when the person activates the service here with the word 'hi', the assistant says what the person can do. However, the assistant sends an advertisement, like 'connect with the new feature, I don't know what, access the super app' and sends a PDF, so that is completely out of order if the person only knows how to activate the command 'I want to pay Pix', and the person does everything in the order the person already knows. The assistant sent an advertisement in the middle, that the person would no longer know how to use.*".

Finally, group 1 highlighted that consideration 14 is not met because the conversational system does not provide an

Table 4. Bank Example and Seems About Design and Evaluation Considerations by Group

Group	Bank Example	Evaluated Considerations	Seem
Group 1	Yellow Bank	2. Trigger voice commands via buttons or by pronouncing activation keywords	Not implemented
		14. Provide an audio description of data previously entered by users	Not implemented
		21. Define clear orders on forms to reduce errors	Not implemented
Group 2	Red Bank	12. Provide voice feedback to indicate alerts or errors about user-reported data	Not implemented
		13. Present icons that are easy to understand for the user	Not implemented
		19. When performing form-filling tasks, display a single task at a time on the screen	Not implemented
Group 3	Blue Bank	10. Provide titles and captions in large fonts, with few characters and highlighted keywords throughout the application	Not implemented
		17. Present a list of user favorites Pix keys	Not implemented
		27. The voice assistant must ask if the user is in a safe environment before providing personal information	Not implemented

audio description of the data entered by emergent users in the answers the assistant gave. Thus, a participant in this group indicated that "*[...] It (the assistant) said: 'you can make a Pix for up to 300 reais'. That is it. What is the value? The person writes 10, and it (the assistant) says: 'follow (attached) the transfer data', but everything is written, the customer's name and so on, but it (the assistant) does not give an audio description. Like 'Person X, do you want to send 10 reais (BRL) to Person Y?'. It (the assistant) sends everything written and then directs it to the application page, so it also failed to comply with this consideration.*".

Group 2 called attention to the lack of icons to make it easier for emergent users to understand the tasks. In their speeches, they highlight "*[...] For example, there is a message: 'what is the key for who will receive the Pix?' Like, putting the icon next to the key phrase, right? This is for the person to understand they are asking for the key, whether CPF, email or telephone.*".

In addition, group 2 highlights that the conversational banking system does not meet consideration 12 on voice feedback to indicate alerts or errors in data entered by users. With this, a participant indicated that "There is a part of the conversation where it says like this: "*What is the key of Pix receiver? If it's CPF/CNPJ or a phone number, they're just numbers without special characters. Then the person sends audio; the app returns, 'The Pix key format you entered is invalid.' yet this stage, it should not say 'The Pix key format you provided is valid'; the app should, like, return the feedback.*" and "*Much of the interactions that the user provides are by audios, but at no time does this bank provide any audio response. Everything it returns is by text, right? So, this voice feedback ends up not happening.*".

Regarding consideration 19, of displaying a single task at a time when filling out forms, group 2 highlighted that there is a violation due to the assistant not understanding the information and, therefore, moving on to the next step. This way, they indicated "*Because then the app sent the description information, the user put 'Pix of BBQ', but the app returned the description 'bikes of barbecue'. The app should also come back too 'Do you want to confirm this description?'.*".

Finally, group 3 highlighted that the Blue Bank did not meet their chosen considerations. Among these absent criteria is consideration 17, as they describe that no list of Pix keys is presented to users. In this sense, they indicated that "*In these options, we realize that there is no consideration 17, which would be to present a list with the Pix keys [...]. So that makes it difficult for the user, precisely because it would be*

easier for them to access and have that data available [...]".

An improvement indicated by the participants in group 3 was emphasizing the main textual content presented in the messages from assistants in the Blue Bank conversational system. In this context, they reported that "*It (assistant) asks, it (assistant) states, 'Check if everything is ok!'. It informs the type of key, the generated keys, and the account linked to the key. We considered it interesting to have consideration 10, which is to provide titles, subtitles with large fonts, characters with highlighted words, and everything else. Because then it (the assistant) is dealing with sensitive data, it would be interesting to highlight this to the user so he can be aware that this is being done and is relative to the given data.*".

Finally, group 3 indicated the need for the Blue Bank's conversational system to provide audio resources that maintain user safety: "*[...] the moment he (assistant) says 'enter your password.', [...] in this bank, you have the option for the assistant to read everything that is being talked about. So, if the person presses the option to read what he talked about, his cell phone will be screaming that he will enter the password for God and the world.*".

6.7.4 Designing Accessible Financial Conversational System to Inclusion of Emergent Users

In the fourth dynamic, participants built, using the technique of *Braindrawing*, paper prototypes with improvements in the interaction resources of conversational financial systems, with the the inclusion of emergent users to this type of digital service in mind. This way, they used the concepts and tools presented in the workshop carried out in the previous stages. Then, they consolidated their ideas for improvements into a prototype built with the whole group.

About group 1, participants indicated that their suggestions for improvements were mainly focused on the inclusion of interaction via voice command, allowing emergent users to use this type of resource from the beginning of their conversations (Figure 12). In this sense, they highlight: "*I would say that the main thing we implemented [...] would be the option of being served via audio and text, and letting the user choose that. It also allows users to interact with the Chatbot with audio only [...]. So from that moment on, the Chatbot starts communicating with the user only via audio.*".

In addition, participants in group 1 improved the Chatbot's information through clarity about the order of content presented in the conversation with the user. To address this, they created new initial and final messages to help users better un-
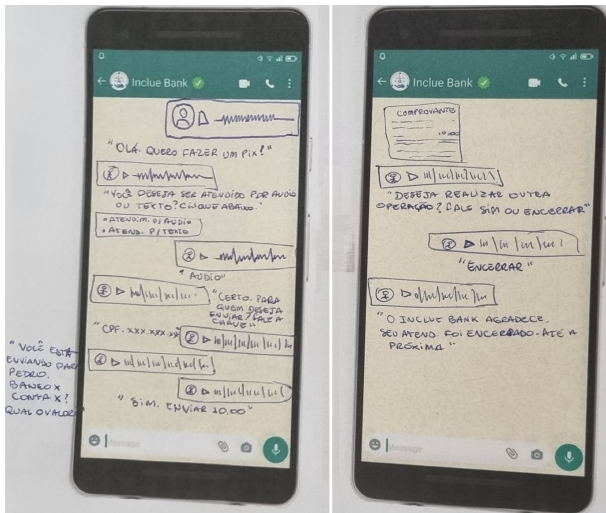
Figure 12. Parts of the prototype created by group 1

Figure 13. Parts of the prototype created by group 2

derstand the beginning and completion of a Pix payment. In this way, they highlight that "*There is also the issue of the Chatbot ending the service that we found problematic, the service not being closed, right? It keeps things in the Chatbot's memory [...]. Then, the service ends. The Chatbot says, 'your service has been closed,' and that is it; it is over.*" and "*And it is also the fact that the user arrives asking for something instead of assistant having that whole sequence, like saying, 'look, I'm the bank's chat bot Include and, next, 'what do you want to do?'.*".

Ultimately, participants had difficulty improving the interaction to identify the user's authenticity. Therefore, they indicated that "*We could not think of how to do this in a way that was safe and accessible. Because we did not want to say, 'say your password'. Finally, saying the password aloud if you are in public is dangerous. Please enter your password here in the chat; it is insecure. So, we could not think of a better way to do this.*".

Participants in group 2 highlighted two improvements (Figure 13). They added confirmation options through questions about data previously entered by users and, in addition, highlighted the need to implement audio resources to describe the data returned by the conversational system. In their speeches, they indicate the improvements "*The Chatbot returns 'do you confirm Pix? Yes or no!' In this case, you will confirm, and then the Chatbot will return with Pix's confirmation and the receipt below. Moreover, finally, the Chatbot asks, 'do you want to hear the receipt description?'. Then, the person says yes, and the Chatbot describes all the details of the receipt. Then it ends, asking if you want to repeat the Pix. Otherwise, [...] closes the transaction.*".

Group 3 indicates that the main improvement was for user security when the system assistant provides sensitive data via audio (Figure 14). Furthermore, like group 2, group 3 also indicates data confirmation message capabilities through questions about data previously entered by the user. In this sense, a group representative indicates that "*The user informs that he wants to create the key through the CPF. Then, the system asks if he is in a safe environment to share this information. The user responds yes, and then the Chatbot informs the user that he does not need to say the dashes or the scores, just numbers, so the user makes this order. Finally, he informs*
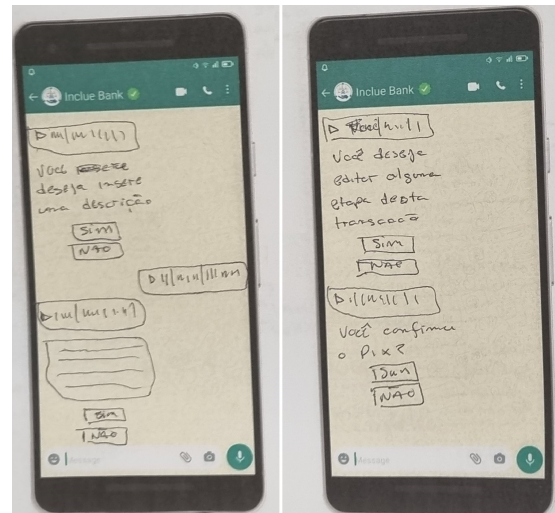
his CPF. Then, the Chatbot asks the user to confirm the information. Here, the Chatbot informs the user of the type of key, the key being the CPF and the account conveyed to the user, and asks the user to confirm this information.".
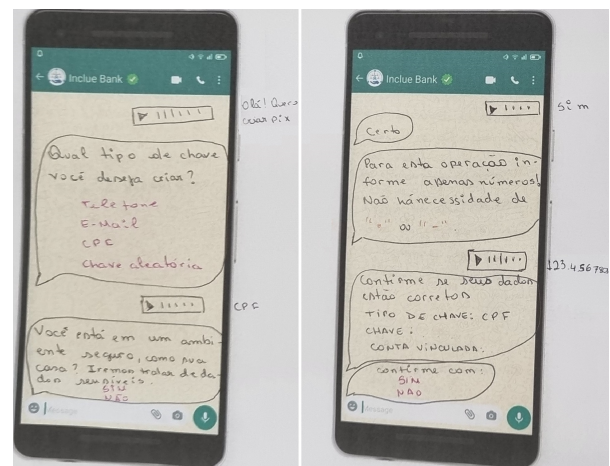

Figure 14. Parts of the prototype created by group 3

6.8   Workshop Acceptability and Learning

The nine participants indicated their satisfaction with the workshop and described the learning obtained through the theoretical and practical materials used by the researchers.

Using a Likert scale, participants indicated their level of satisfaction with the workshop. Of the nine participants, eight indicated they were delighted, and one indicated they were satisfied. Eight participants indicated that it was straightforward, and one indicated that it was easy to carry out the dynamic activities. All participants indicated that they would recommend the workshop to others.

We obtained similar responses regarding the workshop support tools. Seven participants indicated that it was straightforward to understand, and two highlighted that it was easy to use the Incle platform. Likewise, seven participants indicated that it was straightforward to understand, and two indicated that it was easy to understand the persona cards and considerations used in the dynamics of the workshop.

Table 5. Bank Example and Seems About Design and Evaluation Considerations by Group

Group	Participants' Phrases
Group 1	*emergent users are users who, for some reason, have not been able to keep up with the development of communication technologies. They need and want to participate in society and access interactive systems. Here, therefore, is a system that allows instant payments to be made through a conversational agent, which recognizes commands and data through text and voice, as well as being able to communicate with users through text and voice, giving the user the option to choose how they want to be served, guaranteeing emergent users access to instant payment services.*
	It is my interpretation of emergent users Maria Nazaré and João Santana. They both need to use banking applications to carry out monetary transactions. Here is the system I have designed for emergent users, which they can or should use to achieve a series of objectives associated with instant payment activity. For emergent users Maria Nazaré and João Santana, it is essential that the conversational system can maintain conversations via audio, as both users have little familiarity with banking systems. Furthermore, Maria Nazaré has a greater degree of difficulty as she is not familiar with smartphones. Another essential feature is the organization of the form's questions. Separating the form into several small questions and maintaining the sequence of questions is essential to facilitate the user's response and memorization of the steps a user must take to carry out a transaction via the conversational system.
	It is my interpretation of emergent users who need to use their smartphones and the Internet to pay bills, reduce distances, and earn income from their business through PIX. Therefore, the system we designed is a Chatbot with voice command, keyword activation, and clear and objective paths so that they can carry out transactions simply and directly without confusing them with other links, advertisements, or many steps to accomplish what they want.
Group 2	*I understood that the emergent user is unfamiliar with technology and needs easy access to interaction. We can define this effort towards greater social inclusion possible using the ease of technology.*
	emergent users have difficulty accessing information for geographic, educational, or age reasons. However, access to information and services is fundamental for all users, and the system must be prepared to be accessible.
	In my interpretation, emergent users are those who have not had access to interactive systems throughout their educational, professional, family, and other trajectories. Their lack of ease in using these systems creates blockages and makes their lives difficult in several aspects. Thus, to meet the needs of these users, interactive systems must be easy to use, with short and objective explanations, simple operations, and a programmable assistant that can assist the user in case of difficulties.
Group 3	*emergent users have not kept up with the progressive development of technology and need it to assist in personal and professional activities. The system I designed for emergent users to create a Pix key accepts both voice and text to communicate with the user in a way that does not jeopardize their privacy and security.*
	Emergent users are people with a low level of digital literacy and formal education who want to use interactive systems without the help of other people. Interactive systems must contain short, easy-to-understand textual elements and images that can support these people.
	It is my interpretation of emergent users; they are people who have not kept up with the period of growth and technological innovation and, therefore, do not have much digital literacy; they are usually people with low income, from areas far from urban centers or with little or no literacy. Therefore, I designed the system for emergent users, which they can or should use, with functionalities that inform their usefulness, systems that adapt to the reality of data connection, and texts with larger fonts and images suited to the context.

In this context, queries regarding the benefits and problems related to the workshop were made in an open way. Concerning the workshop problems, a participant mentioned having difficulty carrying out the *Brainstorming* activities due to initially not understanding what should be done in this dynamic. One participant indicated that he sometimes felt lost, but ultimately understood and appreciated the topic covered.

Six participants highlighted the benefits of the workshop. They indicated the benefits of collaboration between participants, which stimulates digital service problem-solving, exchange of ideas, and creativity for the inclusion of emergent users. Furthermore, they highlighted the importance of using personas to understand the socio-digital challenges faced by emergent users. Finally, the participants indicated clarity and clarification of doubts about the conduct of the dynamics and their contents presented in the workshop.

Participants indicated the importance of developing interactive systems accessible to emergent users. The responses describe the need to include as many people as possible and build equality, strengthen the economy, and enhance autonomy and security in access to digital services. The reports *"[...] stand out as evidence. It is super important to develop accessible systems for emergent users, as this benefits the inclusion of people with little familiarity with technologies. This inclusion brings several positive impacts on the lives of emergent users, both in the economic and social spheres. It is essential because our society is increasingly connected with technology. Therefore, providing inclusion for emergent users in digital environments is crucial."*, *"It is essential to include these users who are not as familiar with technology, as it is currently present in everything, and permeate many everyday activities."* and *"The importance of developing accessible interactive systems aims to allow these users autonomy in the face of vast applications that constantly evolve. Furthermore, it contributes to reducing social inequalities."*.

Finally, participants were asked to construct a sentence about emergent users, how they use interactive systems, and what interaction resources are necessary to include these people. In summary, participants indicated that emergent users have not kept up with technological developments, face challenges accessing social services, and need inclusion in digital technologies. Furthermore, participants indicated that it is necessary to implement short and easy-to-read texts, audio output and voice command features, and to present better organization for communication with forms. The reports are presented in the paragraph in the Table 5.

7   Discussion

The following results highlight the discussion about the data obtained through case studies with riverside people and the workshop aimed at improving access to systems financial conversations.

7.1 Case Study with Riverside People

This case study shows the importance of conducting HCI surveys for emergent user groups, new users, or users with limited access to internet services. Understanding their culture and how they relate to society, nature, and technology, generates opportunities for social inclusion. In the case of IPS, this case study considerations provide improvements to reach the interaction aspects of riverside people in new financial services. In addition to giving them more possibilities for raising income, it maintains their interaction with nature, such as, for example, receiving resources related to the extraction of açaí, hunting, and fishing. It also provides financial inclusion for interactive systems in emergencies, avoiding access interruptions, as has occurred in the Covid-19 pandemic.

Accessible IPS strengthens competitiveness and showed that the organs are concerned and involved with socio-environmental, based on the 2030 agenda of ONU [2015], on the National Policy for the Sustainable Development of Traditional Peoples and Communities [Brasil, 2007] and on the Brazilian legislation for the Inclusion of People with Disabilities [Brasil, 2015]. The Sustainable Development Goals [ONU, 2015] highlight the opportunities to create more social equality between the people. The absence of Accessible IPS violates the tenth goal of sustainable development, related to reducing social inequalities.

When analyzing the socioeconomic data, we realized the importance of social projects for indirect and direct income transfer to riverside people. These services have migrated to the digital way more frequently, which shows the need to build services that meet the experiences of their primary beneficiaries. The inaccessibility of these services can generate bilateral losses between digital access and, consequently, the acquisition of income of these people.

Pix users reported increased payment convenience, lowered commuting costs, and more daily life productivity. Conversely, non-Pix users have limited interaction with computer systems, preferring traditional transactions cash methods, visiting bank branches on deposit days, or entrusting financial tasks to reliable individuals.

Some aspects may affect the application of these design considerations, such as time, knowledge, and financial cost. Knowledge is necessary, so those involved in the design of the project understand the considerations to apply them to their mobile banking applications. The institution's management must improve access for these users and provide the necessary inputs to the instant payment system development team, needing financial and time costs. Another important aspect is to strengthen the contact of development professionals with the system's target audience and the experiences of these users so that all stakeholders work together on improvements and remain encouraged in the challenges that arise during the development of the interactive system.

We were able to observe that education of the riverside people has been evolving, given the advance in the possibilities of logistics provided by the public power that sends students to schools in the cities closest to their region. However, despite the participants indicating that elementary school grades have been offered in their communities, focused on rural education, it is still necessary to go to the nearest city to attend secondary, technical, or higher education. This scenario means that the education of riverside people is partially in the community and partially in the nearest town, as indicated by P4: "*But at that time it wasn't like it is now, with a boat, a boatman, right, to take you to (a nearby city) to study*". Therefore, the lack of formal education in the community makes the nearest city school a need and a reality for students. This situation can make their journey exhausting due to the time spent in daily commute, in addition to making absent the applicability of the contents learned in the classroom that strengthen its community tradicional. Rural education plays an essential role in forming a traditional community, as in the case of a riverside community, since culture and sustainability are the basis of the pedagogical content of its teachers.

Another essential aspect is strengthening the financial and digital inclusion of riverside communities. Participants learn to use interactive systems with family members and have feelings about using banking apps to avoid security breaches. Not knowing how to use a critical interactive system involving family income, such as a banking application, typically generates fear in these users.

The participants indicated that they use television to consume information and use social networks and instant messaging applications to communicate. Adding to these results, according to Regional Center for Studies on the Development of the Information Society [2023], in 2022 there was a strong application and use of instant messaging applications by Brazilians (93%).

The literature highlights the importance of educational campaigns on ICTs for emergent users [France and Selormey, 2009]. Thus, awareness policies can be provided in these communication channels through television stations, social networks, and instant messaging applications to enhance emergent users' education about financial services and conscious entrepreneurship. Therefore, these potential users' fear of accessing the digital environment, both clients and self-employed professionals, should be alleviated, and they should be motivated to use financial applications autonomously and securely to acquire income.

We noticed that there are access barriers in the internet infrastructure of riverside people and ruptures in the target of reducing the price of this means of communication by 2020, item c, of the ninth objective of sustainable development, which must be overcome by private or governmental. The only option for mobile data is a limiting user experience in the DICTs age, given that an application cannot be downloaded or a website cannot be accessed because the internet of data plan may be blocked when the data quota is completely consumed. Users can avoid acquiring applications, as they prioritize only the essentials for their access, such as talking to family members, to avoid this blockage.

Sign analysis proved to be an exciting method for application design. This way, it is possible to measure its adherence to the final product before users interact with the production version. Thus, it was possible to understand which symbols needed to be improved to facilitate the user's understanding of using the system, bringing the virtual interpretation closer to the real one.

Regarding the interaction experienced by the participants,

we noticed that the segmented actions in choosing the key, indicating an amount received in the resources of receiving and paying with the Pix, generated communicability failures at a tactile level. However, as these small activities were interconnected to Pix's primary resources and required necessary analyses related to participant data and balances, they are also classified as failures that reach strategic levels of communicability. The participants identified some ruptures in operational-level communicability with the prototype, such as touching fields to fill in the text, touching buttons, and reading metalinguistic signs. On the other hand, these disruptions were connected with steps to achieve a further model objective and correlated with more significant disruptions at the tactical level; that is, in the initial stages of using the prototype or Pix resources, gradually overcome during the tests.

This case study shows the importance of using the design recommendations [Thies, 2015; Srivastava *et al.*, 2021; Capra *et al.*, 2021; Modesto and Ferreira, 2013] to improve emergent users' access to interactive systems. The related works served as the basis for the prototype's interface design, contributing to new findings related to financial inclusion and digital accessibility. The results are based on the socio-environmental characteristics of emergent users and the barriers that create challenges for digital accessibility. These users reported difficulties with formal education access, the absence or rare access to digital ways, and restrictions in telecom services.

The CEM was essential to generate design considerations for the target audience of the research. Furthermore, this method generates quality in the software industry's design and evaluation of products. However, it took about three months to complete the data analyses: tagging, interpretation, and semiotic profile. Thus, it seems benefic to the developing information systems that support the design and evaluation of interactive systems in the industry through SIM and CEM, providing quality data analysis with less cognitive load required by a designer, and easing the time needed to apply them in the development process of the interactive system.

7.2 Workshop about Conversational Systems

Out of nine participants, seven indicated they are very interested, and two are interested in developing accessible software. It shows that accessibility is a quality criterion that these participants seek to understand and apply during systems development. However, most participants know reasonably (2) or not (3) how accessibility should be implemented in practice. In this sense, many professionals in training are interested. There is a need for more initiatives that enhance knowledge of digital accessibility, thus impacting the training of professionals and the inclusion of users who benefit from it.

Participants indicated they did not work on development projects to include emergent users. It highlights that this audience was absent from these people's design and evaluation decisions. However, after the workshop, participants highlighted the importance of developing accessible software for this target audience, fixing the socio-digital barriers emergent users face. With this, these users could be contemplated

from then on, given that participants know the impact of technology on these people's lives.

The dynamics of the workshop stimulated reflections on the interaction characteristics of emergent users and how financial conversational systems can be improved to include these people. In the first case, participants highlighted the barriers faced by emergent users in accessing the technology. In this sense, they describe that age, income, lack of infrastructure, and formal education influence these people's distance from computational developments. However, participants declare that, despite interaction barriers to computer systems, emergent users' social and economic needs, including interactive financial systems, influence the adoption of TDICs.

The workshop participants' reflections converge with the study's data with riverside people. They occur because riverside people highlight the need to use government systems to receive financial aid or conversational systems to stay informed. Furthermore, riverside people who use banking applications highlighted greater practicality in managing their income, which leads to the solution of geographic barriers to accessing financial services.

When analyzing the data from design considerations and chosen evaluations by emergent users, it is clear that not all of them are applicable in financial conversational systems. Participants in group 1 described that consideration 24 should be discarded in conversational systems, since the back feature is implemented on the conversation screen between the end user and conversational assistant. However, other criteria were considered essential to meet the socio-digital characteristics of emergent users in this type of system, mainly highlighting the use of audio description and voice command resources (considerations 2, 12, and 14), ease of understanding of the signals presented (consideration 13), organization of the form to understand the data to be entered by users (considerations 17, 19, and 21) and easy-to-understand texts (consideration 10) and security regarding users' sensitive data (consideration 27).

Although the above considerations were very important to workshop participants, none of the financial conversational systems implemented them, demonstrating the need to improve these services for emergent users' digital, financial, and social inclusion.

The design and evaluation considerations and personas provided by the Inclue platform and used by participants supported improving conversational financial systems and strengthening digital accessibility. According to the participants, the workshop dynamics and the Inclue platform provide collaborative discussions, understanding of the problems of interactive systems to include emergent users, and stimulating creativity and problem-solving. However, there is a need for a better explanation of the dynamics of Braindrawing so that it does not make it difficult for participants to understand the solutions to be developed.

Finally, workshops favoring and guiding designers and developers can build metamessages suitable for their potential users. The evidence was obtained by the question that prompted participants to specify emergent users' identities and interactions. Furthermore, the participants presented the resources needed for better communication and accessibility

of conversational financial systems to emergent user inclusion. All participants understood the workshop proposal, felt satisfied, and can recommend it to others.

8   Threats to Validity

In this section, we highlight some threats to validity that can generate bias in the research. We do not employ systematic research techniques to survey studies of recommendations and accessibility to emergent users. It is widely recognized that such an approach has the potential to improve the theoretical foundation of a study significantly.

Only a single evaluator was responsible for carrying out the SIM evaluation. We know that the number of evaluators increases the identification and refinement of localized communication failures.

Data collection for the case study was carried out in the participants' homes to facilitate their collaboration. The ideal scenario for the CEM is to follow the recommendations of Barbosa *et al.* [2021], which indicate that data collection should be carried out in an environment that captures the attention of study participants.

The generated considerations have not been validated in a new study with the target public. Building a prototype that follows these considerations is interesting, and the target audience validates that.

Some threats may impact the quality of the study in the planning, conduction, and data analysis phases. One possible threat is having only one person conduct these steps, which can cause research bias. To minimize this threat, we took some steps.

In the planning, this study's first author wrote a research plan detailing the workshop goals, methodology, and schedule, which the other authors reviewed. In the conduction, the first author conducted the study with the help of the third author to maximize the amount of information gathered and reduce the chance of forgetting some details. In the data analysis phase, this study's first author analyzed the data and drew conclusions, which all authors reviewed and agreed on.

9   Final Considerations

The research presented in this article included a case study to evaluate IPS communicability and improve digital inclusion of the financial systems, specifically Pix, with a riverside community in the Legal Amazon region. A prototype was developed following the accessibility guidelines for emergent users from the literature, a user experience manual [Central Bank of Brazil, 2022c], and an accessibility improvements report based on a proposal to improve the bank application partner UX.

It was observed that emergent users face significant barriers when accessing digital financial systems, often due to a lack of familiarity with icons and functionalities present in banking apps. This research presented the social aspects of emergent users and how they relate to digital barriers. The IPS assessment strengthens the idea of further HCI studies that encourage the development of inclusive systems for the riverside dwellers, which includes the financial scenario or support artifacts that can be used in software development. In this scenario, the study found that riverside people have predominantly used instant messaging systems to communicate with friends and family. In this sense, conversational systems have become an interesting object of study for possible inclusive digital technologies for emergent users.

Subsequently, a workshop with computing students was conducted to discuss how to develop financial conversational systems for emergent users to analyze the accessibility of conversational systems with real-time payment and identify improvements to make these resources more inclusive.

The workshop demonstrated participants' - computing students - interest in developing more accessible systems, but also revealed a gap in practical knowledge for implementing these solutions.

According to the workshop participants, not all traditional systems' resources were suitable for financial conversational systems. For example, group 1 suggested removing consideration 24 due to its redundancy in conversational interfaces. However, other resources were crucial, including audio description, voice commands, clear signals, data organization, easy-to-understand texts, and security of sensitive data.

Despite their importance to workshop participants, none of the financial conversational systems implemented these resources, highlighting the need for improvement to support digital, financial, and social inclusion. The Inclue platform, along with the workshop, provided a framework for collaborative discussions and problem-solving, enabling participants to discuss and address inclusive interactive system challenges.

The research highlights the importance of continued research to enhance digital inclusion for emergent users through workshops guiding designers and developers to enhance the communication and accessibility of conversational financial systems for this population. Participants felt satisfied with the workshop and recommended it, demonstrating its effectiveness in promoting inclusivity.

Finally, we highlight that this research contributes in design and development of interactive financial conversational systems that can be accessible to emergent users. In other words, the inquiries and results contribute to these people's digital and financial inclusion, strengthening their access to technology and income. Within the industry and education, the research promotes awareness of financial inclusion and emergent user concepts among current or future software development professionals.

Further research is needed to increase emergent users' inclusion in instant payment systems. We plan to investigate the adoption of voice recognition technologies for users with different accents and speech patterns, the creation of tutorials or practical guides, and the development of more easy-to-understand interfaces to facilitate interaction with digital financial systems. Furthermore, constructing a conversational system prototype containing the recommendations of the workshop participants is necessary to evaluate the proposal during the interaction of emergent users and, thus, verify its effectiveness for these people.

Declarations

Authors' Contributions

LT contributed to conducting the case studies and the workshop, analyzing the data, and writing and reviewing the article content. CC contributed to the method, reviewing the case study and workshop, collecting the theoretical background and writing and reviewing the article content. JC contributed to the methodology, conducting the workshop, collecting the theoretical background, and writing and reviewing the article content. MM contributed to the methodology, reviewing case studies, the workshop and article content, and providing guidance. All authors read and approved this article's version.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The materials used in this research are available at the link https://github.com/human-interaction-with-tecnologies/open-science-case-study-riverside-and-workshop. This availability enhances consultation, reproducibility, and, consequently, the principles of open science and knowledge sharing.

References

Barbosa, S. D. J., Silva, B. S. d., Silveira, M. S., Gasparini, I., Darin, T., and Barbosa, G. D. J. (2021). *Interação Humano-Computador e Experiência do Usuário*. Autopublicação. Access on 24 October 2024.

Borsci, S., Malizia, A., Schmettow, M., Van Der Velde, F., Tariverdiyeva, G., Balaji, D., and Chamberlain, A. (2022). The chatbot usability scale: the design and pilot of a usability scale for interaction with ai-based conversational agents. *Personal and ubiquitous computing*, 26:95–119. DOI: https://doi.org/10.1007/s00779-021-01582-9.

Brasil (2007). Decreto nº 6.040, de 7 de fevereiro de 2007. http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm. Access on 24 October 2024.

Brasil (2014). eMAG - modelo de acessibilidade em governo eletrônico. https://emag.governoeletronico.gov.br/. Access on 24 October 2024.

Brasil (2015). Lei nº 13.146, de 6 de julho de 2015. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm. Access on 24 October 2024.

Candello, H. and Pinhanez, C. (2016). Designing conversational interfaces. https://www.researchgate.net/profile/Heloisa-Candello/publication/333022441_Designing_Conversational_Interfaces/links/5cd6d7b1458515712ea35172/Designing-Conversational-Interfaces.pdf. Access on 24 October 2024.

Capra, E. P., Ferreira, S. B. L., Da Silveira, D. S., Ribeiro, B. B., and Modesto, D. M. (2011). Evaluation of web accessibility from the perspective of functional illiteracy. In *Proceedings of the 10th Brazilian Symposium on Human Factors in Computing Systems and the 5th Latin American Conference on Human-Computer Interaction*, IHC+CLIHC '11, page 280–288, Porto Alegre, BRA. Brazilian Computer Society. Access on 24 October 2024.

Capra, E. P., Ferreira, S. B. L., Marques, J. M., and Portela, S. S. (2021). Acessibilidade de interfaces web para cuidadores com baixa escolaridade: Aspectos e reflexões. *Conexões-Ciência e Tecnologia*, 15:e021026–e021026. DOI: https://doi.org/10.21439/conexoes.v15i0.2087,.

Central Bank of Brazil (2022a). Manual de uso da marca. https://www.bcb.gov.br/content/estabilidadefinanceira/pix/Regulamento_Pix/I_manual_uso_marca_pix.pdf. Access on 24 October 2024.

Central Bank of Brazil (2022b). O que é pix. https://www.bcb.gov.br/estabilidadefinanceira/pix. Access on 24 October 2024.

Central Bank of Brazil (2022c). Requisitos mínimos para a experiência do usuário. https://www.bcb.gov.br/content/estabilidadefinanceira/pix/Regulamento_Pix/IV_RequisitosMinimosparaExperienciadoUsuario.pdf. Access on 24 October 2024.

Central Bank of Brazil (2024). Encontre uma instituição regulada/supervisionada pelo bc. https://www.bcb.gov.br/estabilidadefinanceira/encontreinstituicao. Access on 24 October 2024.

Chaudry, B. M., Connelly, Kay H. ans Siek, K. A., and Welch, J. L. (2012). Mobile interface design for low-literacy populations. In *Proceedings of the 2nd ACM SIGHIT International Health Informatics Symposium*, IHI '12, page 91–100, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/2110363.2110377.

de Souza, C. S. (2005). *The Semiotic Engineering of Human-Computer Interaction*. The MIT Press. DOI: https://doi.org/10.7551/mitpress/6175.001.0001.

de Souza, C. S., Leitão, C. F., Prates, R. O., and da Silva, E. J. (2006). The semiotic inspection method. In *Proceedings of VII Brazilian Symposium on Human Factors in Computing Systems*, IHC '06, page 148–157, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/1298023.1298044.

de Souza, C. S. and Leitão, C. F. (2009). *Semiotic Engineering Methods for Scientific Research in HCI*. Synthesis lectures on human-centered informatics. Morgan & Claypool Publishers.

Devanuj and Joshi, A. (2013). Technology adoption by 'emergent' users: the user-usage model. In *Proceedings of the 11th Asia Pacific Conference on Computer Human Interaction*, APCHI '13, page 28–38, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/2525194.2525209.

Dhaygude, M. and Chakraborty, D. (2021). Rethinking design of digital platforms for emergent users: Findings from a study with rural indian farmers. In *Proceedings of the 11th Indian Conference on Human-Computer Interaction*, IndiaHCI '20, page 62–69, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/3429290.3429297.

Ferrari, B., Junior, D. P. d. S., Oliveira, C. M., Ortiz, J. S. B., and Pereira, R. (2020). Socially aware design of games: an early workshop for game designers. *Journal on Interactive Systems*, 11(1):92–109. Access on 11 August 2024. DOI: https://doi.org/10.5753/jis.2020.757.

France, F. and Selormey, D. (2009). Biometrics improving financial accessibility. *Biometric Technology Today*, 2009(7):10–11. DOI: https://doi.org/10.1016/S0969-4765(09)70115-8.

Guimarães, A. P. N. and Tavares, T. A. (2014). Avaliação de interfaces de usuário voltada à acessibilidade em dispositivos móveis: Boas práticas para experiência de usuário. In *Anais Estendidos do XX Simpósio Brasileiro de Sistemas Multimídia e Web*, pages 22–29, Porto Alegre, RS, Brasil. SBC. Access on 24 October 2024.

IBGE (2021). Pesquisa nacional por amostra de domicílios contínua: Acesso à internet e à televisão e posse de telefone móvel celular para uso pessoal 2019. https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=2101794. Access on 24 October 2024.

Iconify (2022). all open source icons in one framework. https://iconify.design/. Access on 24 October 2024.

Junior, O. G. G., Gerstenberger, G. S., and Yamashita, T. G. (2022). Implementação do pix e expectativas do mercado. *Revista Brasileira de Ciências Econômicas e Negócios 2764-4472 ISSN-e*. DOI: https://doi.org/10.5281/zenodo.6527314.

Kazi, A. K. and Mannan, M. A. (2013). Factors affecting adoption of mobile banking in pakistan: Empirical evidence. *International Journal of Research in Business and Social Science (2147- 4478)*, 2(3):54–61. Access on 24 October 2024. DOI: https://doi.org/10.20525/ijrbs.v2i3.73.

Liotto, P., Barros, L., Silva, T., and Albuquerque, V. (2018). Projeto sustentável de escola flutuante ribeirinha. *Revista de Estudos e Pesquisas sobre Ensino Tecnológico (EDUCITEC)*, 4. DOI: https://doi.org/10.31417/educitec.v4i08.526.

Marins, M. T., Rodrigues, M. N., Silva, J. M. L. d., Silva, K. C. M. d., and Carvalho, P. L. (2021). Auxílio emergencial em tempos de pandemia. *Sociedade e Estado*, 36:669–692. DOI: https://doi.org/10.1590/s0102-6992-202136020013.

Marçal dos Santos Menezes, T. and de Almeida Viana Perdigão, A. K. (2021). O TIPO PALAFITA AMAZÔNICO: entre formalidade e informalidade do habitar na vila da barca (belém, pará, brasil). *Revista Projetar - Projeto e Percepção do Ambiente*, 6(2):44–59. DOI: http://doi.org/10.21680/2448-296X.2021v6n2ID23710.

Melo, G. L. N., Marques, R. P., Menezes, N. d. S., Teran, L. A., and Mota, M. P. (2024a). Inspecting the accessibility of chatbots and mobile banking for emergent users in the context of people with low literacy. *Journal on Interactive Systems*, 15(1). DOI: https://doi.org/10.5753/jis.2024.4317.

Melo, G. L. N., Menezes, N. D. S., Da Silva, I. M. M., Teran, L. A., and Mota, M. P. (2024b). Inspecting the accessibility of instant payment systems from the perspective of low literacy people. In *Proceedings of the XXII Brazilian Symposium on Human Factors in Computing Systems*, IHC '23, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/3638067.3638127.

Modesto, D. M. and Ferreira, S. B. L. (2013). Acessibilidade de recursos em uma interface de motor de busca com foco em usuários com baixo letramento. In *Proceedings of the 12th Brazilian Symposium on Human Factors in Computing Systems*, IHC '13, page 32–41, Porto Alegre, BRA. Brazilian Computer Society. Access on 24 October 2024.

Monteiro, M. d. S., Batista, G. O. d. S., and Salgado, L. C. d. C. (2023). Investigating usability pitfalls in brazilian and foreign governmental chatbots. *Journal on Interactive Systems*, 14(1):331–340. DOI: https://doi.org/10.5753/jis.2023.3104.

Nedungadi, P., Devenport, K., Sutcliffe, R., and Raman, R. (2020). Towards a digital learning ecology to address the grand challenge in adult literacy. *Interactive Learning Environments*, 31:1–14. DOI: https://doi.org/10.1080/10494820.2020.1789668.

Oliveira, A. C., da Silva, L. F., Eler, M. M., and Freire, A. P. (2021). Accessibility of brazilian federal agencies' mobile apps: Requirements, conformance and response to complaints. *iSys - Brazilian Journal of Information Systems*, 14(4):45–73. DOI: https://doi.org/10.5753/isys.2021.2016.

ONU (2015). Transformando nosso mundo: A agenda 2030 para o desenvolvimento sustentável. https://brasil.un.org/sites/default/files/2020-09/agenda2030-pt-br.pdf. Access on 24 October 2024.

Ortiz, J. S. B., Moreira, C., Menezes, K., Ferrari, B., Silva Junior, D., and Pereira, R. (2022). Computational thinking and mental models: Promoting digital culture in the youth and adult education. *Interacting with Computers*, 35(2):91–104. DOI: https://doi.org/10.1093/iwc/iwac028.

Prates, R. O., de Souza, C. S., and Barbosa, S. D. J. (2000). Methods and tools: a method for evaluating the communicability of user interfaces. *Interactions*, 7(1):31–38. DOI: https://doi.org/10.1145/328595.328608.

Regional Center for Studies on the Development of the Information Society (2023). Executive summary - survey on the use of information and communication technologies in brazilian households - ict households 2022. https://cetic.br/pt/publicacao/executive-summary-survey-on-the-use-of-information-and-communication-technologies-in-brazilian-households-ict-households-2022/. Access on 24 October 2024.

Ribeiro, E. R. D. (2020). Desafios digitais no setor financeiro: efeitos das tecnologias da informação e comunicação nas atividades bancárias no brasil pós 2014. http://hdl.handle.net/11449/193244. Access on 24 October 2024.

Srivastava, A., Kapania, S., Tuli, A., and Singh, P. (2021). Actionable ui design guidelines for smartphone applications inclusive of low-literate users. *Proc. ACM Hum.-Comput. Interact.*, 5(CSCW1). DOI: https://doi.org/10.1145/3449210.

Teran, L. A., Melo, G. L. N., Silva, I. M. M. d., Salles, R. B. d., Rocha, T. A. d., and Mota, M. P. (2024a). A set of professional tools to support the design and evaluation of real-time payment systems and emergent users. *Journal on Interactive Systems*, 15(1):790–809. DOI: https://doi.org/10.5753/jis.2024.4207.

Teran, L. A. and Mota, M. P. (2024). Design considerations for real-time payment systems and emerging users. In *Proceedings of the XXII Brazilian Symposium on Human Factors in Computing Systems*, IHC '23, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/3638067.3638107.

Teran, L. A., Silva, A. T. D. A., De Carvalho, C. P., Farias, S. H. L., Dos Santos, S. S., Araujo, F. P. O., de Souza, C. R. B., and Mota, M. P. (2024b). A case study with a riverside community to improve apps instant payments access. In *Proceedings of the XXII Brazilian Symposium on Human Factors in Computing Systems*, IHC '23, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/3638067.3638090.

Thies, I. M. (2015). User interface design for low-literate and novice users: Past, present and future. *Foundations and Trends® in Human–Computer Interaction*, 8(1):1–72. DOI: https://doi.org/10.1561/1100000047.

Tulaskar, R. (2020). Study of instructional illustrations on icts: Considering persona of low-literate users from india. In *Proceedings of the 2020 Symposium on Emerging Research from Asia and on Asian Contexts and Cultures*, AsianCHI '20, page 53–56, New York, NY, USA. Association for Computing Machinery. DOI: https://doi.org/10.1145/3391203.3391217.

W3C (2018). Accessibillity. https://www.w3.org/mission/accessibility/. Access on 24 October 2024.