Maria Lilian de Araujo Barbosa, Lívia Flávia de Albuquerque Campos, Maria Lúcia Leite Ribeiro Okimoto*

Recommendations for acceptance of digital public services by low-income seniors in smart cities by human-centered design

Abstract Background: In Brazil, the federal government has developed a digital platform for public health services, with state and municipal governments connecting their solutions to unify citizen registration. Objective: To understand the phenomena involved, in order to provide recommendations for the acceptance of digital technologies by low-income elderly people in the context of smart cities. Method: The theory of the consolidated meta-analytic approach was used for a systematic bibliographic review. It is complemented by case studies presented in a Design Postgraduate class, carried out in collaboration between two Brazilian Federal Universities. Results: Creation of recommendations in three categories within the framework of human-centered design. Conclusions: This study identifies opportunities for the development of products, services and public policies for the digital inclusion of low-income older people in the context of smart cities.

Keywords Smart cities, Technology acceptance, Elderly, Human-Centered Design, TCMA

*

Maria Lilian de Araujo Barbosa Holds a PhD in Design from the Federal University of Paraná, with research focused on the integration of digital assistive technologies in housing for low-income seniors and human-centred design. STEAM background includes a degree in design (visual arts), a postgraduate degree in ergonomics, and a master's degree in mechanical engineering, with the best dissertation award at the 2019 International Workshop on Assistive Technology. Expertise includes qualitative research using qualitative data software, artificial intelligence, project management, working with multidisciplinary teams, focus group development and conceptual tool design.
<lilianresearcher@gmail.com>
ORCID 0000-0002-5438-9061

Lívia Flávia de Albuquerque Campos Adjunct Professor at Federal University of Maranhão, holds a PhD in Design from UNESP - Bauru, and a Master's degree from the same institution. Her Ba-

chelor's degree in Industrial Design is from UFMA. She is a permanent professor in UFMA's Graduate Programme in Design, focusing on Design and Ergonomics research. Co-leader of LABDESIGN Experience and Innovation, she serves on UFMA's Research Ethics Committee and reviews for journals including Estudos em Design, Educação Gráfica, Ergodesign, HCI, and Tríades em Revista. Her interests span Product and Interface Design, Product and Interface Ergonomics, and Human x Product Experience..
<livia.albuquerque@ufma.br>
ORCID 0000-0002-3968-1793

Maria Lúcia Leite Ribeiro Okimoto
Post-doctorate at Technische Universität München, Germany (July 2012 - Feb 2013). PhD in Production Engineering from Federal University of Santa Catarina and RWTH-Aachen, Germany (2000). Full Professor in Mechanical Engineering at Federal University of Paraná. Vice-coordinator of Graduate Programme in Design (2022-2024). Coordinates Araucária Foundation's NAPI-TA for Assistive Technology (2022-2027). Works in Mechanical Engineering (UG) and PG programmes at UFPR. Leads LABERG, UFPR's Ergonomics and Usability Lab. Coordinator of Assistive Technology R&D Network (RPDTA). Expertise in Product Development, Inclusive Design, Usability, Ergonomics, Assistive Technology, Smart Design, Modelling.
< lucia.demec@ufpr.br>
ORCID 0000-0002-1968-1964

Recomendações para a aceitação de serviços públicos digitais por pessoas idosas com baixa renda em cidades inteligentes com base no design centrado no ser humano

Resumo Contexto: No Brasil, o governo federal desenvolveu uma plataforma digital para serviços de saúde pública, com os governos estaduais e municipais conectando suas soluções para unificar o registro de cidadãos. Objetivo: Compreender os fenômenos envolvidos no contexto apresentado, a fim de fornecer recomendações para a aceitação de tecnologias digitais por idosos de baixa renda no contexto de cidades inteligentes. Método: Utilizou-se a teoria da abordagem meta-analítica consolidada para uma revisão bibliográfica sistemática. Ela é complementada por estudos de caso apresentados em uma turma de Pós-Graduação em Design, realizada em colaboração entre duas Universidades Federais brasileiras. Resultados: Criação de recomendações em três categorias no âmbito do design centrado no ser humano. Conclusões: Este estudo identifica oportunidades para o desenvolvimento de produtos, serviços e políticas públicas para a inclusão digital de idosos de baixa renda no contexto das cidades inteligentes.

Palavras-chave Cidades inteligentes, Aceitação de tecnologias, Pessoas idosas, Design centrado no humano, TEMAC.

Recomendaciones para la aceptación de servicios públicos digitales por parte de ancianos con bajos ingresos en ciudades inteligentes mediante el diseño centrado en el ser humano

Resumen *En Brasil, el gobierno federal ha desarrollado una plataforma digital para los servicios de salud pública, con los gobiernos estatales y municipales conectando sus soluciones para unificar el registro de ciudadanos. Objetivo: Comprender los fenómenos involucrados, con el fin de proporcionar recomendaciones para la aceptación de las tecnologías digitales por parte de las personas mayores de bajos ingresos en el contexto de las ciudades inteligentes. Método: Se utilizó la teoría del enfoque meta-analítico consolidado para una revisión bibliográfica sistemática. Se complementa con estudios de caso presentados en una clase de Postgrado en Diseño, realizada en colaboración entre dos Universidades Federales brasileñas. Resultados: Creación de recomendaciones en tres categorías en el marco del diseño centrado en el ser humano. Conclusiones: Este estudio identifica oportunidades para el desarrollo de productos, servicios y políticas públicas para la inclusión digital de las personas mayores de bajos ingresos en el contexto de las ciudades inteligentes.*

Palabras clave *Ciudades inteligentes, Aceptación de la tecnología, Personas mayores, Diseño centrado en el ser humano, TEMAC.*

Introduction

This study began with the authors' concern about the issue of digital inclusion for low-income older people, as there is a lack of equity, accessibility, and digital inclusion for these users in the face of the variety of digital solutions that smart cities have incorporated.

Roy (2016), emphasizes that Smart Cities do not involve citizens in the proposals for digital solutions, because they prioritize technological aspects, neglecting the process of listening to local communities in the implementation of public policies. Therefore, they are technocentric and not humanocentric.

Mullick, Patnaik (2022) suggests that the marginalized and digitally excluded have few rights to the Smart City, be it spatial, participation or digital inclusion. In addition to education, family income, and age, cultural and socioeconomic factors also contribute to digital exclusion. These need to be addressed in order to embrace digital technologies in smart cities.

In this context, the question arises: How do smart cities address not only technological efficiency and innovation, but also equity, accessibility and inclusion requirements related to the social and structural conditions of older and low-income people?

Norman (2023) extends the discussion of the concept of human-centered design to the level of humanity-centered design and seeks to answer these questions. The author argues that it is necessary to take a deeper perspective on ecosystems and populations in the long term with the focus is on participatory design.

In this approach, designers should act as facilitators, designing solutions with communities and not for them, taking into account the negative impacts on the planet and the survival of species, so that this would be a way to make cities more humane, not only for this generation, but also for future ones.

However, Gorichanaz (2024) criticizes human-centered design, arguing that it is incoherent in several ways, including the fact that it doesn't show exactly how this approach can or should be implemented. The author argues that the goal is to overcome the limitations of human-centered design and that more discussion is needed for its application.

Based on these arguments, the aim is to answer these questions by looking at digital public services to identify the barriers to older people adopting and interacting with these digital technologies.

We analyzed the case studies developed as part of the subject offered in the Postgraduate Diploma in Design, carried out in collaboration between the Federal University of Maranhão and the Federal University of Paraná, through the inter-institutional project PROCAD - AM Creative Communities and Local Knowledge. Its theme was Human-Centered Design for Interactive Products, in order to identify convergences between the theoretical basis and the practical application.

This inter-institutional project is a partnership between three Bra-

zilian educational institutions: Federal University of Paraná (UFPR), Federal University of Maranhão (UFMA), Federal University of Minas Gerais (UFMG), with a focus on design for low-income social and cultural contexts, with emphasis on the mapping, analysis and development of processes and products.

Human-centered design is an appropriate approach for the study proposed here, as it aims to apply knowledge and techniques from usability, human factors and ergonomics to improve the efficiency of systems by focusing on users, their requirements and needs. In this way, the system becomes more efficient and improves well-being, user satisfaction, accessibility and sustainability, preventing or eliminating adverse effects of its use in terms of health, safety and performance (ABNT, 2011).

Therefore, the study adopts a human-centered design (HCD) perspective to understand the phenomena involved in making recommendations that can contribute to the acceptance of digital technologies by low-income elderly people, with the aim of making smart cities more humane and inclusive.

Theoretical background

The theory of the consolidated meta-analytic approach (TCMA), proposed by Mariano and Rocha (2017) for a systematic bibliographic review (SBR), was used.

The Human-Centered Design (HCD)

Krippendorff (2000), notes that the focus on people came in the early 1950s, when mass-produced products with functionalist characteristics from the industrial era were seen as consumer, information, and identity goods.

In this context, since the introduction of ISO 13407 "Human-centered design processes for interactive systems" in 1999, ISO standards have been developed to address the need to develop more usable interactive systems with greater efficiency and effectiveness (ISO 13407, 1999). Over the years, this standard has been updated and refocused, and today ISO 9241-210:2019 provides guidance on the relationship between usability and accessibility. However, there is still a distinction to be made between user-centered design and human-centered design (Ferreira, Venturelli, 2022).

The user-centered approach presents methods for solving predetermined and technical problems and fails to promote human interests. Its socio-cultural and contextual aspects are not sufficient for designers to create a human-centered system. To meet the human-centered perspective, contextualization, problem identification and solution are essential. (Chaves; Bittencourt; Taralli, 2013).

In this sense, IDEO (2009) proposal is innovative and pragmatic, with a focus on human-centered design (HCD). This version responded to a re-

quest from the Bill and Melinda Gates Foundation and was delivered in the form of a toolkit. This model prioritized design around social innovation processes consisting of 3 stages: listening, creating, and delivering. This approach has been validated in several poor communities in India, Africa and other third world countries, making it an applicable methodology for low-income contexts and communities.

According to Torcate et al. (2020), HCD has been widely applied in the health field, allowing systems and products to become more efficient and usable, with use ranging from the creation of useful tools that meet the social and economic needs of those involved, to the creation of campaigns to promote public health.

Human-Centered Design and its importance for smart cities

HCD is a methodology that infuses the entire spectrum of innovation-related activities with human core values, according to Brown (2010).

Neumann et. al (2023) argue that it is essential to use human-centered and user-centered design approaches to develop digital solutions in the context of smart cities. Solutions must be truly inclusive and accessible.

In the context of the elderly, especially those on low incomes, the most relevant challenges are lack of familiarity with digital technologies, security concerns, privacy, and accessible solutions. (Oliveira et al, 2022)

To overcome these barriers, it is recommended to create intuitive and user-friendly interfaces, such as voice assistants, which can make it easier for those unfamiliar with digital devices to use the technology. In addition, transparency about the use and protection of personal data is essential to gain users' trust. (Neumann et al, 2023; Oliveira et al, 2022, Lemos, 2013).

Mullick e Patnaik (2022) argue that citizens have a right to a smart city. They report on how India's Ministry of Urban Development is approaching the issue from the perspective that citizens have the right to access and curate proposals for the technologies that will be implemented in smart cities.

In this sense, it is possible to identify IDEO (2009) approach to HCD, i.e. desirable, feasible and practicable design, when they state that smart cities include a wish list of infrastructures and services to satisfy citizens' needs and aspirations for basic, sustainable infrastructures for quality of life.

Figura 3. Representação inicial do esquema abstrato-visual
Fonte Os autores

Para Mullick, Patnaik (2022), The right to a smart city is linked to several rights, including the right to housing, participation and empowerment. Other related rights, such as the right to information, freedom of expression, culture, equality, autonomy, freedom to work, freedom of movement and the right to private property, must be respected. In this sense, it is consistent with Krippendorff's (2000) assertions that designers have come to realize that products are not things, but social practices, preferences, and symbols.

According to Giacomin (2017), HCD has its roots in the semi-scienti-

fic fields of ergonomics, computer science, and artificial intelligence, and is based on techniques that communicate, interact, highlight, and stimulate people's involvement in order to gain an understanding of their desires, needs, and experiences, usually beyond their own perception.

Use of digital public services by older people

One of the great revolutions in the smart cities and digital public services scenario is mobility. Mobility is an evolution that aims to improve the delivery of public services through the use of mobile technology, facilitating more effective interaction between governments and citizens, promoting social inclusion and reducing the digital divide. (Mensah, Mwakapesa, 2022).

Successful acceptance of mobile technologies requires a holistic approach that considers not only technological innovation, but also the social, cultural, and psychological factors that influence how people adopt and use these technologies. Understanding these factors is essential to the development of services that not only meet technological needs, but are also accessible, inclusive, and valued by users. (Mensah, Mwakapesa, 2022).

Venkatesh et al. (2003) brought together the basic elements of the Unified Theory of Acceptance and Use of Technology (TUAUT), which aims to understand the user's intention to use a digital technology based on four determinants: quality expectancy, effort expectancy, social influence, and favorable conditions. Other factors, such as age, gender, and experience, are considered moderators that can influence the relationship between these determinants and the acceptance of digital technology.

According to Mensah and Mwakapesa (2022), the discussion on perceived usefulness, trust and mobility can be linked to TUAUT, which analyzes how users perceive the benefits of using mobile technology and mobile government. The authors argue that ease of use, expectation of effort, and how it fits into different technological contexts are directly related to technology acceptance.

The analysis of each of these terms allows for a better understanding of the four constructs of Venkatesh et al. (2003). Performance Expectancy is one of the basic prerequisites for satisfaction. Effort Expectancy is the sense of ease associated with using the technology. Social Influence is the perception of how relevant other people think the technology is. Facilitating Conditions" is the user's perception of the resources and support available for using the technology.

Llorente, Sánchez e Viñarás (2023) conducted a survey of 405 Spanish Internet users between the ages of 60 and 79, with the goal of creating a categorization of Internet users with a focus on e-commerce and e-government.

The authors emphasize that age is a factor influencing digital exclusion on three levels: older people have fewer resources (first level), lower digital skills and engagement with the Internet (second level), and fewer

physical benefits from using digital media in their lives (third level) compared to younger users who benefit more from using digital technologies.

The author suggests that there is a need to develop strategies to increase access, skills and perceptions of the benefits of Internet use among older people in order to reduce their digital exclusion, as there are significant differences in the level of digital literacy among older people, especially in the routine use of the Internet for online shopping and accessing government services via the Internet. Many older people only use the internet for WhatsApp and email, showing a low level of adherence to digital potential. (Llorente, Sánchez, Viñarás, 2023).

According to Shamsujjoha et al. (2024), there are shortcomings in various e-health applications. Differences among users make them ineffective or inaccessible for some, especially those with low incomes. The authors propose a development approach that incorporates human aspects throughout the application lifecycle to create more efficient and inclusive e-health solutions.

Wu, Huang e Zong (2023) emphasize the need to identify and understand the specific attributes of the interface that most influence the behavioral intentions of the elderly, taking into account barriers such as: lack of familiarity with digital technologies, unintuitive interfaces, and complex operating procedures.

According to the authors, the rapid growth of the elderly population is putting pressure on the creation of hospital and healthcare resources, as well as the need to integrate digital technologies to streamline workflows and improve the patient experience.

Methods

This study is characterized as mixed, being quantitative in its methodological procedure of bibliographic review, qualitative and descriptive in the phase of case studies and analysis of its results.

The study was carried out in two phases, a phase of systematic bibliographic review (SBR) followed by case studies developed in the framework of a subject taught in the postgraduate programs of two universities, seeking a convergence between theory and practice. An adaptation of the theory of the consolidated meta-analytic approach (TCMA) by Mariano and Rocha (2017) is used to provide the theoretical framework. (Figure 1).

TCMA is an efficient quantitative method, based on criteria of academic rigor, that allows a systematic search and selection of studies and an efficient synthesis to build a theoretical base. Table 1 shows the TCMA protocol used in the study to create the theoretical framework (Mariano, Rocha, 2017).

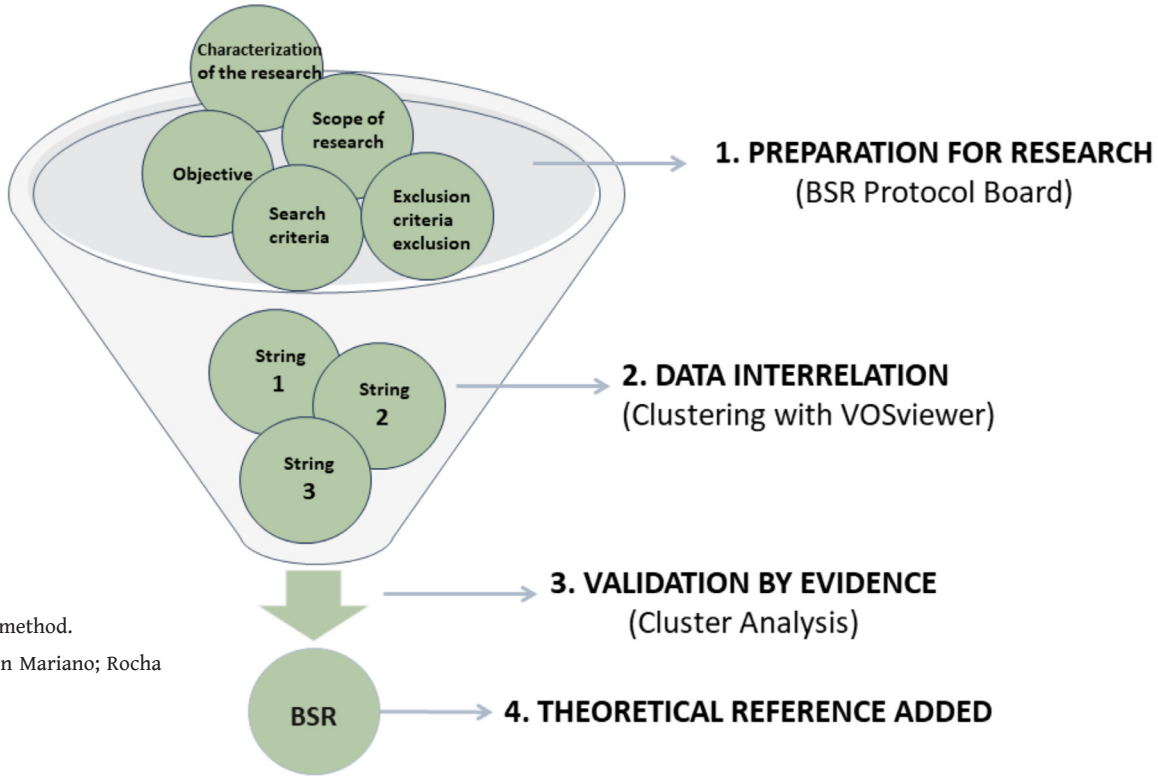


Figure 1. Visual overview of TCMA method.
Source The authors (2024) based on Mariano; Rocha (2017)

Table 1. Summary literature review protocol
Source The authors (2024)

Element	Attribution
Characterization of the research	Quantitative in its methodological approach; qualitative in its analysis and presentation of results. Descriptive in the presentation of the case studies.
Aims	On the basis of the theoretical framework and the case studies, to make recommendations for the acceptance of digital technologies by lower-income seniors in the context of smart city.
Research scope	RBS: Scopus database; RBA: references cited in RBS articles, referrals from other researchers and DCH students, smart cities websites.
Research criteria	Strings defined; filter criteria: Search 1: "All Fields" without filters. Search 2 with filters: Document type: Peer-reviewed articles; 5-year period.
Criteria for exclusion	Does not meet the objectives and criteria of the research; duplicates.
Interrelation of data	Evolution of the topic from year to year; the most cited works; the authors who publish the most on the topic; the frequency of the key words.
Evidence-based validation	Bibliometric analysis: coupling.
Software features	Vosviewer for building and visualizing bibliometric networks and identifying clusters by correlating data and validating evidence.

Scopus was used for the search. According to Vera-Baceta, Thelwall and Kousha (2019), Scopus has a larger number of indexed documents. In addition to the BSR, an Asystematic Bibliographic Review (ABR) was conducted. According to Santos (2018), ABR is a common technique in design research and can be conducted after the BSR as a strategy to find publications that did not pass the BSR filter. The search strings in Scopus are described in Table 2.

Table 2. Search strings in the Scopus database
Source The authors (2024)

	Strings
1	"Smart cities" AND "Digital inclusion" AND Elderly
2	"Smart cities" AND "Acceptance of technologies" AND " Elderly
3	"Smart cities" AND AND Elderly AND "Human-Centered Design

To ensure rigor in the collection and analysis of the documents selected according to the BSR protocol, the VOSviewer software, version 1.6.20, was used for the interrelationship analysis and validation of the data exported directly from the Scopus database, without any inference by the researcher.

The case studies were developed as part of the human-centered design discipline with the analysis of healthcare applications, and sought to determine whether the goals of digital and social inclusion were being met with respect to the needs of an aging population (Figure 2).

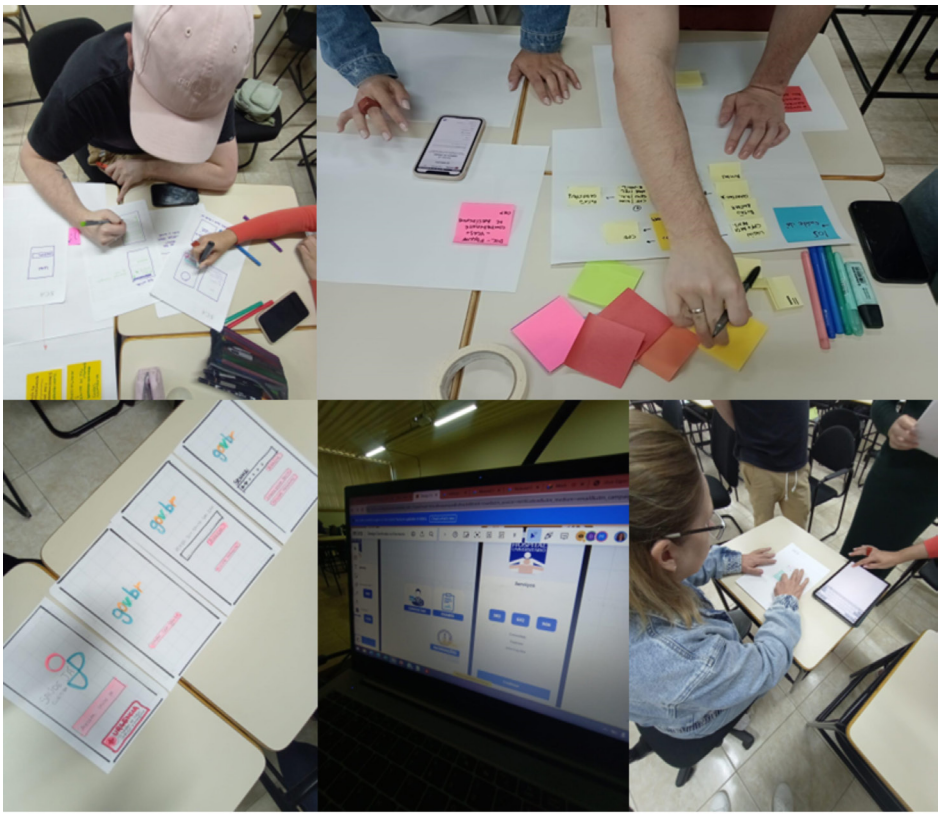


Figure 2. Student activities developed during the class
Source The authors (2024)

Students used the DCH iterative cycle process observed in NBR 9241 (ABNT, 2011) to analyze applications of public health services considering the elderly user, performing activities related to the 4 (four) stages of the cycle: (1) Understand and specify the context of use; (2) Specify user requirements; (3) Produce design solutions that meet user requirements; (4) Evaluate design solutions in relation to requirements.

Results

The results of each phase of the study will be provided below.

Results of BSR Protocol

Table 3. Results of string search
Source The authors (2024)

	Strings	1ª search	Research criteria	Reading Filter 1	Reading Filter 2	Reading Filter 3
1	"Smart cities" AND "Digital inclusion" AND Elderly	113	59	26	5	4
2	"Smart cities" AND "Acceptance of technologies" AND " Elderly	64	42	8	6	2
3	"Smart cities" AND Elderly AND "Human-Centered Design"	64	34	8	7	5

Filter 1 refers to reading the title and abstract, filter 2 refers to reading the introduction and conclusion, and finally filter 3 is reading the entire article when deciding whether or not to include it in the theoretical framework.

Data Interrelationship and evidence validation

VosViewer software was used to correlate data and validate evidence by constructing and visualizing clusters of bibliometric networks.

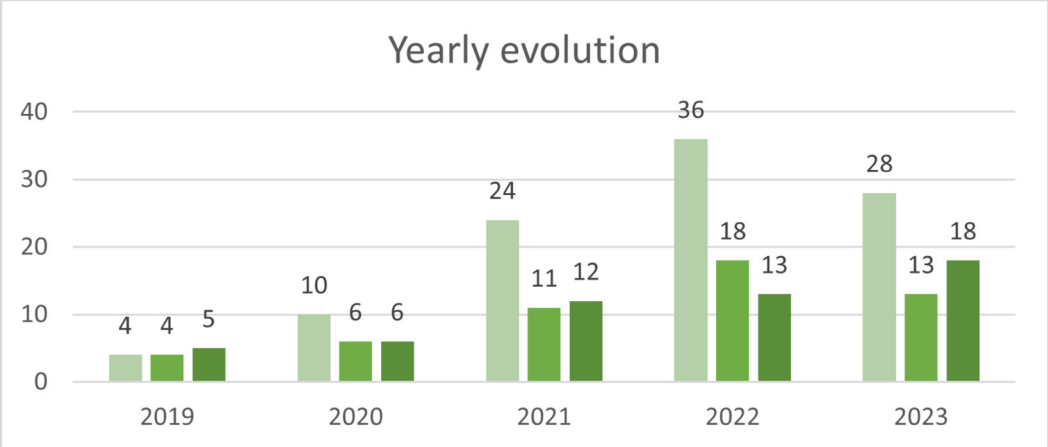
The evolution of research topics from year to year, according to search terms (Graph 1).

It can be seen that topics related to string 1 showed the greatest growth. Strings 2 and 3 showed similar results. The table below highlights the 3 most cited papers and the 3 authors who published the most on the topic (coupling).

The first keyword map was created using general Scopus data without a filter, showing the universe of topics found by the RBS protocol. The goal was to get a broader overview of the topics in the search strings.

By analyzing the connections of each keyword to analyze each re-

currence based on clustering with VOSviewer software. The latest themes related to smart cities (Figure 4) are human-centered design. The fact that this cluster is linked to the sustainable development cluster shows a trend towards a more holistic vision and an awareness of and concern for the ecosystem, referring to the concept of human-centered design.



Graph 1. Year-to-year evolution of the research topic
Source Scopus (2024)

Category	Publishing and Authors
3 most cited articles	1. The effects of trust on behavioral intention and use behavior within e-government contexts. Authors: Hooda, A., Gupta, P., Jeyaraj, A., Giannakis, M., Dwivedi, Y.K (59 citations) 2. Pandemic management, citizens and the Indian Smart cities: Reflections from the right to the smart city and the digital divide. Authors: Mullick, M., Patnaik, A. (13 citations); 3. Review of the theory, principles, and design requirements of human-centric Internet of Things (IoT). Authors:Ystgaard, K.F., Atzori, L., Palma, D., Heegaard, P.E., Bertheussen, L.E., Jensen, M.R., De Moor. (12 citations).
3 Authors most published on the topic.	1. Llorente-Barroso, Carmen (h-index 9) Universidad Complutense de Madrid - Espanha; 2. Zhou, Siyu (h-index 5) Hangzhou Normal University Zhejiang - China; 3. Nguyen, Thi Xuan Hoa (h-index 1) School of Economics and management.Vietnam

Table 4. Relevant authors and articles
Source The authors (2024)

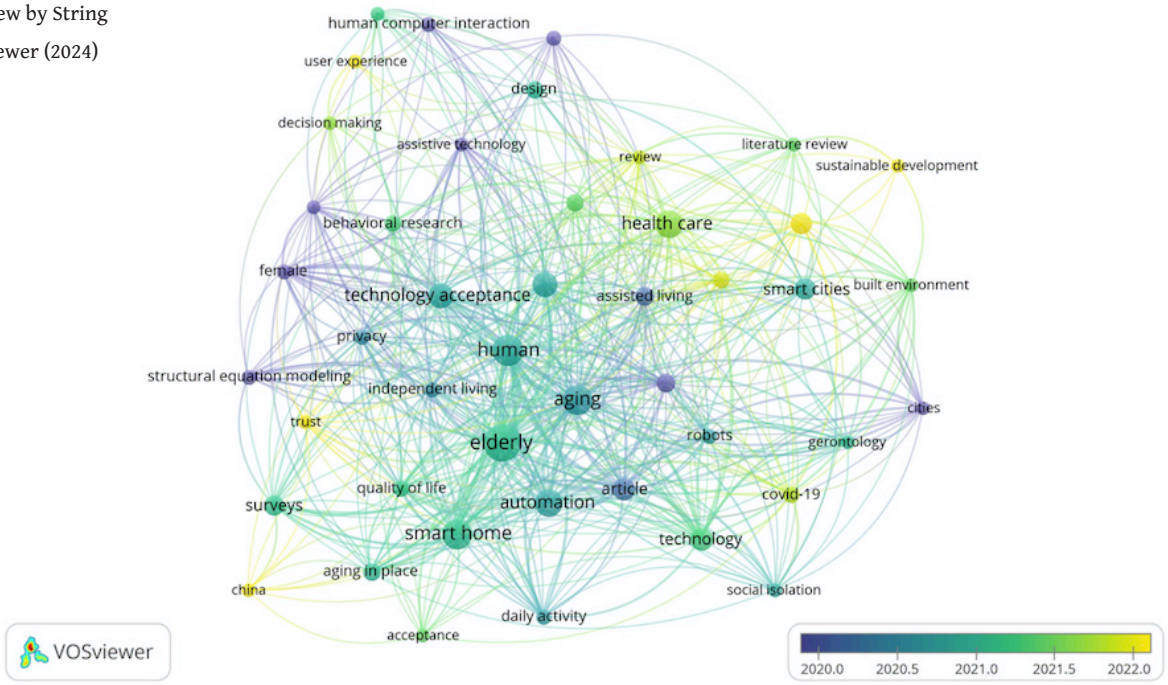


Figure 3. Topic Overview by String
Source Scopus/ VOSviewer (2024)

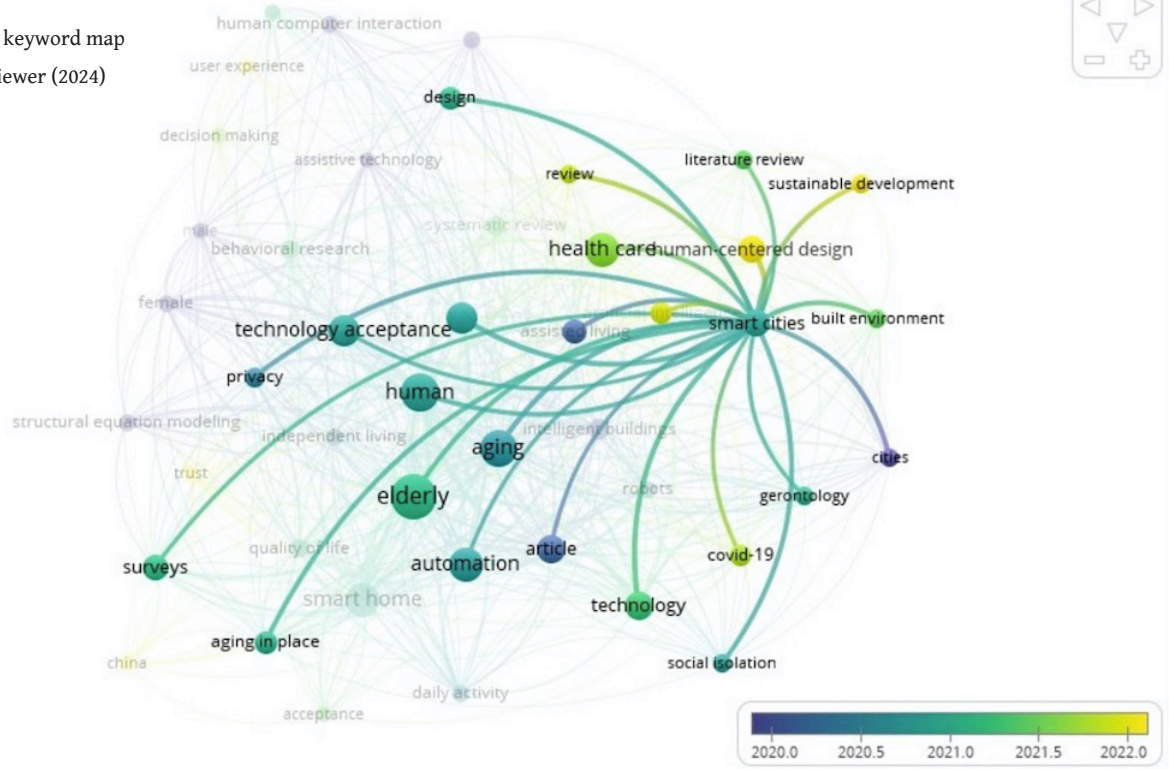


Figure 4. Smart Cities keyword map
Source Scopus/ VOSviewer (2024)

The "Technology Acceptance" group in Figure 5 to be related to the topic of user experience, and the light color indicates a tendency to search with that term.

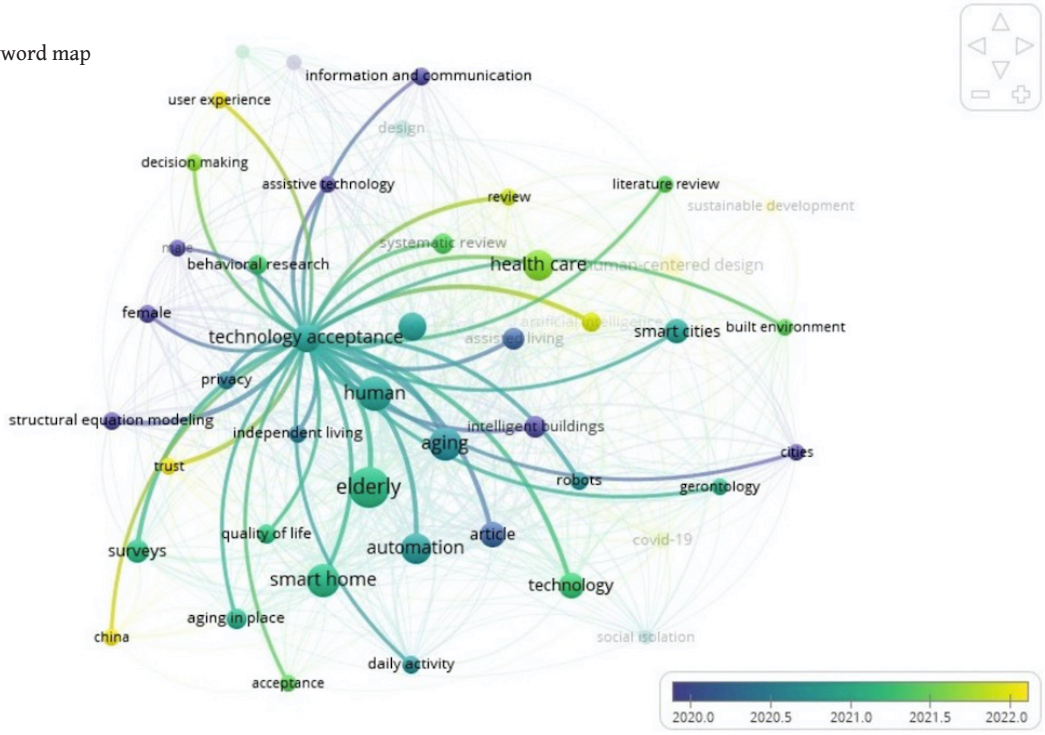


Figure 5. Technology Acceptance keyword map
Source Scopus/ VOSviewer (2024)

Figure 6 shows that the Elderly cluster is related to Human-Centered Design.

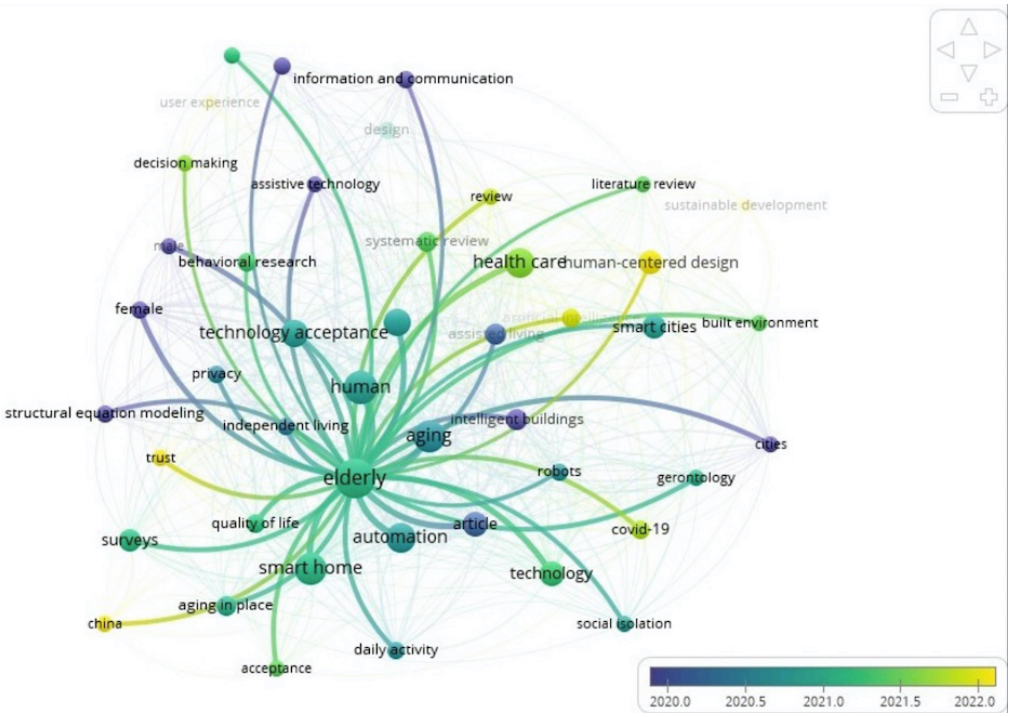


Figure 6. Elderly keyword map
Source Scopus/ VOSviewer (2024)

The color of the clusters assigned to Human-Centered Design indicates the relevance and timeliness of addressing this topic. The light color predominates in all its branches, indicating its centrality in relation to other clusters.

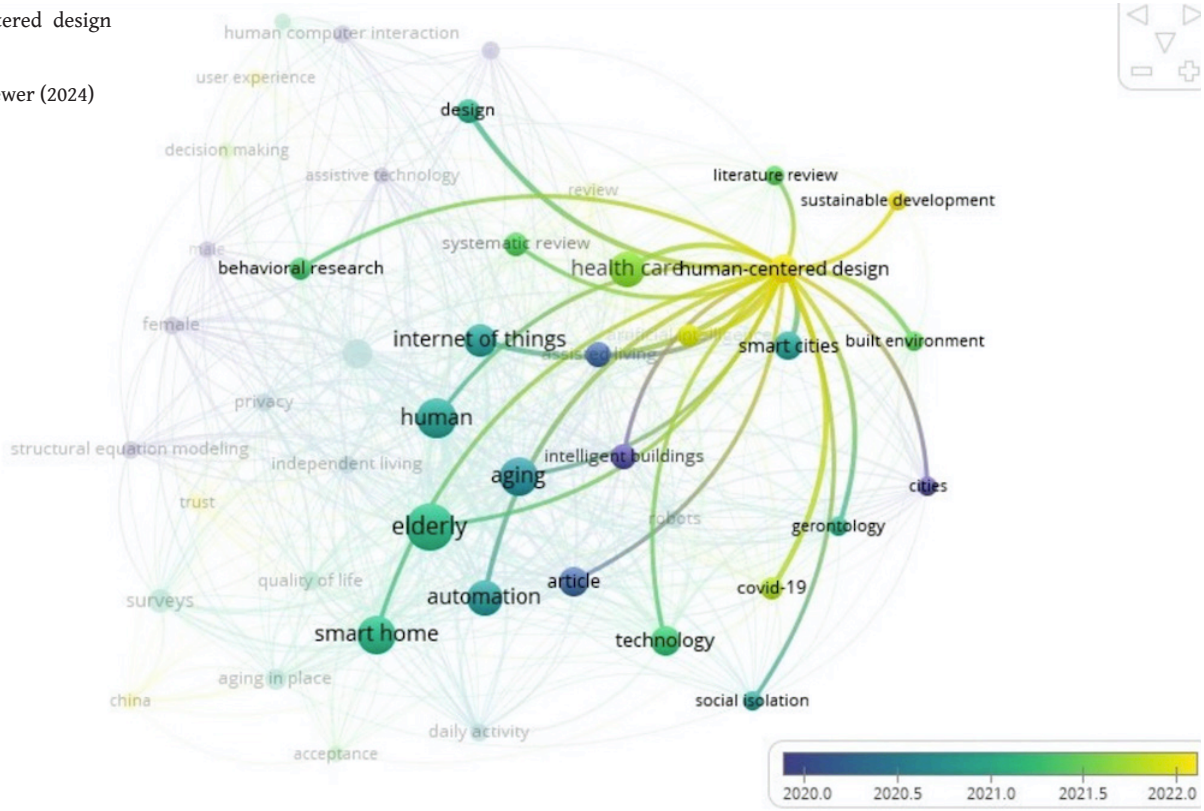


Figure 7. Human-centered design keyword map
Source Scopus/ VOSviewer (2024)

Older articles tend to be cited more often, so their cluster may be larger and darker because they are older. The size of the cluster is an indication of the recurrence of the term, and the lighter color of the cluster is an indication of the timeliness and trend of research using that term.

Case Studies: Digital public health services in Brazil

In Brazil, various public services are delivered to the population through applications at the federal, state and municipal levels, available in a web version and apps for iOS and Android, based on the information available in the National Health Data Network (Figure 8). The network data aims to integrate and unify health services on a single digital platform, with state and municipal governments linking their solutions to unify citizen registration.

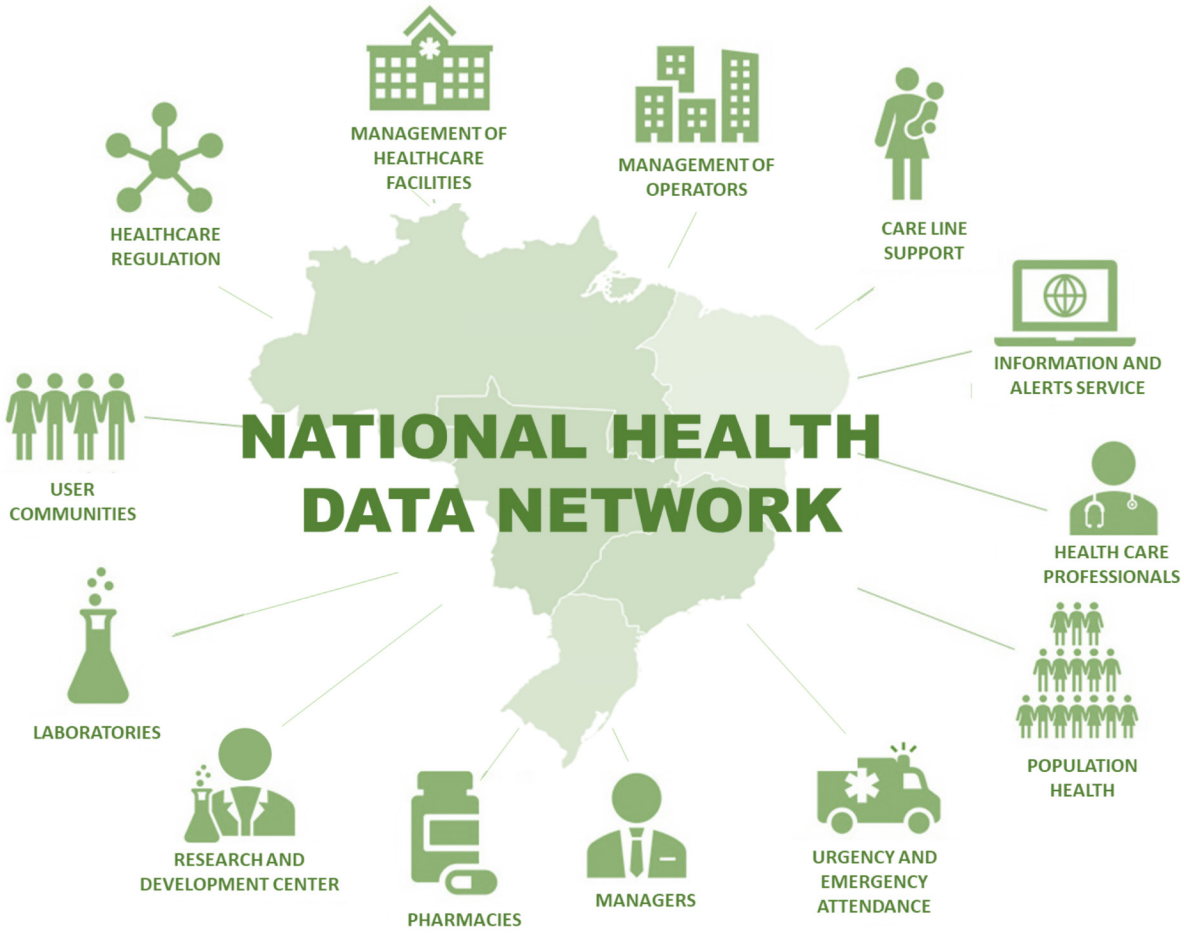


Figure 8. Human-centered design keyword map
Source Adapted from BRASIL (202?)

The aim of the Ministry of Health is that, by 2028, the RNDS will be recognized as the digital platform for innovation, information and health services throughout Brazil.

Digital transformation and integration of HCD for elderly digital inclusion

Zhou et al. (2022) argue that digital transformation can be analyzed using a framework that breaks down into three levels: macro (governance), meso (services), and micro (technology), to provide a holistic approach necessary for effective and comprehensive digital transformation.

It is possible to correlate the digital transformation proposed by Zhou et al. (2022) and the HCD (Figure 9) at three levels with respect to the digital inclusion of older people.

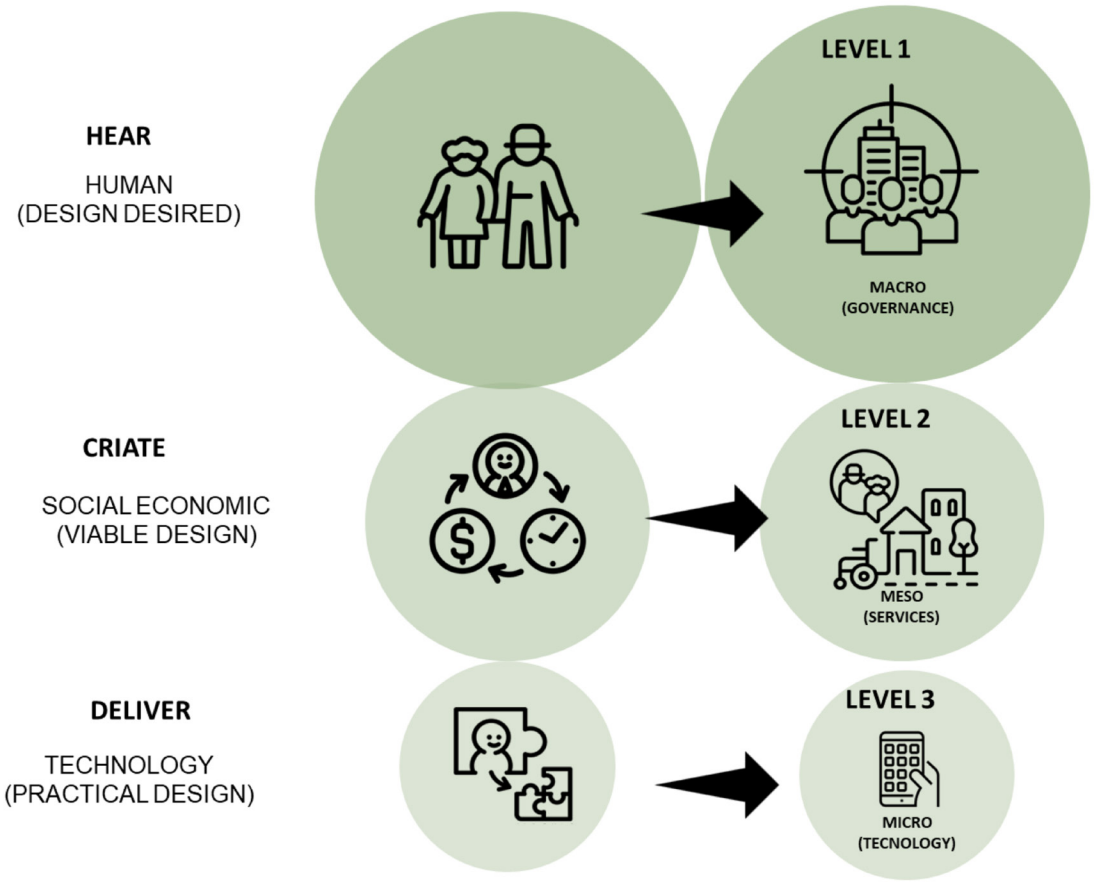


Figure 9. Digital transformation for digital inclusion by HCD

Source The authors (2024)

At the macro level, it highlights the importance of governments and institutions managing digital transformation for the digital inclusion of older people, providing a robust framework to support the transition to accessible and efficient digital services.

At the meso level, the focus is on the design of services, which need to be tailored to the specific needs of older people, ensuring that they are accessible, understandable and useful to this age group.

At the micro level, the focus is on technical elements to simplify interfaces, using methods adapted to the abilities and limitations of the elderly, with constant updating and evaluation to ensure that technologies remain relevant and accessible (Zhou et al., 2022).

In this sense, in the context of HCD, the input starts from listening to the target audience in order to create solutions, services, environments and products based on their priorities and needs, facilitating the acceptance of digital technologies.

Convergence of theory and practice: HCD in Public Health

The following are general considerations arising from the exercise proposed in the course, since the detailed results of the studies will be published by the respective students, authors of the research within the framework of the course.

The first case study

The first case study analyzes the accessibility of a municipal public health system app: The "Saúde Já Curitiba app", with the aim of identifying areas that need specific improvement, taking into account the needs of an aging population. The app allows users to book their first appointment at the municipal health center.

To access the service, the user must have an active registration with e-citizen, which is a single registration with the municipality that allows residents to use the digital services provided by the City Hall.

It was found that the interface needs many adaptations in terms of digital accessibility guidelines, which is essential to ensure that older people have equal access to digitized health services. This application is the only way to access the appointment service, such as dental appointments.

The registration process proved to be a barrier and a critical point. When the application is launched, the possibility of error, doubt, or complex action, such as having to navigate to another system to perform or complete an action, reduces accessibility and makes the application more susceptible to blocking due to validation errors.

Analyzing the user's journey through the application, especially for critical tasks such as scheduling vaccinations and issuing certificates, it is necessary to improve fluidity and simplicity, which can be achieved by reducing the number of steps and taps on the screen, enlarging and simplifying button labels.

This requires compliance with accessibility guidelines and interactive testing with older people. These actions can help identify and correct specific usability problems in the context of older people, taking into account the sensory losses associated with aging.

The results of the exercise suggest that it is necessary to invest in teaching older people how to navigate and use its functionalities in order to build a relationship of trust between the interface and older people. In addition, collecting post-use feedback will allow for continuous adjustments based on real-life experiences, promoting a human-centered digital health experience and increasing satisfaction and effectiveness for older people.

The findings suggest that human-centered approaches can be used to develop more user-friendly interfaces that take into account this audience's age and familiarity with technology.

This approach is particularly relevant in creating healthcare applications that meet the specific needs of older people, such as readability, navigability, and simplicity, increasing their satisfaction and consequently providing a more effective.

We can see that the students' findings support Harte et al. (2017), who argue that an approach based on Human Centered Design (HCD) is ideal for improving the usability of applications for older people, as it involves the study of their specific difficulties in practice and reveals opportunities that can be addressed through interface design solutions.

The second case study

The second case study assessed an app designed for scheduling appointments and exams at a University Hospital. The app aims to enhance and expedite healthcare for users of the Unified Health System (SUS) by enabling them to schedule and monitor appointments and exams from their cell phones and homes. (BRASIL, 2020).

In this case, the example is the application for scheduling return appointments, inter consultations and examinations provided by HU-UFMA in the city of São Luís, Maranhão, Brazil. The app doesn't allow to schedule your first appointment, which can only be done in person at the city's appointment center. Registration is done within the app, where can follow the four steps to manage appointments/exams: 1) request appointments/tests, 2) confirm attendance at scheduled appointments or tests, 3) validate scheduled/confirmed appointments and tests, and 4) track your appointment/test history (BRASIL, 2023).

Dissatisfaction was observed with the lack of service and feedback, which are crucial elements for usability, as defined by the ISO 9241-210:2019 standard. This lack of communication leads to a negative experience, increasing the feeling of anxiety due to the inability to complete tasks in the app.

The study pointed out that the application does not meet the expectations of the elderly, especially with regard to the ease of communication between patients and the healthcare providers, one of the essential functions of such applications.

In general, it was noted that the intention to reduce the digital divide of the elderly by bringing services to the "palm of their hand" does not necessarily mean that the proposed solutions are efficient and effective.

Recommendations for the acceptance of digital public services.

The following are recommendations (Figure 10) for the acceptance of digital technologies for use by low-income older adults by low-income seniors from the perspective of HCD in smart cities.

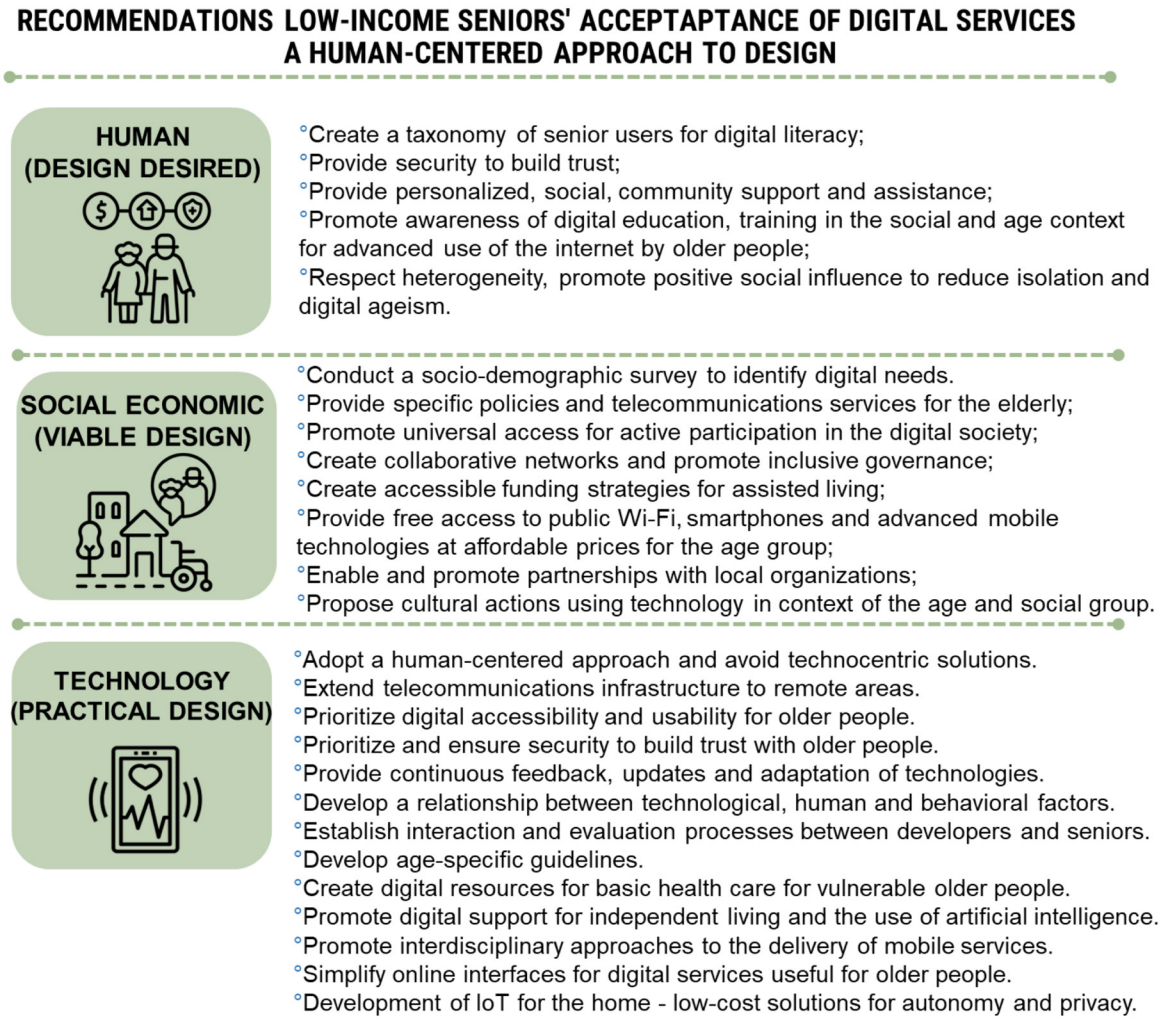


Figure 10. Recommendations categorized according to HCD

Source The authors (2024)

The list of recommendations has been divided into three categories aligned with the HCD, within the framework of desirable, economically viable and technically feasible design, based on the analysis of the theoretical reference and the case studies presented as a contribution to this study.

Final considerations

Based on the achieved results, three considerations were deemed most relevant.

The concepts of interaction, acceptance, and acceptance of digital technologies.

According to the Merriam-Webster dictionary, interaction refers to the action that occurs when individuals, groups, or systems communicate, relate, or engage in dialogue.

The acceptance of technology begins with a person's choice to acquire it for various reasons, such as need or entertainment. Acceptance is related to the perceived usability and usefulness of the technology (Li; Luximon, 2018).

The listed recommendations present the elements that make interactions friendly, usable, and useful from the perspective of older individuals. These aspects are delimited by the DCH based on the version presented by IDEO (2009), including human, socio-economic, and technical aspects.

Contributions to equity, accessibility, and inclusion of low-income seniors in smart cities.

There has been a proliferation of technological solutions to meet human needs. However, these solutions do not always translate into care for the elderly, particularly those with low incomes. This study provides recommendations that prioritize the needs of low-income seniors to facilitate their acceptance of digital technologies.

These recommendations can be applied to the development of digital services for this age group, ensuring that the solutions created are practical, viable, and desirable. Additionally, this study makes a valuable contribution to the field of design.

Convergences between theory and practice

By analyzing the case studies presented by the students of the class, it was possible to compare the data show from the two institutions. One located in the South of Brazil and the other in the Northeast, the results represent two different Brazilian populations and social realities, however, the problems are the same, as social and economic factors continue to affect access to digital services, especially for low-income seniors, regardless of location.

As a recommendation for future research, it is important to emphasize the need to evaluate these recommendations by applying them to projects involving low-income seniors in the context of smart cities. The recommendations based on Human Centered Design are a practical contribution to the field of design, considering that designers and public managers can use the recommendations as a basis for digital product and service projects aimed at the digital inclusion of low-income elderly people in the context of smart cities.

Finally, it presents an example of inter-institutional collaborative research between three Brazilian Federal Universities: UFPR, UFMA and UFMG, which can generate solutions that integrate academia and society.

Referências

ABNT - ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR ISO 9241-11. Requisitos ergonômicos para o trabalho com dispositivos de interação visual Parte 11: Orientações sobre usabilidade. Rio de Janeiro, 2011.

ABNT - ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR ISO 9241-210:2011. Ergonomia da interação humano-sistema. Parte 210: Projeto centrado no ser humano para sistemas interativos. Rio de Janeiro, 2011.

BRASIL. Ministério da Educação. HU-UFMA cria aplicativo para marcar retornos, interconsultas e exames. 2023. In: https://www.gov.br/ebserh/pt-br/hospitais-universitarios/regiao-nordeste/hu-ufma/comunicacao/noticias/hu-ufma-cria-aplicativo-para-marcar-retornos-interconsultas-e-exames

BRASIL. Ministério da Saúde. Boletins Conecte SUS 2020: A jornada da transformação digital do SUS. 2020. In: https://www.gov.br/saude/pt-br/composicao/seidigi/publicacoes/resumo-boletins-conecte-sus.pdf

BRASIL. Ministério da Saúde. Rede Nacional de Dados em Saúde. 202?. In: https://www.gov.br/saude/pt-br/composicao/seidigi/rnds

BROWN, Tim; WYATT, Jocelyn. Design thinking for social innovation. In: Development Outreach 12.1, 2010: 29-43. DOI:10.1596/1020-797X_12_1_29

CHAVES, Iana Garófalo; BITTENCOURT, João Paulo; TARALLI, Cibele Haddad. O design centrado no humano na atual pesquisa brasileira-uma análise através das perspectivas de klaus krippendorff e da IDEO. In: HOLOS, v. 6, p. 213-225, 2013. DOI: https://doi.org/10.15628/holos.2013.1560

FERREIRA, Diego Monteiro; VENTURELLI, Suzete. O design centrado no ser humano e os desafios para a interação humano-computador a partir da ISO 9241-210: 2019. In: DAT Journal, v. 7, n. 4, p. 106-123, 2022. DOI: https://doi.org/10.29147/datjournal.v7i4.559
GIACOMIN, Joseph. What is design for meaning? In: Journal of design, business & society 3.2 (2017): 167-190. DOI https://doi.org/10.1386/dbs.3.2.167_1.

GORICHANAZ, Tim. Toward Humanity-Centered Design without Hubris. In: arXiv preprint DOI: https://doi.org/10.48550/arXiv.2402.11576

HARTE, R., QUINLAN, L. R., GLYNN, L., RODRÍGUEZ-MOLINERO, A., BAKER, P. M., SCHARF, T., ÓLAIGHIN, G. Human-centered design study: enhancing the usability of a mobile phone app in an integrated falls risk detection system for use by older adult users. JMIR mHealth and uHealth, 5(5), e7046. DOI: 10.2196/mhealth.7046

HOODA, Apeksha; GUPTA, P.; JEYARAJ, A.; GIANNAKIS, M.; DWIVEDI, Y. K. The effects of trust on behavioral intention and use behavior within e-government contexts. In: International

Journal of Information Management, v. 67, p. 102553, 2022. DOI: https://doi.org/10.1016/j.ijinfomgt.2022.102553

IDEO. HCD: Human Centered Design. Kit de Ferramentas. E-book. 2. ed. San Francisco, 2009. In: https://www.ideo.com/journal/design-kit-the-human-centered-design-toolkit

KRIPPENDORFF, Klaus. Propositions of human-centeredness: a philosophy for design. In: Doctoral education in design: Foundations for the future: Proceedings of the conference held. Staffordshire (UK): Staffordshire University Press, 2000. p. 55-63.

LLORENTE-BARROSO, Carmen; SÁNCHEZ-VALLE, María; VIÑARÁS-ABAD, Mónica. The role of the internet in later life autonomy: Silver surfers in Spain. Humanities and Social Sciences Communications, v. 10, n. 1, p. 1-20, 2023. DOI: https://doi.org/10.1057/s41599-023-01536-x

LEMOS, A. Cidades inteligentes: De que forma as Novas tecnologias como a computação em Nuvem, o Big Data e a internet das coisas podem melhorar a condição de Vida nos espaços urbanos? In: GVexecutiVo. V 12. N 2 • Jul/Dez 2013. DOI: https://doi.org/10.12660/gvexec.v12n2.2013.20720

LI, Q.; LUXIMON, Y. Understanding Older Adults' Post-Adoption Usage Behavior and Perceptions of Mobile Technology. In: International Journal of Design [Online] 12:3. 2018. https://www.ijdesign.org/index.php/IJDesign/article/view/2869/837

MARIANO, Ari Melo; ROCHA, Maíra Santos. Revisão da literatura: apresentação de uma abordagem integradora. In: AEDEM International Conference. 2017. p. 427-442. https://www.pesquisatemac.com/o-uso-do-temac-na-pesquisa.

MENSAH, Isaac Kofi; MWAKAPESA, Deborah Simon. The impact of context awareness and ubiquity on mobile government service adoption. In: Mobile Information Systems, v. 2022, p. 1-20, 2022. DOI: https://doi.org/10.1155/2022/5918826

MERRIAM-WEBSTER DICTIONARY In: https://www.merriam-webster.com/

MULLICK, Maitrayee; PATNAIK, Archana. Pandemic management, citizens and the Indian Smart cities: Reflections from the right to the smart city and the digital divide. In: City, Culture and Society, v. 30, p. 100474, 2022. DOI: https://doi.org/10.1016/j.ccs.2022.100474

NEUMANN, S., BLEJA, J., KRÜGER, T.; GROSSMANN, U. Participating Citizens= Smart Citizens? Applying the Human-Centered Design Approach on a Digital Care Platform. In: Digital Government: Research and Practice. 2023. DOI: https://doi.org/10.1145/3604618

NGUYEN, T. X. H., TRAN, T. B. N., DAO, T. B., BARYSHEVA, G., NGUYEN, C. T., NGUYEN, A. H., LAM, T. S. Elderly people's adaptation to the evolving digital society: A case study in Vietnam. In: Social Sciences, 11(8), 324. 2022. DOI: https://doi.org/10.3390/socsci11080324

NORMAN, Donald A. Design for a better world: Meaningful, sustainable, humanity centered. MIT Press, 2023.

OLIVEIRA, R. D. de; BARBOSA, M. L. de A.; KLEIN, A. A.; KISTMANN, V. B.; OKIMOTO, M. L. L. R. Privacy by design and the privacy aspects of personal data in the context of inclusive design and services. In: DAT Journal, [S. l.], v. 7, n. 2, p. 179–197, 2022. DOI: 10.29147/datjournal.v7i2.613.

ROY, Souvanic. The smart city paradigm in India: Issues and challenges of sustainability and inclusiveness. In: Social Scientist, v. 44, n. 5/6, p. 29-48, 2016. http://www.jstor.org/stable/24890283

SANTOS, A. D. Seleção do método de pesquisa: guia para pós-graduando em design e áreas afins. Curitiba: Insight, 2018.

SHAMSUJJOHA, M., GRUNDY, J., KHALAJZADEH, H., LU, Q.; LI, L. Developer and End-User Perspectives on Addressing Human Aspects in Mobile eHealth Apps. In: Information and Software Technology, 166, 107353, 2024. DOI: https://doi.org/10.1016/j.infsof.2023.107353

TORCATE, Arianne Sarmento et al. Design Centrado no Ser Humano Aplicado a Projetos em Saúde: Panorama e Perspectivas. In: Anais do IV Simpósio de Inovação em Engenharia Biomédica-SABIO 2020, p. 37, 2020.

VENKATESH, Viswanath et al. User acceptance of information technology: Toward a unified view. In: MIS quarterly, p. 425-478, 2003. DOI: https://doi.org/10.2307/30036540

VERA-BACETA, Miguel-Angel; THELWALL, Michael; KOUSHA, Kayvan. Web of Science and Scopus language coverage. In: Scientometrics, v. 121, n. 3, p. 1803-1813, 2019. DOI: https://doi.org/10.1007/s11192-019-03264-z

WU, Qun; HUANG, Lan; ZONG, Jiecong. User Interface Characteristics Influencing Medical Self-Service Terminals Behavioral Intention and Acceptance by Chinese Elderly: An Empirical Examination Based on an Extended UTAUT Model. In: Sustainability, v. 15, n. 19, p. 14252, 2023. DOI: https://doi.org/10.3390/su151914252

YSTGAARD, K. F., ATZORI, L., PALMA, D., HEEGAARD, P. E., BERTHEUSSEN, L. E., JENSEN, M. R.; DE MOOR, K. Review of the theory, principles, and design requirements of human-centric Internet of Things (IoT). In: Journal of Ambient Intelligence and Humanized Computing, 14(3), 2827-2859. (2023). DOI: https://doi.org/10.1007/s12652-023-04539-3

ZHOU, Siyu; NI, Z., OGIHARA, A.; WANG, X. Behavioral patterns of supply and demand sides of health services for the elderly in sustainable digital transformation: A mixed methods study. In: International journal of environmental research and public health, v. 19, n. 13, p. 8221, 2022. DOI: https://doi.org/10.3390/ijerph19138221

Recebido: 25 de março de 2024
Aprovado: 12 de julho de 2024