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Older women in online interaction codesign: an analysis of participation and involvement

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Abstract: This article presents a study on the participation and involvement of five Brazilian women, most aged 60 or over, in an online interaction codesign process. To understand women's participation and involvement during the process, content analysis was carried out, using a specific method to identify emerging patterns and themes. The results revealed the active participation of women, contributing significantly to the design solution. Furthermore, participants' involvement was expressed through positive feelings such as joy, interest, pride and satisfaction, demonstrating the positive impact of their participation in the codesign process. However, significant challenges were also identified, such as distractions caused by external noise, family interference and internet connection problems. Some aspects related to the way people feel and perceive their participation in a design process, as well as the stimuli that encourage them to actively participate, stand out as motivational factors for greater involvement and active participation. They include elements such as recognition and appreciation of their contributions, belonging, interest in the research topic, empowerment, adequate facilitation, flexibility of the research team, development of social skills, and personal experiences. It is hoped that this study will provide valuable guidance for future inclusive design initiatives, with the aim of promoting meaningful and effective participation of older adults in collaborative activities.

Keywords: Online Codesign, Older Adults, Online Participatory Design, Active Participation

1 Introduction

In 2021, the COVID-19 pandemic led to social distancing, particularly for older adults, one of the most vulnerable groups. This situation increased the reliance on Digital Information and Communication Technologies (DICT), essential for older adults to stay connected with family, friends, and their communities [Souza Filho and Tritany, 2020].

During the 15th Aging Seminar, held on 10/01/2020 and available on YouTube[1], Professor Carla da Silva Santana Castro, then president of SBGTec, highlighted issues affecting older adults in Brazil. These include: (i) lack of societal recognition of older adults' needs; (ii) limited access to digital technologies; and (iii) insufficient development of basic digital skills.

According to the United Nations (UN), in developing countries, someone is considered older than 60 years old, but in developed countries, only 65 years old [ONU, 1982]. However, research on the relationship between old age and digital technology often focuses on people aged 50 and older [Kakulla, 2020].

ONU projections indicate that by 2050, one in six people will be over 65 years old, and the number of those aged 80 or older will rise from 143 million in 2019 to 426 million [Desa, 2019]. This demographic shift has driven interest in creating accessible and inclusive computational systems [Tavares and de Souza, 2012].

In this context, Participatory Design (PD), specifically Codesign, emerges as a solution to involve older adults, especially women over 50, who are often considered digitally excluded [Morris *et al*., 2007; Morris and Brading, 2007], in the design processes, actively participating in creating solutions more suitable to their needs and abilities.

Codesign enables professionals and potential users of services/products to work side by side to create, test, and refine services/products that they believe will improve design outcomes [Burkett, 2012]. According to Baranauskas *et al*. [2013], codesign entails the user's active participation across all project stages.

Although including older adults in design processes is essential [Bjering *et al*., 2014], their involvement in the full cycle of technological development, from conception to evaluation, remains limited. Most codesign studies involving older participants are conducted in co-located settings [Newell *et al*., 2007].

The COVID-19 pandemic forced scientific research to move online, including participatory practices like Participatory Design. Adapting these techniques for older adults in an online setting posed significant challenges.

Thus, it became necessary to understand how older adults can participate in an online codesign interaction process. In this sense, this article presents our experiences conducting an interaction codesign process carried out *online* with/by five older women, considering aspects of their participation and involvement in the process.

[1]Available at: https://www.youtube.com/watch?v=2BSdKw5zqQg

The employed process was the SPIDe (Semio-Participatory Interaction Design Process) adapted by Rosa and Matos [2020]. SPIDe is

> a Semioparticipatory Interaction Design process that combines Participatory Design techniques with the theoretical conceptual foundation of Semiotic Engineering [Zabot *et al*., 2019, p.2].

For this study, SPIDe techniques and methods were adapted to the online context.

This article is an extended and revised version of the work entitled "Codesign of online interaction: experience report with older women", published in the IHC '23 Congress: XXII Brazilian Symposium on Human Factors in Computing Systems, held in Maceió, Brazil, from October 16 to 20, 2023 [Rosa *et al*., 2023a]. This work, which is part of the doctoral thesis of the first author, Valéria Argôlo Rosa de Queiroz[Queiroz, 2023], presents a more detailed analysis of the results and discussions related to the participation and involvement of older adults in the design stages.

This paper is organized as follows: Section 2 details the study process; Section 3 reviews related works; Section 4 outlines the methodology; Section 5 describes the process execution; Section 6 presents the results and discussions on the participation and involvement of older women in the design stages; Section 7 reflects on challenges and lessons; and Section 8 concludes with contributions, limitations, and future directions.

2 SPIDE

The SPIDe was developed by Rosa and Matos [2016] and was inspired by the concept of semioparticipatory design, which is "a generic term for participatory practices that carry messages" [Baranauskas *et al*., 2013, p.49]. These messages refer to the study of communication among participants in the interaction design process.

The SPIDe was conceived as a process consisting of three stages: Context Analysis, Interface Engineering, and Evaluation. Initially, it aimed at the (re)design of interaction in educational software, emphasizing the cultural aspects of a school environment [Rosa and Matos, 2016]. However, after being applied to specific groups such as individuals with visual impairments [Pita *et al*., 2017], deaf and hard-of-hearing children [Zabot *et al*., 2019], and women aged 80 and older [Rosa and Matos, 2020], it became necessary to make some adaptations. This study used the SPIDe adapted by Rosa and Matos [2020], which will be presented next.

2.1 Adapted SPIDe

Rosa and Matos [2020] adapted the SPIDe in a study involving co-located female participants aged 80 years or older. In this modified version, the SPIDe consists of six iterative stages and, in addition to the participants, involves specific actors such as facilitators, monitors, observers, and developers. Empathy is also integrated as a central element throughout all stages of this new SPIDe structure. In the case of the online study, the adapted SPIDe retained its core essence regarding the process stages. However, new techniques and procedures were introduced to address the demands of the online environment. Figure 1 shows the SPIDe used in this study, along with the corresponding techniques.

[Mattelmäki and Battarbee, 2002, p.266] define empathy in design as "people being seen and understood from where they are, not as test subjects, but as people with feelings." It is in this context that empathy is established and strengthened throughout the process in the structure of the SPIDe adapted by Rosa and Matos [2020], contributing to the construction of emotional bonds of friendship and trust among all involved in the process, with the sharing of experiences among people, thus building an "empathetic relationship".

The stages comprising the process of the adapted SPIDe are i) Involvement; ii) Preparation for Design; iii) Context Analysis; iv) Interface Engineering; v) Evaluation; and vi) Development. Table 1 presents the description of each stage, along with suggestions for activities and techniques. These suggestions proved effective in the present study, particularly in a remote scenario. However, for in-person contexts, other recommendations can be found in the article by Rosa and Matos [2020].

3 Related Works

Studies involving older adults in the interaction codesign process are generally conducted in person [He, 2020], as was the case in the study by Rosa and Matos [2020], two of the authors of this article. In this study, the authors share their experiences with ten older women, most of whom were over 80 years old, in an interaction codesign process. They present strategies used to improve involvement throughout the process, reflecting on the challenges faced and lessons learned.

In the remote context, few studies involve older adults, most of which focus on digital inclusion. For instance, the study by da Hora Rodrigues *et al*. [2021] discusses the implementation of a new didactic approach in a remote course for older adults to promote their digital inclusion. The study by de Freitas *et al*. [2022] examines the obstacles faced in digital inclusion before and during the Covid-19 pandemic, providing a comparative analysis between face-to-face and remote learning, addressing everything from methodology to developing new resources to facilitate distance learning.

However, few studies address the remote interaction codesign process involving older adults. In this context, noteworthy studies include those by Cajamarca *et al*. [2022], Han *et al*. [2022], Chen *et al*. [2021], and Brinkley *et al*. [2021].

In these studies, the participatory approach was used primarily to understand the needs of a specific service/product. Only the study by Han *et al*. [2022] went beyond understanding, encouraging participants to propose design alternatives.

Most studies focused their efforts on artifacts within the healthcare context. For example, Cajamarca *et al*. [2022] aimed to obtain design insights for health data representations on medical devices. The study by Han *et al*. [2022] explored opportunities to visualize data on a voice-based intelligent virtual assistant to improve quality of life and collect important health information from older adults. The study by

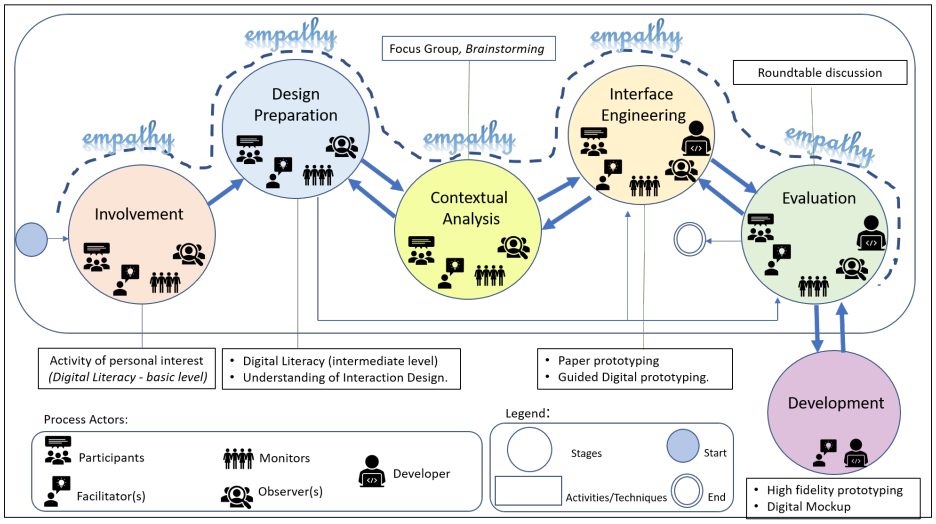

Figure 1. SPIDe utilized in this study.

Table 1. Description of the adapted SPIDe stages

Stage	Description	Suggestions for Activities/Techniques
Involvement Stage	This stage aims to understand the participants' worldview and establish an empathetic relationship through activities of personal interest. It creates a safe space for exploration and sharing, favoring project development based on their real needs.	- **Online Digital Literacy Course/Workshops:** Introduction to using digital devices, connecting content to participants' daily lives, promoting engagement and active participation.
Preparation for Design Stage	Prepares participants for design activities, helping them understand interface elements, interaction, and the phases of the interaction design process.	- **Online Digital Fluency Course/Workshops:** Aims to provide participants with the necessary knowledge to communicate their ideas and needs to the design team. - **Interface Analysis:** Participants evaluate existing interfaces to better understand their elements and functions. - **Digital Games about Interface Elements:** Stimulates learning in a playful and engaging way.
Context Analysis Stage	This stage seeks to identify the participants' problems and needs, defining and ideating the artifact to be developed.	- **Focus Group:** Enables open and rich dialogue about participants' experiences and challenges, inspiring the definition of the artifact. - **Brainstorming:** Stimulates creativity and collects suggestions, contributing to the collection of requirements and ideas.
Interface Engineering Stage	In this stage, prototypes are produced based on previously developed ideas.	- **Guided Digital Prototyping:** Creation of prototypes under the guidance of designers/facilitators using PowerPoint, allowing for quick visualization and iteration of proposed ideas. - **Conversation Circle:** facilitate the discussion and decision-making regarding the choices of the developed prototypes.
Evaluation Stage	This stage checks whether the developed prototypes meet the identified expectations and needs.	- **Conversation Circle:** Allows participants to provide feedback on the prototype and validate it in relation to what was ideated and prototyped.

Chen *et al*. [2021] aimed to understand barriers and design opportunities to improve older adults' health and quality of life through voice-based intelligent virtual assistants. Only Brinkley *et al*. [2021] directed the study toward another context: an autonomous vehicle-sharing application.

These studies share reflections, challenges, and opportunities. However, it is important to note that few delve into discussions about conducting the codesign process, particularly considering the modes of participation and involvement of older adult participants in the same way as discussed in this article. Our research focuses not only on the design stages but also on analyzing the participation and involvement of older women in each phase of the process. This aspect is crucial to understanding how older adults actively contributed to the creation and development of the technological solution, offering valuable insights that enriched the entire design process.

4 Methodology

The experience reported here was conducted through a case study from June to August 2021, involving five Brasilian women aged 57-67, registered with the Interdisciplinary Center for Studies and Extension in Family Health Care in Conviviality with Chronic Diseases *(*Núcleo Interdisciplinar de Estudos e Extensão em Cuidados à Saúde da Família em Convivialidade com Doenças Crônicas - NIEFAM), affiliated with the State University of Southwest of Bahia (UESB), Campus Jequié, Bahia, Brazil. In this study, although there were women in the age range of 50 years, the group of women is defined as older women since most of them were 60 or older.

We emphasize that the exclusively female composition of the sample was not intentional. The exclusive participation of women is partly because only women volunteered to participate. This can be attributed to several contextual factors. For example, we observed that the number of older men registered with NIEFAM is significantly lower than that of women. Of the 85 people registered, only five are men.

This study was part of a broader research aimed at investigating how to engage older adults in a semioparticipatory (co)design interaction process for the production of digital technologies. The present study was conducted as part of an action proposed in an Extension Project submitted and approved by the call for extension action no. 11/2020 provided by UESB.

Table 2 displays the basic information of the five participants. To preserve the participants' identity, they were identified by the codes P1, P2, ..., P(n). Regarding education, most completed high school and still work in the job market as self-employed professionals. Only two declared themselves retired, but previously, they were employees.

In addition to the older women, five individuals participated in the research: i) a researcher, a PhD student in Computer Science, who led the study, acting as a facilitator; ii) four undergraduate students from the Information Systems course at UESB, two males and two females, who served as monitors and observers. Only one student also worked as a developer. Except for the researcher, the others were in the 20-30 age range.

Table 2. Sociodemographic data of participants

Part.	Age	Education	Occupation
P1	57	High School	Saleswoman
P2	58	High School	Pizza maker
P3	60	Incomplete Elementary School	Seamstress
P4	63	High School	Federal public servant (retired)
P5	67	High School	Nursing Technician (retired)

4.1 Codesign process used in research

The process used was the SPIDe adapted by Rosa and Matos [2020], and for this study, an online course on smartphone usage was offered as an activity of interest to the participants. In this sense, the first two stages of the adapted SPIDe are related to the participants' understanding of smartphone usage (digital literacy and digital fluency) and Interaction Design (interface elements and process steps).

In the *Involvement stage*, digital literacy skills were addressed, while in the *Preparation for Design stage*, digital fluency and elements of Interaction Design were covered, including interface elements and the stages of the process.

The skills developed in the digital literacy and fluency courses mentioned in the first two stages are discussed in greater depth in the article by two of the co-authors of the present study [Rosa *et al*., 2023b].

Although these stages are fundamental and relevant to the overall scope of the research, we will focus our descriptions on the stages directly related to design activities (Context Analysis, Interface Engineering, and Evaluation), focusing on the participation and involvement of older women, aiming to understand this specific context of interaction design for the production of digital technologies aimed at older adults.

The online codesign sessions were conducted through the Google Meet platform. Google Meet was chosen because it was free, easily accessible, and, at the time of the study, had unlimited duration for video conferences and allowed audio and video recording.

In this study, WhatsApp was also used as a support tool to facilitate communication and relationships between the research team and participants.

4.2 Data Collection

Data was collected through various methods:

- Participant observation during online meetings, with observations recorded in field notes.
- Review of Google Meet recordings from design sessions.
- Transcriptions of semi-structured interviews conducted virtually via Google Meet.
- informal conversations, including text messages and audio, shared in the WhatsApp group, as these conversations proved valuable for complementary data collection.

- online questionnaires created using Google Forms to evaluate the design sessions. It is relevant to highlight that the only device used by the participants was the smartphone. Thus, the questionnaires were made available through links shared via WhatsApp group.

4.3 Data Analysis

We employed Content Analysis, following the method endorsed by Bardin [2011], to investigate both the explicit and implicit meanings of the messages collected. The analysis aimed to identify patterns, themes, and relevant insights related to the mode of participation and involvement of participants during the design stages.

Following Bardin's guidelines, the content analysis was conducted in three steps:

1. Pre-analysis: This step aims to organize and systematize the materials available for the research. At this stage, the research corpus is constituted, i.e., the set of documents to be subjected to analytical procedures.
2. Exploration of the material: In this stage, the research corpus is studied more deeply, aiming to establish the unit of record and the unit of context.
    - The unit of record "is the unit of meaning to be coded and corresponds to the content segment to be considered as the basic unit, aiming at categorization and frequency counting" [Bardin, 2011, p.134]. Words, phrases, or themes are examples of units of record found repeatedly throughout the texts.
    - The unit of context "corresponds to the segment of the message, whose dimensions (larger than those of the unit of record) are optimal for understanding the exact meaning of the unit of record" [Bardin, 2011, p.137].
3. Inference and interpretation of results: In this stage, the raw results are processed to make them meaningful and valid. This allows for proposing inferences and interpretations aimed at the intended objectives.

4.4 Ethical Considerations

This research was submitted to and approved by the Research Ethics Committee of UESB, under registration number 17517019.2.0000.0055. All ethical and legal procedures were followed according to the guidelines established by the committee.

To ensure voluntary and informed participation, we employed a Free and Informed Consent Form (TCLE), through which participants formally agreed to take part in the study. Additionally, an Image and Testimonial Authorization Form was used to secure consent for the use and disclosure of participants' images and statements exclusively for research purposes.

Rigorous measures were taken to address the vulnerabilities inherent in conducting online research with older adults. The research team received specific training to address the needs of this group, fostering a safe and respectful research environment. It was acknowledged that participants might face challenges related to digital exclusion, such as lack of familiarity with technological devices, practical difficulties in using digital tools, and anxiety in online interactions. These factors could lead to insecurity, hinder understanding of the procedures, and impact trust in the process.

To mitigate these barriers, the first stage of the study (Involvement Stage) was structured as a digital literacy process. Training and continuous support were provided to equip participants with the necessary skills to use digital tools such as videoconferencing platforms, online safety practices, and navigation on mobile devices. This approach not only improved participants' digital competence but also enhanced their confidence in fully participating in the study.

Only after this preparatory phase were participants formally invited to join the study. During an interactive session conducted on Google Meet, the TCLE and the Image and Testimonial Authorization Form were read and explained in detail, ensuring a clear understanding of the study's objectives, procedures, potential risks, and benefits. This session allowed all questions to be answered in real time, ensuring that consent was genuinely informed. For participants who still had doubts or difficulties after the meeting, additional support was provided via telephone, emphasizing our commitment to accessibility and clarity throughout the process.

Consent was treated as a continuous process. Participants were reminded of their freedom to withdraw from the study or request the removal of their data at any time, without any prejudice or negative consequences. This approach aimed to create an atmosphere of trust and transparency, essential for ethical engagement.

Document signing was conducted in person, given the small group of participants (five women). A monitor or researcher visited their homes on previously scheduled dates, strictly adhering to Covid-19 prevention guidelines, including the use of masks, hand sanitizer, and physical distancing. These precautions ensured safety and ethical compliance during all in-person interactions.

Additionally, strategies were adopted to mitigate potential power imbalances between the research team and participants. We fostered a welcoming environment where older adults felt comfortable sharing their opinions and experiences at their own pace, without pressure. Our approach was adapted as necessary to meet their individual needs, ensuring that their contributions were valued and incorporated as an essential part of the research process.

4.5 Data Privacy

Additional measures were implemented to protect the privacy and confidentiality of the data. To ensure transparency and reproducibility of the results, the collected data was anonymized and initially stored in a secure environment on Google Drive, with access restricted to the research team only. Currently, the anonymized data is available in the Zenodo repository (10.5281/zenodo.13955872), allowing public access with the necessary privacy safeguards, where it is stored according to Zenodo guidelines for the secure sharing of research data.

5 Execution of Stages

5.1 Context Analysis Stage

In the *context analysis* stage, the aim is to identify problems and/or needs and, thus, define a solution. For this purpose, the following participatory techniques were used: Focus Group and Brainstorming. A total of three sessions were conducted to determine and ideate an artifact. The first two sessions are related to understanding the context and defining the artifact. For this, the Focus Group technique was used, and the last session was for ideating the artifact using the Brainstorming technique. In all sessions, there were also one or more monitors in addition to the five participants and the facilitator. Each session of this stage lasted for 1 hour and 30 minutes and will be described below:

1st Session: Understanding the Context - Part I

In the first session, the Focus Group technique was used to identify problems and/or needs. This session involved the participation of all women. The session began with an explanation of the meaning of the *context analysis* stage, its objective, and also an explanation of the Focus Group technique.

After the explanations and clarification of any doubts, the Focus Group began, which was conducted through a script of questions related to topics such as aging, pandemics, technologies, products, and services. These questions were defined in alignment with the research objective. Each question was presented through a slide in Microsoft PowerPoint software as the facilitator verbalized the question. Figure 2 shows the moment when the first question was presented.

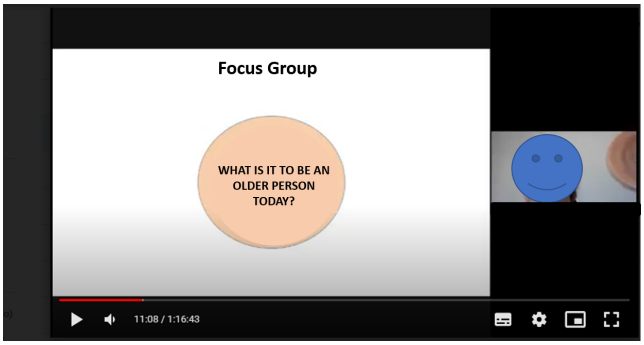

Figure 2. Question presented on a PowerPoint slide at the beginning of the focus group.

In the first session, only questions regarding aging were addressed: **"What is it to be an older person today? What challenges and difficulties do you perceive in this phase of aging?"**

These questions revisited discussions about perceptions of aging in today's world and situations experienced by them and older adults in general. The responses were compiled into topics, as shown in Figures 3 and 4.

According to the responses represented topics (Figure 4), it is evident that the participants have a clear understanding of the challenges and difficulties that arise in the aging phase. In this regard, they brought up situations experienced both by themselves, such as health problems, memory issues, and by the older adults in general, such as lack of respect and attention, abandonment, financial exploitation, among others.

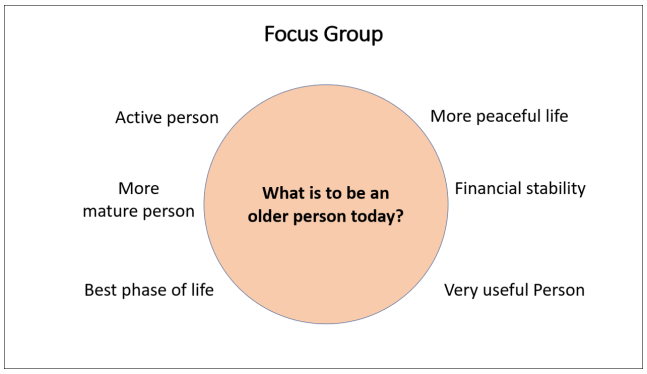

Figure 3. Responses that emerged from the second question related to the topic of Aging

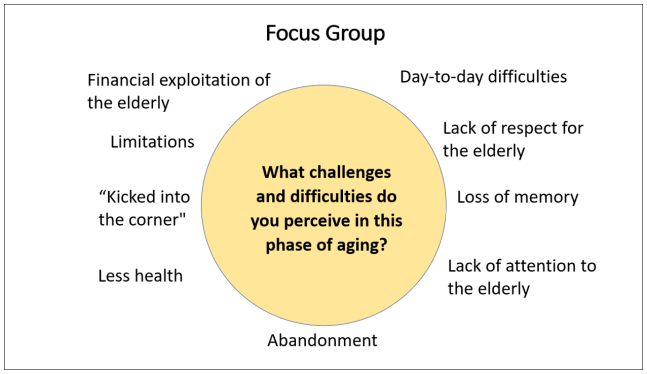

Figure 4. Responses that emerged from the second question related to the topic of Aging

Despite being aware of the challenges and difficulties faced by the older adults, all of them have a positive perception of being older adults in today's world, and unanimously, all of them considered the aging phase as the best phase of life (Figure 3).

2nd Session: Understanding the Context - Part II

The second session took place two days after the first session. In the second session, to review what was discussed in the previous meeting, the responses regarding the theme of aging, compiled into bullet points, were presented. Subsequently, the Focus Group continued with questions about the themes of pandemic and technology. Figures 5 and 6 display the responses.

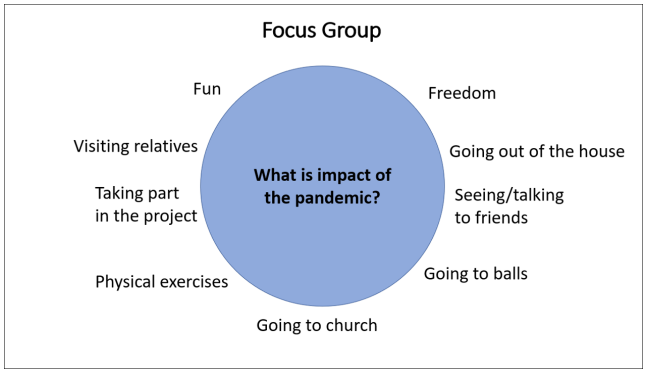

Figure 5. Responses that emerged from the question about Pandemic.

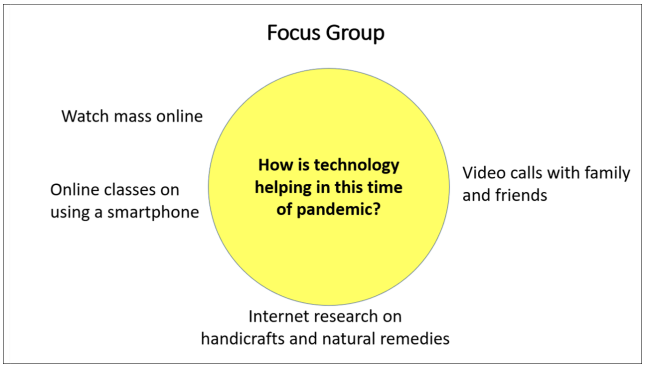

Figure 6. Responses that emerged from the question about Technology.

Regarding the impact of the pandemic on the participants' lives, it was observed that the lack of freedom, specifically the absence of it, was at the center of discussions. The participants mentioned that the imposed social distancing due to the pandemic made it impossible to interact with family and friends, attend church, or participate in NIEFAM's activities in person, among other limitations (Figure 5). They all reported it was a very difficult and challenging time.

In terms of their perception of technology's help during the pandemic, it was highlighted that technology brought them closer to family and friends through video calls, allowed to take online courses on smartphone usage, internet research, attending church services online, among other activities (see Figure 6). Furthermore, during this session to identify problems and/or needs to define the artifact to be ideated, other questions were discussed, such as: **What products and services perceived by them were not developed with the older adults in mind?**.

The responses revolved around services they used the most and had a poor experience with, such as health care services and public transportation. The condition of the streets and the transfer of alimony responsibilities were also highlighted by the participants, as shown in Figure 7.

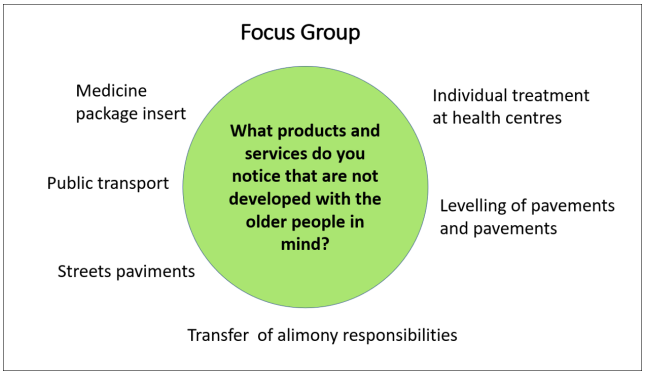

Figure 7. Responses that emerged from the question about Products and Services.

In light of this issue, some discussions arose about what the city manager could improve for the benefit of the older population. Thus, the creation of an application was suggested so that more older adults could also assert their rights, share their needs, and report complaints about services and products inadequate for the older adults audience, allowing municipal, state, and federal managers to have access. Consequently, the creation of an application addressing the needs of older adults was defined. With this definition, the third session proceeded with elucidating the topics/subjects that would compose the application.

3rd Session - Artifact Ideation

The third session took place a few weeks after the previous session. In this session, the brainstorming technique was used for artifact ideation. Initially, a review of the last sessions and what had been discussed and defined was conducted. Then, the objective of the session and the technique were explained. With all participants clarifying and understanding how to collaborate, the technique began with the following questions: **What will this application be like? What do you imagine and/or wish this application to have?**

From there, several ideas emerged about topics that could be included in the application, such as complaints, workshops for older adults, tips, and booklets. Based on these ideas, the next stage was interface engineering.

5.2 Interface Engineering Stage

The interface engineering stage took place one week after the brainstorming session using the low-fidelity prototyping technique. In total, six sessions were conducted, which will be described below.

1st Session: Sketching the Idea

The first session of the interface engineering phase aimed to sketch the artifact ideated in the previous session. Three participants (P2, P4, and P5) were present in this session. The facilitator began by reviewing the ideas suggested and discussed in the previous session, then asked each participant to take a piece of paper, a pencil/pen, and draw a rectangle as if it were a cell phone screen.

To make this activity more transparent, it was presented through a slide how they should draw (Figure 8), and it was explained that in the rectangle, they would draw the initial screen of the application based on the ideas suggested or new ideas.

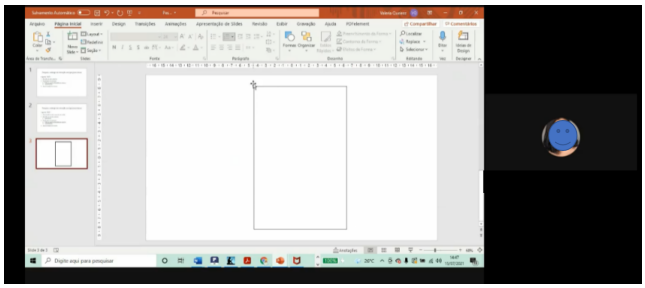

Figure 8. Explanation slide for paper prototyping.

It was clarified that they could use both drawings, representing icons on the screens and texts, and they were not to worry about making perfect drawings. They were asked to think about what should be on the application's initial screen and how these icons/texts could be arranged on the screen. After these clarifications, it was also informed that if they had any questions, they could ask, emphasizing that there is no right or wrong, and they could use creativity to carry out this activity.

No specific time was set for them to sketch a low-fidelity interface calmly. Therefore, each one's time was respected. While doing this activity, the slide with all the ideas they suggested in the previous stage was displayed in the virtual room, as shown in Figure 9.

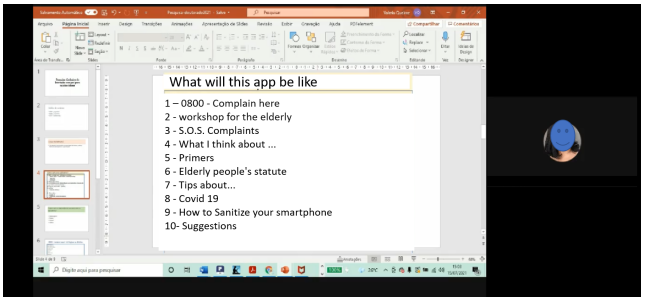

Figure 9. Slide with suggested ideas.

After some time, one of the participants said, ´´I did it here, but I'm not sure if it's right." It was again emphasized at that moment that there is no right or wrong. Then the participant said, ´´after I see the others, then I'll know [laughs]." This statement shows noticeable natural insecurity from someone, not a designer, engaging in a new activity, primarily online.

Therefore, it was understood that there was a need to inform them that there was no right or wrong, that all ideas were ´´welcome", that their collaboration was essential, and that at the end of each session, they should always praise their participation.

They took an average of 20 minutes to sketch the first screen. After everyone signaled they had finished, they were asked to create a second screen on another sheet. For this, they would need to draw the rectangle representing the application screen again, and they could choose one of the ideas suggested in the first screen to make the second screen. The facilitator had to provide an example to make the objective of this activity more transparent.

The average time for this activity was also 20 minutes. After everyone indicated they had finished, each participant was asked to take a photo of the two screens they had created and send it via WhatsApp to the facilitator's or monitor's contact. It's worth noting that this was only possible due to the literacy and digital literacy phase they participated in during the first and second stages of the process. With the photos sent, the session was concluded, and all participants were informed that the presentation and discussion of the sketches would take place in the next session, which occurred the following day.

2nd Session: Presentation and discussion of sketches

The second session aimed to present and discuss the sketches created in the previous session. For this purpose, the *roundtale discussion* technique was used with the same participants of the prior session. This session lasted one hour.

The session began with presenting the images of the Initial Screen sketches created by the participants in the previous session (Figure 10).

Three draft proposals differed in three design aspects: the first was purely textual but with explanations of what should be in that position on the screen; the second had icons and text, and the third consisted only of icons. After discussions and clarifications about what they created for the Initial Screen, the presentation and discussion of the drafts of the second screen (Figure 11) made in the previous session followed.

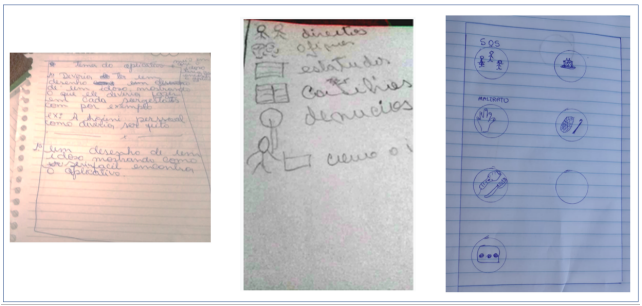

Figure 10. Sketches of the initial screen.

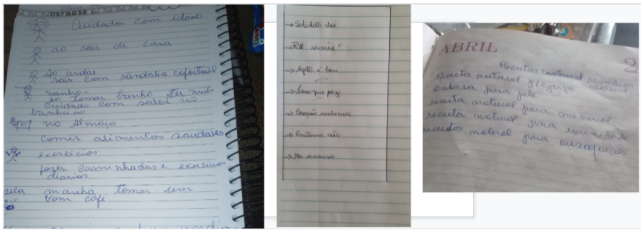

Figure 11. Sketches of a second screen.

As no specific topic had been determined for the second screen, each participant chose different issues, such as older adults Care, Reports, and Natural Recipes. Only one participant used drawings (icons and texts). However, all three had interesting ideas for composing the application regarding content. Nonetheless, it was necessary to use another technique to work on the visual and interaction elements of an interface. Thus, we proceeded to a third session utilizing the technique of *guided digital prototyping*, which took place the following week.

3rd Session: Refining the Initial Screen

The third session aimed to refine the prototype developed in the previous session using the technique of *guided digital prototyping*. Digital prototyping in this study refers to developing a prototype with the assistance of a digital tool. The term "guided´´ means that the prototype was created under the guidance of monitors and the facilitator. Three women who had participated in previous sessions (P2, P4, and P5) took part in this session.

The session began with an explanation of the activity and its objective. The facilitator explained that the activity would be carried out individually under the guidance of a monitor, a member of the team, who would send a link to a new virtual room to the participant's WhatsApp contact.

As a result, three virtual rooms were opened via Google Meet. This activity aimed to refine the initial screen prototype based on visual interface elements. After explaining the activity and clarifying, the participants were asked to leave the main room. Each participant, along with their assigned monitor, then entered their specific virtual room.

In these specific rooms, each monitor initially presented, using slides, an image of a cell phone mockup with a blank screen. Next to this mockup were lists of topics defined in previous sessions and various icons (Figure 12), allowing the

participant to choose the icon that best represented each topic and its layout on the screen.

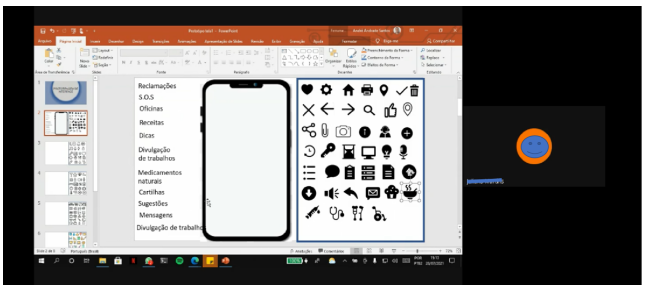

Figure 12. Session of Guided Digital Prototyping.
Source: Authors' elaboration.

The activity unfolded as follows: first, the participant chose a topic; then, she selected an icon that best represented that topic, and then she indicated the positions of the topic and icon on the screen. If there was no suitable icon on that screen, the monitor showed another slide with a new list of icons.

Throughout the activity, the monitor guided the participants, who led the process with explanations, questions, and clarifications and directed them to make conscious and meaningful choices. All monitors were trained beforehand to conduct this activity.

The minimum time for completion was 25 minutes, and the maximum was 40 minutes. After all prototypes were completed, the session was concluded. Figure 13 displays the prototypes created for the initial screen of the application. With the initial screen prototype created, we proceeded to the fourth session.

Figure 13. Prototypes of the initial screen of the application.

4th Session: Selection of the Initial Screen

The fourth session aimed to make the necessary choices related to the visual elements of the prototypes created in the previous session. The idea was not to choose the best prototype, but rather to develop a new prototype collaboratively and democratically, based on the group's choices regarding the icons and interface for each prototype. This activity took place one week after the previous session with the same three participants (P2, P4, and P5), and the technique used was a conversation circle.

As in all sessions, the activity and its objective were initially explained. Subsequently, the facilitator presented, through slides, a topic with the appropriate icons chosen for each prototype, and they had to choose only one icon that best represented the topic. After choosing the icon, a new topic was presented. Figure 14 shows the moment of choosing the icon for the "Complaints" topic.

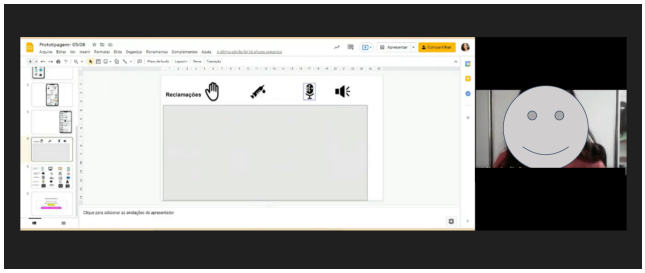

Figure 14. The selection of the icon for the topic "Complaints".
Source: Authors' elaboration.

After completing the selection of icons for all topics, the next step was to define a name for the application. By majority decision, the chosen name was "S.O.S Older Adult" (*S.O.S. Idoso*, in Portuguese). After choosing the application name, the next step was to discuss and choose the most suitable interface for older adults, i.e., one that was easier for the older adults to interact with the application, in terms of the arrangement of icons and text on the screen. The prototypes created inspired the participants to decide on "icons + text" arranged in a list. After the choice, the session was concluded, and they were informed that in the next session they would prototype a second screen. This session lasted about one hour.

5th Session: Creating Second and Third Screens

The fifth session took place the following week after the previous session and aimed to prototype a second and third screen. By majority decision, the topic chosen to create the prototypes was "Complaints". For this purpose, the digital prototyping technique was also used. In this session, only 2 women participated (P2 and P5). Initially, each participant went to a specific virtual room and, under the guidance of a monitor, they prototyped the "Complaints" topic screen. Participant P5 produced two screens for this topic (Figure 15), and P2 produced only one screen (Figure 16). This activity lasted about 40 to 50 minutes.

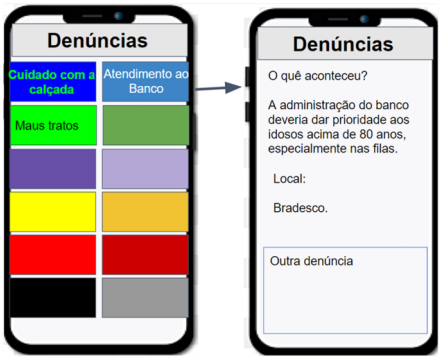

Figure 15. Prototypes of the second and third screens for the topic of "Complaints" (P5).

In this same session, the color of the application's title bar was also chosen. Thus, the participants were invited to choose a color that would compose the top bar of the initial screen, highlighting the application title.

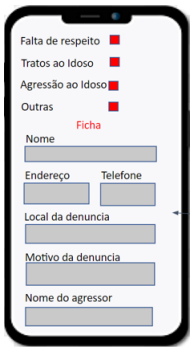

Figure 16. Prototypes of the second screen for the topic of "Complaints" (P2).

6th Session: Selection and Evaluation of the Second and Third Screen Interfaces

The sixth session aimed to present the prototypes created in the previous session. In this session, each participant could explain their prototype idea, and after all presentations and discussions about the positive and negative aspects of each interface, the selection of the most appropriate screens for "Complaints" followed.

For the second screen of the "Complaints" topic, the prototype created by P5 was chosen (Figure 15), as according to P2, the colors facilitate interaction for the older adults, who can memorize the topic by color, making interaction easier. As for the third screen, after some discussions, the choice was also the one made by participant P5.

In consensus, the participants found that this prototype was the most appropriate because it contained necessary and relevant information without compromising the identification of the person making the complaint, who may not wish to be identified. After the choices, the session was concluded. This session lasted 1 hour and 30 minutes.

With all the digital prototypes chosen, the next step was the Development/Implementation stage. This stage is carried out only by the developer(s) of the team. In this stage, a high-fidelity prototype was developed so that the participants could see more closely what they had prototyped, facilitating an initial evaluation. This prototype was developed using the Figma tool. From this prototype, a digital mockup of each screen was generated. This mockup enabled the initial evaluation. Next, the evaluation of the digital mockups of each screen will be described.

5.3 Evaluation Stage

The evaluation stage aimed initially to understand how well the participants were comprehending what they themselves had designed and to verify if the mockups were representing what they had ideated and prototyped. The evaluation took place one week after the prototypes were chosen, with the presence of four participants (P2, P3, P4, and P5), and the session lasted 1 hour and 30 minutes.

In this session, the facilitator began by providing a recap of everything the participants had accomplished since the context analysis stage. After this recap, the mockup of the initial screen was presented through slides, and then the evaluation was conducted using the Conversation Wheel technique through questions about the icons, the position of visual/textual elements, and the participants' understanding of the application. The same process was carried out for the other two mockups (second and third screens for the "Reports" topic). Figure 17 displays the three mockups presented in this stage.

Figure 17. Mockups of the three screens.

The participants shared their opinions regarding what they were visualizing. It was noted that they found the application easy to use, as P4 (63 years old) mentioned, "It's perfectly understandable at first glance." P4 further added, "Because the icons lead us to understand the need of each suggestion presented." Participant P5 also commented, "Because everything is very visible: the icons, the text. Everything is legible."

The participants felt respected when they realized that the ideas, icons, and everything that was defined and chosen by them were present in the digital mockup, as mentioned by P4 (63 years old): "It was an example of respect for us who participated, and it was proof of the respect, although we already perceived it, but we had the concrete proof of the respect you have for us, and we can only thank you." She further added, "[...] you could have changed a lot of things, however, you embraced our ideas."

After this evaluation, the process was finalized without the need for any adjustments. Unfortunately, until the present moment, it has not been possible to conduct an evaluation to obtain feedback on possible interaction issues because this would require the participants to download the prototype to their smartphones and share their screens through the video conferencing application using another computational device.

6 Results and Discussions: Participation and Involvement of Older Women in the Design Stages

Although in the scientific literature of the areas of HCI and Computer Science it is common to find the term "involvement" being used similarly to "participation" and "engagement', Barki and Hartwick [1989] establish a differentiation between the concepts of "participation" and "involvement". According to the authors, the term "participation" relates to the actions or activities carried out by users during the system development process, while "user involvement" is characterized as a subjective psychological state that reflects the

importance and personal relevance that users attribute to a specific system or to system development activities, thus becoming involved not with a system, but with a process.

In this research, the term "people's involvement" is used to denote participants' positive and/or negative affective and emotional reactions to design activities, their participation in the research, and other elements that constitute the process. It is characterized by the demonstration of positive emotions such as joy, well-being, satisfaction, interest, among others, or negative emotions such as disgust, sadness, frustration, disinterest, insecurity, among others.

In other words, while participation focuses on the activities carried out by participants, involvement refers to the quality and depth of that participation. A participant may be physically present and perform the requested tasks, but their level of involvement may vary depending on their interest, motivation, and emotional connection to the process.

Thus, the analysis of the participation and involvement of the older adults in the design stages is a fundamental aspect to understand the dynamics and results of initiatives aimed at promoting the inclusion and involvement of this demographic group in activities related to the development of products and services tailored to their specific needs.

In this context, besides observing the modality of participation of the older adults throughout the process, it is equally important to consider their affective and emotional reactions, both positive and negative, as these can significantly influence their disposition and involvement with the proposed activities.

Consequently, it is essential to consider both participation and involvement when developing and conducting interaction design activities, as both are crucial to ensuring the quality and effectiveness of the process and the results. Next, we present the results and discussions regarding the behaviors of the participants during the design stages, taking into account the modes of participation suggested by Yuan and Dong [2014].

6.1 Modes of Participation of Older Women in the Design Stages

6.1.1 Data Analysis Process

To understand the participation of older adults in the design stages, we adopted the content analysis method [Bardin, 2011], in which the collected information was systematized in an analysis grid composed of four columns: Category, Subcategory, Unit of Record, and Context Unit.

In the pre-analysis phase, following the modes of participation proposed by Yuan et al. (2014), we selected topics directly related to the category "Modes of Participation." The subcategories corresponded to the four modes of participation (Active, Semi-active, Indirect, and Passive). Coding was performed based on a careful reading of field notes, transcriptions of design sessions recorded via Google Meet, and text and audio messages exchanged on WhatsApp. Each relevant data point was manually identified and coded into the subcategories.

Although we did not use formal inter-coder reliability metrics, the consistency of the coding was ensured through a collaborative review process. A second researcher reviewed the coding, which ensured the consistency and coherence of the results, minimizing subjective biases in data interpretation. This double-checking process was sufficient for the objectives of this research, given the limited scale and depth of the study. The coded data were organized into registration units and context units, systematically arranged in analysis grids.

According to Bardin [2011], an analysis grid is a methodological tool used in the process of categorizing and analyzing content. It consists of a chart or table that organizes and structures the data into units of analysis (such as context and registration units), allowing the information to be systematically classified, compared, and interpreted. The grid aids in identifying themes, patterns, and relationships within the data, facilitating the construction of inferences and the interpretation of results according to the research objectives.

6.1.2 Structure of the Analysis Grids

The analysis grids were divided into four columns: Category, Subcategory, Unit of Record, and Unit of Context. The term 'Modes of Participation' was included in the Category column. In the Subcategory column, the four modes of participation suggested by Yuan and Dong [2014] were distributed.

The Unit of Record column presents words or phrases extracted from the field notes and the recordings of the design sessions, which were taken as indicative of a particular occurrence. The field notes captured relevant observations and interactions, while the recordings allowed for revisiting the discussions and verifying details that might have been missed in the initial data collection. This process contributed to a more detailed and accurate analysis of the observed interactions and dynamics. In the Unit of Context column, text fragments that encompass the record unit are found, thereby providing context for it.

Following the steps proposed by Bardin [2011], the results were processed through the inference and interpretation of data from the selected topics. The interpretation was based on existing literature, relating the findings to relevant theories and previous studies.

The following Tables 3, 4, and 5 present the analysis grids corresponding to each stage of the design process: Context Analysis, Interface Engineering, and Evaluation. These tables are essential for understanding how the data were categorized and analyzed in relation to the participation of the older women. Based on these table, the results and discussions will be presented, exploring how the data connect to the modes of participation and the relevant theories for the study.

6.1.3 Results and discussions

In this subsection, the results obtained from the analysis of the grids for each stage of the design process will be presented, which includes Context Analysis, Interface Engineering, and Evaluation. Each table will provide a detailed view of the categorized information, allowing for an in-depth understanding of the participation of older women in each of these phases.

Table 3. Analysis Grid of Participation Modes in the Context Analysis Stage.

CATEGORY	SUBCATEGORY	UNIT OF RECORD	UNIT OF CONTEXT
Modes of participation in the Context Analysis stage.	ACTIVE	Relevant contribution	FN/DSR:The participants actively contributed with relevant suggestions and personal accounts."
			FN/DSR: All of them participated actively, bringing relevant discussions and sharing experiences lived by themselves or by people close to them.
			FN/DSR: The participants shared ideas, suggestions, and indignations regarding situations affecting the older adults, issues that bother them, and that they observe. These participants stood out with pertinent and relevant remarks.
		Significant contribution	FN/FN/DSR: P4, P5, and P2 significantly contributed with suggestions regarding the importance of including information about the rights of the older adults and the need for an accessible format.
	SEMI-ACTIVE	Not identified	There was no observation of participation in a semi-active manner
	INDIRECT	Not identified	There was no observation of participation in an indirect manner.
	PASSIVE	Non-existent	There was no observation of participation in a passive manner.

Note: FN = Field Notes; DSR = Design Session Recordings.

Table 4. Grid for analysis of modes of participation in the Interface Engineering stage.

CATEGORY	SUBCATEGORY	UNIT OF RECORD	UNIT OF CONTEXT
Modes of participation in the Interface Engineering stage.	ACTIVE	Active, effective and conscious participation	FN/DSR:The participants showed interest.
			FN/DSR: P6 participated in this stage actively and effectively, especially after the guidance from the monitor/facilitator.
			FN/DSR: The participants actively engaged in the discussion circle, sharing their ideas and receiving feedback on the presented sketches.
			FN/DSR: P2, P4, and P5 developed the prototypes consciously.
			FN/DSR: The interaction among the participants was active, with collaborative discussions about the strengths and weaknesses of the prototypes.
			FN/DSR: The participants actively engaged in the discussion circle.
		Creativity	FN/DSR: P3 participated in this activity actively and effectively, as she was aware of what she was doing and choosing, and she stood out as a very creative participant.
		Collaboration	FN/DSR: The participants discussed and clarified the elements they created for the Home Screen, fostering a collaborative and learning environment.
			FN/DSR: The fourth session had a participatory and collaborative dynamic.
			FN/DSR: [...] with collaborative discussions about the strengths and weaknesses of the prototypes.
	SEMI-ACTIVE	Not identified	There was no observation of participation in a semi-active manner
	INDIRECT	Not identified	There was no observation of participation in an indirect manner.
	PASSIVE	Non-existent	There was no observation of participation in a passive manner.

Note: FN = Field Notes; DSR = Design Session Recordings.

Table 5. Grid for analysis of modes of participation in the evaluation stage

CATEGORY	SUBCATEGORY	UNIT OF RECORD	UNIT OF CONTEXT
Modes of participation in the Evaluation stage.	ACTIVE	Contribution	FN/DSR: The participants actively contributed their opinions, praising the design and the ease of navigation of the application.
			FN/DSR: Participants P2-ER, P4-ER, and P5-ER expressed their opinions and evaluated the application positively.
		Recognition of the Value of Ideas	FN/DSR: P4 acknowledged that her ideas were valued, mentioning that "A lot could have changed, but the goal was to take advantage of our ideas."
		Relevant Questions	FN/DSR: P2 asked a pertinent question, helping to direct the discussion to critical aspects of the system: "Valéria, will the person who receives the complain know which city the complaint was filed in?"
		Inclusion Suggestions	FN/DSR:P4 brought to the discussion the suggestion of including questions about the occurrence of witnesses in relation to the topic of complaints.
	SEMI-ACTIVE	Not identified	There was no observation of participation in a semi-active manner
	INDIRECT	Not identified	There was no observation of participation in an indirect manner.
	PASSIVE	Non-existent	There was no observation of participation in a passive manner.

Note: FN = Field Notes; DSR = Design Session Recordings.

The results will be discussed in light of existing literature, highlighting how the findings relate to theories and previous studies on participation in codesign activities.

- Context Analysis Stage.

The results from the Context Analysis stage, presented in Table 3, revealed that all participants actively contributed, sharing ideas, suggestions, and even expressing indignation about situations affecting the older adults. They addressed issues that bother them and that they observe in their daily lives, standing out with pertinent and relevant interventions.

Therefore, it was clear that, in this stage, all participants played a significant role, actively engaging in discussions and reflections on the context presented. The participation of those involved can be categorized mainly as active, as discussed in the theories of collaborative participation [Baranauskas *et al*., 2013], [Sanders and Stappers, 2008] which emphasize the importance of deep and reflective involvement in interactions.

No participation in semi-active, indirect or passive modes was observed, indicating a high level of engagement on the part of all participants.

This homogeneity in participation reflects the impact of an environment of collaborative exchange, where the voices and experiences of the participants were welcomed and respected, as recommended by studies on active participation in user-centered design contexts [Sanders and Stappers, 2008], [Schuler and Namioka, 1993].

- Interface Engineering stage.

Regarding the Interface Engineering stage, the results of the analysis, presented in Table 4, reveal that the participants maintained characteristics of active participation, contributing significantly to the creation of the prototypes. They demonstrated awareness of what they were developing in all sessions of the stage. They made decisions, suggested innovative solutions, and collaborated in the choice of visual and functional elements, such as the layout of the screens and the organization of the information. In addition, there was collective engagement in the discussions, where the participants not only expressed their opinions, but also incorporated the feedback received, refining their ideas in a collaborative and creative way, which enhanced the quality of the final prototypes.

The relationship between the data collected and the identified modes of participation indicates a strong predominance of the active and collaborative mode. The active participation of users, as detailed in the analysis, is aligned with participatory design theories, where users are seen as co-creators and not just passive consumers of technology [Schuler and Namioka, 1993], [Baranauskas *et al*., 2013].

Participants were involved in all phases of design, suggesting improvements and validating functionalities, which reinforces the relevance of the user-centered approach, more specifically the codesign methodology, which actively involves users in the co-creation of solutions [Sanders and Stappers, 2008].

However, in this stage, there was only collaboration from P2, P4, and P5, which also confirms the tendency of variability in participation observed in collaborative activities [Steen, 2013]. Participants P1 and P3 justified their absences due to personal commitments, such as medical appointments and unforeseen family events. Although the absence of these participants limited the diversity of opinions, the engagement of the others ensured that the discussion remained productive and focused on the design objectives.

- Evaluation stage.

In the Evaluation stage, only P1 did not participate, while the other participants remained active, as shown by the analysis results presented in Table 5. The participants expressed their understanding of the designed application and contributed with suggestions and/or modifications. They interacted collaboratively, discussing aspects such as the app's usability and functionality, which enriched the evaluation process. During the discussions, the participants evaluated each screen, the buttons, and other features, offering their insights on ease of use, layout, and the app's suitability for the needs of the olderadults.

Since the study was conducted online, the evaluation of the application took place in a virtual conversation circle. This interaction format allowed for a collaborative environment, in which the participants were able to provide feedback in real time, proposing improvements and adjustments that they considered important.

We can see in Table 4 some contributions made by the participants. P2 raised an important question about the identification of the city in the reporting occurrences, demonstrating an understanding of the context of the screen. P4 brought up the inclusion of questions about the occurrence of witnesses in relation to the reports. P5 mentions that associating the yellow color with the 'violence' category makes the app easier to understand. This makes the process of opening the app and understanding the presented information more intuitive. She also highlights the importance of using colors to assist people who cannot read. This leads us to reflect on the significance of the observation regarding the topics in the 'Reports' menu being distributed by color. This observation sparked an important discussion about the accessibility of the tool, as according to P5, colors facilitate the use of the app for older adults individuals who cannot read.

The variability in the participants' contributions reflects the dynamics observed in codesign processes, where engagement can vary depending on the level of understanding and the users' relationship with the proposed technology. The Evaluation stage, in this context, was essential to validate the interface design, since the suggestions received indicate not only the suitability of the product, but also opportunities for refinement, which is a central point in the codesign methodology. As pointed out in the literature, the evaluation with the end users themselves ensures greater alignment with the expectations and real needs of the target audience, increasing the probability of success of the developed solution [Sanders and Stappers, 2008].

In the evaluation stage, in addition to technical suggestions about the functionality, the participants also recognized the effort to value their ideas. P4's statement ("A lot could have changed, but, nevertheless, the objective was to take advantage of our ideas") reflects the recognition that the design process was inclusive, valuing the contributions of the participants. This shows that the suggestions were incorporated in a meaningful way, generating a feeling of belonging and validation.

We emphasize that the practice of facilitation can influence participation and participatory results. Dahl and Sharma [2022] stress that facilitator responsibilities extend far beyond being a moderator of a group discussion.

In this context, the adapted SPIDe includes actors in the roles of facilitator and monitor. These actors interact with participants and create an open dialogue environment, with the goal of promoting dialogue between individuals with different perspectives, allowing the exploration of various hypotheses and options [Hogan, 2005].

In this case study, both the researcher and the monitors alternated in the role of facilitators. This highlights the flexibility and adaptability of the research team in fostering active participation among older women. Thus, the facilitator's actions were considered important and essential in encouraging this participation. From the outset, all team members were encouraged and guided to develop good social skills, such as patience, actively listening, flexibility. This was evident in the conduct of activities, as observed by the participants:

"They were very patient." (P5, 67 years old).

"You have the patience to explain it to us several times." (P4, 63 years old).

The next step was to understand the participants' involvement throughout the process, answering the following question: *What were the positive or negative affective and emotional reactions of the participants throughout the process?*

6.2 Participant involvement: Affective and emotional reactions

In this section, we will explore the affective and emotional reactions of participants, emphasizing the importance of these reactions in understanding the dynamics of older women's involvement. Analyzing participants' affective and emotional reactions can provide valuable insights into how their experiences and perceptions influence their participation in a codesign process.

6.2.1 Data Analysis Process

To answer this question, *What were the positive or negative affective and emotional reactions of the participants throughout the process?*, we utilized the procedures of Bardin's thematic categorical analysis (2011) in the pre-analysis, material exploration, and results treatment phases, considering that affective and emotional reactions can be demonstrated by positive emotions, such as happiness, well-being, and satisfaction, among others, and negative emotions, such as disappointment, frustration, disinterest, among others [Fredericks *et al*., 2004].

In the pre-analysis phase, topics directly related to the categories 'Positive Emotions' and 'Negative Emotions' were selected for coding. This coding was carried out after consultation, transcription, and thorough reading of the data collection instruments, which included records from online emotion questionnaires, audio and text messages via the WhatsApp group, and individual semi-structured interviews.

As with the analysis of the modes of participation, we did not use formal metrics for inter-coder reliability. However, coding consistency was ensured through a collaborative review between two researchers, ensuring coherence in the results and minimizing subjective biases.

From the online questionnaire, records were extracted regarding the emotions experienced by participants during the

design activities. Regarding the semi-structured interview, three questions were selected:

1. What did you think about the classes conducted on the Meet platform?;
2. Did you enjoy participating in the research?;
3. What is your feeling about your participation in this project and your collaboration in the creation of an application?

The selected data were coded and transformed into Units of Record and Context and are presented in a single detailed analysis grid in Table 6.

6.2.2 Structure of the Analysis Grids

The analysis grid was structured similarly to the previous stage. In the **Category** column, the terms 'positive emotions' and 'negative emotions' were organized. From the reports collected through the online questionnaire, semi-structured interviews, and texts and audio shared in the WhatsApp group, four subcategories emerged: 'regarding the design activities', 'regarding the participating in the research', 'regarding the cell phone classes' , and 'regarding the thematic context of the research.' From these subcategories, the units of record and their corresponding context units emerged, which were extracted from the same data collection instruments, as detailed in Table 6.

In the **Record Unit** column, words representing the emotional experiences expressed by participants during the design and research activities were included. The coding of these units enables an effective categorization of emotions, facilitating future analyses. The **Context Unit** column provides information that helps situate these emotions, allowing for a deeper understanding of the circumstances in which they occurred. Based on these categorizations, it was possible to gain a detailed view of the participants' interactions and experiences throughout the codesign process. Based on Table 6, we will now present the results and relevant discussions.

6.2.3 Results and Discussions

Various feelings were reported by the participants in each analyzed category, as presented in Table 6. *Regarding the design activities*, there was no mention of negative emotions. The statements reveal feelings of **happiness, interest, satisfaction, and pride**. The remarks that express **happiness** and **interest** reflect the perception that the activities are directly related to solving real and significant challenges for the participants themselves, strengthening their identification with the proposed objectives.

The feeling of **satisfaction**, expressed in P4's statement, may be related to both the content delivered and the methodology adopted, which seemingly offered concrete opportunities for learning and personal development. Similarly, the **pride** in participating, expressed by P2, suggests that the activities were perceived not only as tasks to be completed but as a meaningful opportunity to collaborate and contribute to something greater.

In general, the participants reported positive emotions such as happiness, interest, satisfaction, and pride during the codesign activities. These feelings were driven by the practical relevance of the tasks and the opportunity to contribute to something meaningful. These findings reinforce the importance of linking design to real and significant problems for the participants, a principle advocated by Sanders and Stappers [2008] in user-centered design. By providing opportunities for learning and personal development, participatory design can also enhance the self-esteem and well-being of older adults.

Regarding participation in the research, various emotions were expressed by the participants, notably **pride, happiness, satisfaction, and respect**. The feeling of pride, manifested by P5, demonstrates that participants not only value the experience but also feel honored to be part of a group they consider "wonderful." This indicates a strong sense of community and belonging, essential elements in participatory design contexts.

Expressions of **happiness**, especially from P2 and P5, highlight that participation in the research is viewed as a positive experience. The statements show an acknowledgment of the importance of the research and its impact on the participants' lives, particularly concerning the older adults. This association between happiness and contribution to a meaningful project reinforces the emotional value that participants attribute to their involvement.

Satisfaction is a strongly emphasized feeling, particularly in the remarks of P4 and P5, who express joy in participating and gratitude for the opportunity to contribute. P4 mentions their willingness to participate despite challenges, suggesting resilience and commitment. This satisfaction is linked to an environment that values individual contributions, as indicated by P4's remarks about respect.

Furthermore, P4's comments on **respect** indicate that the research not only provides a space for expressing opinions but also acknowledges the contributions and worth of the participants. This perception of respect is fundamental in creating a collaborative and inclusive environment where participants feel valued and heard.

Expressions such as **wonderful, very good, and beneficial** reflect a high level of satisfaction with the overall research experience. The remarks from P3 and P5 reveal genuine enthusiasm, while P5's use of the term "chic" suggests that participants feel important and valued in the process.

These positive emotions highlighted in the participants' statements reveal not only the project's impact on their lives but also the essential role that the adopted methodology plays in fostering a collaborative learning environment. Recognizing the expressed emotions provides valuable insights for future initiatives, emphasizing the importance of creating spaces where participants feel valued, respected, and engaged.

Studies show that positive emotions are often associated with increased engagement and motivation in participatory design processes [Muller and Druin, 2012]. Bratteteig and Wagner [2016] assert that environments that value participants' contributions not only foster a sense of purpose but also promote a feeling of belonging, which is essential for the success of collaborative initiatives.

Table 6. Analysis grid of positive and negative emotional affective reactions.

CATEGORY	SUBCATEGORY	UNIT OF RECORD	CONTEXT UNIT
Positive emotion	In front of design activities	Happiness	P2: "Happiness in giving suggestions about older adults."
		Interest	P4: "Interest because it is necessary to meet our needs needs and solve problems that arise."
		Satisfaction	P4: "Very pleased to have the opportunity to learn."
		Pride	P2: ‘ ‘Proud to be participating."
	By participating in the survey	Pride	P5: "Proud to be participating in this course with this wonderful group."
		Happiness	P2: "Happiness of being involved in the research."
			P5: "Happy, because I am participating in a wonderful project."
		Satisfaction	P2: "Happiness of having contributed to a research on information about older adults."
			P4: "Satisfied because, despite the difficulties, I can be present, in good health, and I am willing to participate in the classes, offer suggestions, and even receive compliments."
			P2: "Satisfaction in participating in a research about older adults."
			P5: "I feel satisfied to have the opportunity to participate in this wonderful course."
			P5: "I was very satisfied."
		Respect	P4: "It was an example of respect in which we participated, and it served as proof of respect. [...] Although we have already lived... we had concrete proof of respect that you have for us, and we can only express our gratitude. You could have changed a lot, but the objective was to make the most of our ideas."
		Wonderful	P2: "Everything was wonderful."
		Very good	P5: "It was very good for me."
		Beneficial	P5: "It was beneficial!"
			P4: "It was beneficial! Nothing to complain about... commendable."
		I liked it/I loved it	P3: "I loved it!!!!"
			P5: "I loved it. It made me feel, how do you say? chic!!!!"(Chic, in this context, refers to feeling important or valued.)
			P1: "I'm glad you liked it!"
	In light of the smartphone usage classes.	Gratitude	P3: "Today's class was very beneficial! Thank you, André."
			P1:"Thank you, André; the class was great!"
		Enthusiasm.	P3: "Wow, even though I couldn't see the images, the class was great."[..]
		Security	P4: "I felt more secure because I knew that if I tried something and couldn't do it, there was someone to help me."
Negative emotion	In light of the thematic context of the research	Sadness	P2: "Sadness for not being able to do more for older adults."
	In light of the smartphone usage classes.	Frustration	P1: "Today's class was confusing for me; I couldn't keep up with anything. First, my grandson needed the cell phone to resolve an issue with his card, and it disrupted my entire class."
		Irritation	P3: "I participated a little... but from what I saw, I thought few people participated.I think it's necessary to have one person speak less so that others can participate, right?"

Regarding the smartphone usage classes, comments were highlighted that reflect both positive and negative emotions. Positive emotions were expressed through feelings of **gratitude, security, and joy**. The feelings of **gratitude and joy** were expressed genuinely, as evidenced by the messages shared in the WhatsApp group shortly after the class ended. This indicates a significant appreciation for what was taught, as well as positive sentiments directed toward the instructor/monitor, as reported by P1: "Thank you, André, the class was great!" This interaction reinforces the emotional bond established from the beginning of the process, strengthening the participant's engagement throughout the course.

On the other hand, participant P4 mentions feeling **secure** because she has someone to help her. This statement relates to the study by Barnard *et al*. [2013], which investigated the intention of older adults to learn how to use technology. The authors emphasize that the availability of technical and emotional support is crucial during the experimentation phase with new tools. Furthermore, they noted that participants with less experience often feel apprehensive about "breaking" something or not knowing how to act if something goes wrong.

These findings highlight the importance of promoting digital inclusion initiatives that create environments that can provide technical and emotional support. It is essential to ensure that older adults feel safe to experiment and learn without fear. Furthermore, this suggests that future participatory online design practices should incorporate continuous and accessible support mechanisms.

In the category of 'Negative Emotion', the feeling of sadness expressed by participant P2 in the online questionnaire stands out, recorded after the focus group aimed at identifying the needs of older adults. This account leads us to reflect that sadness emerged from the reflections and discussions generated during the group, which brought to light various challenges faced not only by the participants but by the older adults in general.

P2's account of sadness occurred early in the context analysis phase. At this stage, P2 had not yet fully realized the contribution that she could offer throughout the process. Her concern and interest in the research topic are evident in her statements, especially when he emphasizes the term 'older adults'. At the beginning of the research, P2 expresses a feeling of sadness by stating: "[...]for not being able to do more

for the older adults." However, at the end of the research, her feelings of happiness and satisfaction become clear as she recognizes his contribution, as demonstrated by the following quotes: "Happiness in having contributed to research on information regarding older adults" and "Satisfaction in participating in research about older adults."

Thus, we observe a variation in P2's emotions, which transitioned from negative to positive as a consequence of her experience as a codesigner and the new possibilities she envisioned for the older adults audience.

The experience of P2 illustrates an emotional journey that goes from initial sadness - due to the inability to do more for older adults - to satisfaction and happiness when recognizing their contribution at the end of the process.

This emotional transition aligns with the findings of Lindsay *et al*. [2012], who state that participatory processes can catalyze personal transformations in participants, fostering a sense of empowerment. Critical reflection and acknowledgment of one's contributions are central elements in this type of transformation.

Codesign projects should consider that participants may go through distinct emotional phases throughout the process. Providing spaces for reflection and recognition of individual contributions can help transform negative emotions into positive ones, increasing engagement over time.

Another feeling expressed was **irritation**. The statement of P3 suggests that she did not feel fully engaged in the discussions, indicating that the class dynamics did not allow for equitable participation. However, after P3's comment, another participant (P1) responds with the following statement:

> "As for participation, I spoke up myself, but I did so because the teacher gave the opportunity, and everyone remained silent. Since I had questions, it was a moment for me to clarify my doubts. He asked several times, and everyone was quiet; no one asked anything except P5, who asked a few times, and P4, who asked once.
>
> So, I, wanting to learn, am in class and have questions; I took the opportunity, you know, to speak. Right? The issue of speaking more is not about wanting to clarify things; if you also wanted to, you would have asked for the opportunity, just like I did. So, he [André] opened the opportunity for everyone.
>
> I took the opportunity because I needed to clarify doubts. Like me, you could have unmuted your microphone and asked another question, as the girls did too. It was open to everyone; it wasn't just for me, not just for one person, okay? Tonha also asked, P4 also asked.
>
> You didn't ask because you had a problem, my friend, or because you didn't have any doubts. So, it's not a reason for anyone to question who spoke, because he did, yes. Everyone spoke. Now, my doubts were more than those of others; I took the chance to clarify" (P1, 57 anos).

P1's statement offers a counterpoint to P3's viewpoint. P1 defends her active participation by stating that she took advantage of the speaking opportunities provided by the teacher. This justification suggests that, for P1, the responsibility to participate lies with both the teacher and the students. P5 mentions that the teacher "asked several times" and that, unlike P3, she was willing to clarify her doubts, emphasizing the importance of learning and interaction.

P1's insistence that "all of you have a moment to ask questions" and that "the microphone could be opened" indicates that she recognizes the importance of freedom of expression in the learning environment. This perspective can be beneficial, as it shows that even in an environment where some may feel inhibited, there are others willing to take advantage of the available opportunities.

To minimize tension among the participants, the instructor/monitor addressed the WhatsAap group with the following audio message:

> "Good evening, everyone! You shouldn't limit yourselves to the idea that one person spoke more than another. You all have a moment to ask questions during the class and even after the class. You can send messages either in the group or privately to us. We are responding, and it is fine regarding that."

The monitor's attempt to ensure that students feel they can communicate, both publicly and privately, reflects an inclusive and supportive approach. He seeks to establish an environment where students feel comfortable expressing their doubts without fear of judgment.

The dynamic between the statements of P3, P1, and the monitor's response reveals the complexity of interactions in participatory learning environments. The irritation of P3 highlights the need for a more welcoming and inclusive space where everyone feels at ease to participate. On the other hand, P1's defense of the importance of seizing opportunities and the monitor's encouragement of communication are essential for creating a more collaborative learning environment. This interaction underscores the importance of mechanisms that promote equity in participation and the need to facilitate communication among all group members.

As argued by Björgvinsson *et al*. [2012], participatory design needs to balance diverse voices and ensure that all participants feel at ease to contribute. In this regard, we emphasize at the beginning of each meeting that all participants have the opportunity to ask questions and clarify doubts. They can interrupt the instructor at any time. If questions arise after class, they can also send messages or audio via the WhatsApp group or directly to the monitors. This not only improved the individual learning experience but also strengthened the dynamics of the group as a whole, resulting in a more collaborative and productive environment.

The practice of continuously reinforcing opportunities for expression and openness to communication, both publicly and privately, can minimize feelings of exclusion and promote a collaborative environment. This is particularly relevant in contexts with older women, often marginalized both by their age and gender, who may feel inhibited when speaking in groups.

By integrating the voices of older women into the design process, the study demonstrated how technological solutions

can be more inclusive, challenging cultural norms that frequently exclude this demographic [Wajcman, 2007], [Wyatt, 2008].

In the context of the presented study, this perspective was particularly evident: the participants not only contributed to the design of a digital solution but also experienced a transformation in their roles, from passive consumers of technology to active collaborators in the development of tools that meet their own needs. By proposing inclusive and intuitive interfaces, the older women demonstrated how their specific experiences and life histories can enrich the design process.

More than overcoming technical barriers, active participation helped challenge underlying 'gender scripts' that often marginalize older women in technological contexts [Wajcman, 2007]. By engaging them in activities such as prototyping, ideation, and interface analysis, the study highlighted how participatory practices can promote digital equity. For example, the use of strategies such as conversation circles and guided prototyping created a collaborative environment that valued these women's unique perspectives, encouraging them to exercise their creativity and leadership.

Therefore, initiatives like this not only create more accessible technologies but also contribute to the deconstruction of structural gender inequalities, promoting a more inclusive future where women of all ages play active and meaningful roles in the digital society.

In summary, the analysis of the participation and engagement of the older women in the design stages reveals not only active participation with relevant contributions but also a positive impact on the well-being of the older women, as through content analysis, it was possible to identify a variety of positive affective reactions expressed by the participants, such as: happiness, interest, pride, satisfaction, respect. It was found that this emotional experience experienced by the participants contributed to the improvement of self-esteem, empowerment, and belonging of the participants.

Given the above, identifying not only the modes of participation of the older women, but also considering their affective and emotional reactions throughout the process, has contributed to obtaining valuable insights into the factors that can motivate the active participation of older adults in an interaction codesign process. These factors will be described below.

6.3 Motivating factors

Motivation is driven by several elements that, in addition to encouraging active participation, also foster a collaborative and respectful environment. In the context of codesign with older adults, identifying these motivational factors is essential to optimizing the participants' experience and engagement.

Table 7 suggests a possible interconnection between the identified motivational factors and the evidence supporting their relevance in this process. The presented data indicate that the **recognition and appreciation of participants' contributions** are important components for motivating them to engage actively, as highlighted by statements mentioning respect and perceived appreciation throughout the process.

In addition, the **sense of belonging** emerges as a significant motivator, promoting an environment where older adults feel integrated and essential to the success of the project. This not only increases satisfaction, but also strengthens the relationship between participants and the research team. The quotes highlight older adults' happiness and pride in participating, which suggests that creating an inclusive space is crucial for active engagement.

The **interest and relevance** of the topic also play a vital role. When older adults feel that their experiences and rights are being taken into account, they feel more motivated to contribute, reinforcing the idea that research should address issues that are meaningful to this group.

Empowerment is another factor highlighted in the table, showing that allowing participants to have control over the process generates more positive emotional reactions. Older adults report feelings of satisfaction and appreciation when they feel "chic" for contributing to the project, which reinforces the importance of providing opportunities for them to take an active role. Finally, **adequate facilitation and flexibility from the research team** are crucial to fostering a learning environment where older adults feel comfortable expressing themselves. Evidence shows that patience and attentiveness from the team help to create a space of trust, which is essential for effective participation.

In summary, the relationship between the motivating factors and the evidence presented in this table not only highlights the complexity of involving older adults in codesign, but also serves as a guide for future initiatives. It is imperative that researchers and facilitators are aware of these dynamics to foster meaningful and productive engagement in projects that seek to integrate the voice of older adults into design processes.

The participation and involvement of older women in the codesign process aligns with the literature on participatory design, which advocates for the active inclusion of users in creating solutions that meet their needs [Sanders and Stappers, 2008]. However, online engagement presents specific challenges and opportunities for older people, expanding the traditional boundaries of participatory design, which is usually focused on in-person environments.

The findings of this study show that older adults can effectively participate in the production of solutions, but factors such as trust, work pace, and appropriate mediation are essential for effectiveness. This echoes studies suggesting that participatory design must be adapted for diverse populations, especially those less familiar with digital technologies [Simonsen and Robertson, 2013].

The literature on aging and technology emphasizes that digital skills are crucial for promoting social inclusion and autonomy in old age [Rasi-Heikkinen and Doh, 2023]. However, inclusion is not limited to access to digital tools but also involves meaningful engagement.

This study advances the discussion by investigating not only older women's access to digital technologies but also their active involvement in participatory online practices, highlighting their role as collaborative agents in developing technological solutions. This focus on active participation in the creative process reinforces the concept of active aging, which refers to aging with social participation and continu-

Table 7. Relationship between Motivating Factors and Corresponding Evidence

Motivating Factors	Relationship	Evidence
Recognition and appreciation	Recognition of their contributions may have motivated participants to become actively involved.	P4: "It was an example of respect in which we participated and the proof of respect came...although we already realized it.. but we had concrete proof of the respect that you have for us and we can only thank you. You could have changed a lot of things, however the objective was to take advantagef our ideas."
Sense of belonging	This sense of belonging is a motivator that increases involvement, as they feel integrated and essential to the success of the project.	P2: "Happiness is giving suggestions regarding the older adults." P4: "Satisfied because despite the difficulties I was able to be present, healthy, and willing to participate in classes, make suggestions and even receive compliments".
Interest and relevance	Interest in the topic encourages participation, as participants feel more motivated to contribute in a context that impacts their lives.	P2: "Because it's in our interest... as senior citizens, right? It's in our interest as senior citizens to have our rights". P5: "Important to participate in a great research".
Empowerment	Empowerment is a strong motivator, because when they feel in control of the process, their emotional reactions become more positive.	P5: "loved it. It made me feel, how do you say? chic!!!!"
Appropriate facilitation and mediation	"Effective facilitation creates a space where participants feel comfortable expressing themselves, which can encourage both participation and engagement."	P5: "They were patient and explained clearly, returning [to the subject] when necessary." P3: "You had the patience to explain things to us several times [...]"
Flexibility and adaptability of the research team	The ability of the research team to adapt to the needs and preferences of older women is essential to promote their active participation;	P3: "[...] the effort they made for us to learn... to teach. The boys did everything they could to make us learn, thinking about finding the easiest way for us to learn the subject."

ous learning [WHO, 2005].

Additionally, the findings highlight the importance of overcoming the stress caused by difficulties in dealing with new technologies, including information overload, fear of making mistakes, and frustration with complex interfaces [Ragu-Nathan *et al*., 2008]. This stress often triggers feelings of insecurity and a lack of confidence in using devices and digital platforms, reinforced by previous negative experiences and the absence of adequate support [Nimrod, 2018].

These factors are especially relevant for older adults, whose learning trajectories may be marked by resistance or demotivation toward technologies. The findings indicate that it is crucial to create welcoming learning environments, provide continuous and personalized support, and simplify interfaces to make the experience less stressful and more intuitive. Promoting empathy, patience, and an adapted learning pace are fundamental aspects to ensure the genuine and sustainable engagement of participants in the participatory design process.

The findings have significant implications, as they encourage further research into the barriers older women face when interacting with digital technologies, promoting the exploration of methodologies that value their voices and experiences. They also emphasize the importance of implementing digital training programs and continuous support focused on the specific needs of older adults, fostering confidence, digital skills, and autonomy to empower them as conscious co-creators in technology development.

Finally, they suggest that designers and researchers actively collaborate with communities of older people to co-create solutions that not only meet their needs but also empower these women as agents of change in their own contexts.

7 Challenges and Lessons Learned: Some Reflections

During the three months of conducting the codesign process with older women, several reflections emerged regarding the challenges faced and lessons learned, as described below.

7.1 Context Analysis

During the context analysis stage, discussions facilitated by the Focus Group and Brainstorming techniques flowed smoothly, with minimal interference from the facilitator. However, it was observed that at times, distractions occurred due to external factors in the virtual space, such as family interruptions, loud bird sounds, external noises, etc.

In other studies of online codesign with older adults, external distractions have also been noted [Cajamarca *et al*., 2022; He, 2020]. Cajamarca *et al*. [2022] mentioned doorbells ringing, the presence or noise of pets, or the need to leave the session momentarily to take medication as external distractions.

The distractions stemming from the physical environment led us to reflect that in an online activity, what occurs in the participant's physical space is beyond the facilitator's control. However, it is worth noting that these are momentary distractions that did not have a significant impact on the conduct of activities or result in prolonged dispersion. The activity resumed immediately after resolving the distractions. However, it is advisable for the facilitator to advise at the beginning of each session that audio be turned off and only reactivated when necessary. This may minimize overall group dispersion but does not preclude individual dispersion where the event is occurring.

Regarding family interruptions, these are recognized as

unforeseen events that can occur at any time with any participant in an online study, including in the facilitators'/monitors' environment.

However, unlike momentary distractions that occur during action, family interruptions occur without the facilitator's knowledge, and it is up to the participant to resolve the situation. However, participants were informed from the outset of the process that if there were any impediments to participation, they should communicate them to the research team.

In terms of lessons learned, we found that, especially in online studies involving older adults, verbal techniques such as focus groups, roundtable discussions, and brainstorming facilitated participants' expression with ease, sharing thoughts, feelings, and experiences genuinely, without fear or embarrassment. This was also observed in Rosa and Matos [2020], conducted with co-located older participants.

In line with Rosa and Matos [2020], it is worth noting that an important factor for this to occur is the empathetic and trusting relationship that must be built from the outset of the process.

Despite the facilitating nature of the techniques used, they also require the facilitator to have some experience and sensitivity in conducting them, as it is common for older adults to become easily distracted, repetitive, and lengthy in their speech [Rosa and Matos, 2020]. However, in the present study, we observed more objective speech without as much dispersion from the discussions.

As in Rosa and Matos [2020], in this study, we also found it important to enable participants to actively listen with respect and without judgment. In line with Lindsay *et al*. [2012]; Kopeć *et al*. [2018]; Rosa and Matos [2020], it is also important in this study to reinforce at the beginning of each session that "there is no right answer and no wrong answer".

7.2 Interface Engineering

During the interface engineering stage, perhaps due to the participants' activity and the experience gained in the first two stages in using smartphones, it was possible, even online, to carry out paper prototyping. However, guided digital prototyping allowed for the creation of prototypes closer to reality.

However, combining the digital prototyping technique with individualized monitoring, providing one monitor per participant, yielded more significant results. This monitoring was crucial for participants to understand the purpose of the technique and to express themselves creatively.

In this sense, the monitor is a key element in conducting this technique, and it is necessary for team members to be encouraged and guided to develop good social skills (being patient, having active listening, being flexible); using appropriate language; providing positive feedback with compliments and always congratulating participation.

One of the challenges in using the digital prototyping technique was initially helping participants understand the purpose of the technique and/or the purpose of the second and third screens in the Complaint topic. However, this was resolved with explanations provided in various ways, including analogies and scenarios closer to their reality. At one point, one of the monitors had to describe the difficulty of walking on the city center's pavement to help the participant understand that such a situation could be reported as a complaint. If this were true, what would she do, and what steps would be necessary to make this complaint? From this scenario, the participant's ideas began to flow.

7.3 Evaluation

In this study, of the three stages conducted, the evaluation stage was the most challenging to conduct online, mainly because it involved evaluating a mobile application, as it is not easy for older participants to share their screens through the video conferencing application being used on their smartphones [He, 2020]. Thus, it was only possible to evaluate the basic design idea using the roundtable discussion technique. However, there is an understanding of the need for further study on evaluation techniques to be conducted online to make it feasible to evaluate potential prototype interaction problems.

The absence of some participants, especially in prototyping activities, compromised the diversity of perspectives, but this was overcome in the Evaluation stage, where absent participants could explain their opinions, contributing to the discussions.

Overall, the configuration of the online format itself is challenging, as corroborated by Cajamarca *et al*. [2022], as the camera provides fewer "clues" about what is happening on the screen or behind it. Thus, it is not possible to control situations that may arise during the design sessions, such as external distractions; internet connection problems; problems with cell phones, among others.

Another challenge noted in the online study is having fewer visual cues to interpret participants' emotions and experiences. This challenge was also pointed out by Cajamarca *et al*. [2022]. In summary, an online codesign process is challenging for both those conducting the process and those participating.

However, it is understood how important it is for the actors in the process (facilitators and monitors) to have a differentiated profile, with peculiar characteristics such as patience, sensitivity, and empathetic ability to guide older participants with respect and tranquility, stimulating their participation through praise for each victory achieved, in the face of the difficulties encountered, and through words of confidence, conveying to them security and empowerment.

These reflections not only enrich our understanding of the collaborative design process dynamics but also provide valuable insights for the continuous improvement of design practices with older adults.

8 Final Considerations

This study presented the experience of conducting an online semi-participatory interaction codesign process with the effective participation of five older women. The participants expressed themselves creatively and collaboratively, becoming codesigners in defining, ideating, prototyping, and evaluating a mobile application tailored to their needs. The study

also integrated research and community outreach, contributing to the education of undergraduate Information Systems students.

Despite its significant contributions, the study has limitations that impact the generalization of its findings. The small, exclusively female sample restricts the diversity of perspectives. Factors such as gender, age range, and level of digital literacy may influence engagement and perceptions of the codesign process. Moreover, the Brazilian geographical context, with its unique cultural and socioeconomic characteristics, may not reflect the realities of older adults in other countries, where access to technology and perceptions of aging vary substantially.

The transferability of the findings will depend on adapting the codesign strategies to different contexts. For instance, in settings with limited connectivity, the use of hybrid or offline approaches may be necessary. Additionally, the inclusion of cultural mediators could facilitate the application of the methodologies to diverse populations. Replicating the study with larger and more heterogeneous samples, considering variables such as gender, age, education level, and social class, will be essential to validate and expand the findings.

Despite these limitations, the study offers valuable insights, demonstrating that online interaction codesign with older adults is both feasible and rewarding. It provides positive affective experiences, such as increased self-esteem and empowerment. These findings reinforce the importance of actively involving older adults in developing technologies that address their specific needs. For the future, the study plans to expand with more diverse groups, improve participatory evaluation techniques, and continue developing the S.O.S. Older Adult prototype in collaboration with the participants.

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Authors' Contributions

V. Rosa contributions: Conceptualization, Funding acquisition, Project coordination, Methodology, Investigation, Visualization, Writing – original draft, Writing – review & editing.

E.S. Matos contributions: Conceptualization, Project coordination, Supervision, Visualization, Writing – review & editing.

D. Zabot contributions: Visualization, Writing – original draft, Writing – review & editing.

J. Santos contributions: Visualization, Writing – review & editing.

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