Practitioners' Perceptions on Human-Centered Design Techniques in Digital Government Development

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Abstract. This paper focuses on the application of Human-Centered Design (HCD) techniques to enhance the agile requirements engineering process within the context of Brazilian Digital Government. Providing a public experience that prioritizes digital platforms represents a significant opportunity to improve citizens' quality of life by facilitating access to information and services. Our analysis is based on a case study conducted in a large Brazilian public company, where a survey was applied to assess the use of HCD techniques such as prototyping, usability testing, Design Thinking, personas, user journey mapping, UX Writing, and Plain Language. The survey results highlighted prototyping as the most widely used technique. There was a high perceived value for usability testing; however, barriers to its broader implementation may exist. Techniques such as persona creation, user journey mapping, and Design Thinking showed moderate usage, while UX Writing and Plain Language had low adoption rates. The adoption of these techniques may vary depending on team roles. Factors such as age group, role accumulation, and time within the company influence their application. The findings reinforce the need to expand HCD training, especially for underutilized techniques, to maximize their benefits within the agile requirements engineering process. This effort can contribute to improving project efficiency and enhancing the quality of digital services in the governmental context.

Keywords. Digital Government, Human-Centered Design, Agile Requirements Engineering, Prototyping, Usability Testing, Personas, User Journey, Plain Language, Design Thinking, UX Writing, Industry Case.
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1. Introduction

The digital revolution is profoundly transforming public administration, gradually redefining the services offered by the State. This process brings challenges and demands that evolve as technologies become more advanced. At the core of this transformation is a citizen-oriented and citizen-driven model, in which users are no longer mere passive recipients of services but become co-creators of these solutions. This is a comprehensive digitalization effort that goes beyond seeking operational efficiency to promote the collaborative development of public services (Viana, 2021).

This movement requires the alignment of institutions, organizations, people, technologies, data, and resources to achieve significant change in both the public sector and society. More than just technological innovation, it represents a true shift in mindset aimed at generating public value and building a more inclusive, participatory, and effective government (Viana, 2021).

The Organization for Economic Co-operation and Development (OECD) defines digital government as the use of digital technologies to modernize government operations, aiming to generate public value. Unlike e-government, which focuses on the use of Information and Communication Technologies (ICT) to enhance operational efficiency and governance methods, digital government proposes a broader evolution. It promotes a paradigm shift by transforming service delivery and governmental processes into "digital by design" practices (Gardenghi et al., 2020).

According to the Brazilian Government GOV.br (2023), user-centered services are those that: i) are easy to find and understand; ii) require the least number of steps possible; iii) are accessible to everyone who needs to use them; iv) function in a way that feels familiar to the user; v) are consistent throughout the entire digital journey (not just parts of it). Understanding users' needs and promoting service quality assessments are essential for public acceptance (GOV.br, 2023).

In this context, Requirements Engineering becomes crucial for the production of quality software, with Human-Centered Design (HCD) practices supporting the process by helping to understand users' needs (Carreira et al., 2022; Neto et al., 2020; Pedrosa et al., 2022; Pereira & Marczak, 2020; Santos et al., 2022). ISO 9241-210:2019 (International Organization for Standardization, 2019) defines HCD as an approach to system design and development that aims to make interactive systems more usable by focusing on system usage and applying knowledge and techniques from human factors, ergonomics, and usability. Although the term "human-centered design" emphasizes the impact on a wide range of stakeholders—not just direct users—the terms "user-centered" and "human-centered" are often used interchangeably.

Additionally, there is a growing emphasis on the use of agile methodologies, as established by Ordinance SGD/MGI 750 of the Secretariat of Digital Government of the Ministry of Management and Innovation in Public Services (PortariaSGD750, 2023). This ordinance recommends adopting a software development process segmented into short iterations, frequent deliveries, and well-defined scopes. In this agile context, Requirements Engineering can integrate HCD to address challenges such as the lack of formal documentation and ensure a proper understanding of customer needs (Keshk et al., 2022).

Although there is extensive research correlating Requirements Engineering with HCD techniques such as prototyping (Bjarnason et al., 2021), usability testing (Keshk et al., 2022), personas (Pinheiro et al., 2019), user journey mapping (Carlos Filho et al., 2021), and Design Thinking (Pereira & Marczak, 2020), there is a noticeable lack of studies focusing on government projects. This work aims to advance the understanding of the integration of Agile Requirements Engineering and HCD techniques through a case study in a Brazilian public company that develops systems used by citizens. The purpose of this case study is to encourage system development teams to adopt HCD techniques, promoting the improvement of the quality of digital services widely used by society.

The remainder of the paper is organized as follows: Section 2 presents the theoretical foundation; Section 3 discusses related work; Section 4 describes the methodology used; Section 5 presents the results obtained; and finally, Section 6 provides final considerations and suggestions for future work.

2. Theoretical Framework

This section provides an overview of Human-Centered Design (HCD) and Agile Requirements Engineering.

2.1. Human-Centered Design

According to Grilo (2019), HCD emerges as an approach in which product decisions are guided by the diverse characteristics of the target audience. Human-centered design involves understanding experiences and narratives related to the circumstances users face (Grilo, 2019).

User-centered thinking is a powerful tool for creating innovative products. To ensure that systems provide meaningful experiences, it is crucial to understand what people seek and what motivates them. A product should be a direct solution to users' problems.

According to International Organization for Standardization (2019), User Experience (UX) encompasses users' perceptions and responses resulting from the actual and/or anticipated use of a system, product, or service. These perceptions and responses include users' emotions, beliefs, preferences, perceptions, comfort, behaviors, and accomplishments before, during, and after use.

HCD shifts the focus to human aspects. Ignoring these principles may lead to consequences such as: (i) lack of product or service adoption; (ii) switching to competitors; (iii) increased training and support costs; (iv) inefficiency in usage; and (v) user dissatisfaction and operational errors (Venson et al., 2022). The following sections describe some techniques associated with HCD.

2.1.1. Prototyping

A prototype is a sample, model, or initial release that simulates one or more aspects of the final product (Olsen, 2015). Prototyping is a requirements engineering practice that allows obtaining feedback on requirements directly from the client. According to Warfel (2011), the requirements process with prototyping significantly contributes to reducing inefficiencies and waste, standing out for the following benefits: (i) reduction of misinterpretation; (ii) tangible experience; (iii) resource savings; (iv) interdisciplinary engagement; (v) exploration of alternatives; (vi) product focus; and (vii) early identification of errors.

Applying prototyping in the early stages of product development offers several benefits, such as testing ideas, avoiding misunderstandings, encouraging constructive criticism, and involving professionals from all sectors related to the product's lifecycle. It is essential to conduct early testing, without waiting for the software to be fully completed. On the contrary, the earlier these tests are conducted, the greater the chances of identifying and correcting issues before investing unnecessary time and resources. Including wireframes alongside a requirements document can increase the accuracy of a written requirement by up to 80% (Warfel, 2011).

However, there is a misconception that using prototypes delays the process by consuming time with simulations. In practice, prototyping accelerates results by enabling learning through trial and error, while facilitating decision-making about which direction to follow (Olsen, 2015).

2.1.2. Usability Testing

Usability testing is one of the most widely used and well-known research techniques in the context of Human-Centered Design (HCD) (Nielsen, 2012). According to ISO9241-11 (2018), usability is defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction.

Usability testing is a valuable tool for evaluating products by involving real users interacting with the designed solution. It analyzes user behavior, actions, and movements, linking their verbal expressions to their reactions regarding the product (Grilo, 2019). The use of prototypes and usability testing is recommended in the literature as an effective strategy to mitigate failures in software projects (Lauesen, 2020).

2.1.3. Design Thinking

Design Thinking (DT) has stood out as an effective approach to help developers better understand users' real needs by leveraging empathy, creativity, and rationality. DT is user-centered and aims to solve complex problems through innovation and iteration (Parizi et al., 2022).

Research conducted by Pereira et al. (2021) indicates that DT improves requirements gathering and specifi-

cation, promoting greater collaboration, communication, and understanding of user needs. Rapid prototyping and a human-centered focus present a promising approach to dealing with ambiguous and volatile requirements from various project stakeholders (Hehn et al., 2019).

However, challenges persist, including a lack of appreciation for the approach, insufficient time to explore user needs, a shortage of experienced professionals in DT, and low stakeholder engagement. Research by Canedo et al. (2022) has shown that developers' lack of knowledge limits the adoption of DT in industrial practice.

2.1.4. Personas

The personas technique is a user-centered approach used to explore and organize data about end-users (Pinheiro et al., 2019). Personas are fictional, specific, and detailed representations of target users. They provide a clear identity for the user, creating a memorable, engaging, and actionable image that serves as a focal point for the design process (Pruitt & Adlin, 2010). Furthermore, personas communicate information more effectively than other artifacts, helping the product team and organization stay focused on users' needs and expectations.

According to Pruitt and Adlin (2010), the application of personas provides the following benefits: (i) exploration of assumptions and knowledge; (ii) user focus; and (iii) generation of empathy.

Although personas offer a wealth of qualitative data, their traditional creation requires significant time and effort in data collection, making it a costly technique. As an alternative, (Pinheiro et al., 2019) propose the use of proto-personas. This agile approach allows designers and developers to quickly create personas based on prior knowledge of the target audience.

2.1.5. User Journey Mapping

According to Melo and Abelheira (2015), User Journey Mapping is used to deepen the understanding of an experience by analyzing its positive and negative aspects along a timeline. A user journey map should illustrate a specific journey for a persona, incorporating elements such as feelings or emotions, needs, barriers, and other relevant metrics aligned with the organization's goals (Carlos Filho et al., 2021).

This technique enables the identification of requirements from the user's perspective, which differentiates it from other approaches. Insights derived from user observations or statements can reveal valuable opportunities (Carlos Filho et al., 2021).

2.1.6. UX Writing

UX Writing is the process of creating text that shapes user interactions with an interface. This includes elements such as titles, buttons, labels, instructions, descriptions, notifications, alerts, and controls visible to the user. The process begins by identifying the project's purposes, opportunities, and constraints. Before writing, the professional must understand both the users' and the organization's goals (Podmajersky, 2019).

To define these goals, the writer collaborates with experts who understand them and with the users themselves, always in a co-creation process. From the early stages of ideation and development, the writer should actively participate in team meetings, contributing to the discovery, design, and refinement of the experience. UX Writing is thus an iterative process involving creation, evaluation, and continuous improvements.

Besides being a key component in product design and development, UX Writing aims to create content that guides users throughout their interactions, providing a more fluid and satisfying experience. According to Lentez and Mager (2023), this work not only improves navigation but also increases user engagement and satisfaction, enhancing the product's success. However, it requires a deep understanding of the target audience, the product or service, and the context in which they will be used (Lentez & Mager, 2023). UX Writers must balance clarity, conciseness, and personality to meet user expectations and organizational goals.

2.1.7. Plain Language

The Plain Language technique aims to make information more understandable to everyone, reducing barriers to inclusion (Oliveira et al., 2023). Clear comprehension is essential, especially when presenting information intended for citizens. Complex texts can pose a significant barrier to interacting with e-government systems, particularly in contexts with low literacy levels and limited access to support resources. The writing style commonly associated with the public sector often uses dense and complex linguistic constructions, making reading and comprehension difficult (Fischer et al., 2019).

Plain Language seeks to promote universal accessibility by creating clear texts that can be easily understood by people with different literacy levels (Fischer et al., 2019). When applied to Requirements Engineering, it can improve communication among developers, stakeholders, and end-users. Its application spans various areas, including technical documentation, user interfaces, and user stories.

2.2. Agile Requirements Engineering

The study by Lauesen (2020) revealed that the main cause of failures in projects is related to requirements. Missing, ambiguous, or incomplete requirements can result in errors in the final system, rework, customer dissatisfaction, and schedule delays. Gralha et al. (2018) highlighted that the requirements process has significant impacts on the product, the team, and the organization. Agile requirements engineering faces challenges such as: Insufficient user stories to adequately communicate the requirements, Interpretation errors and lack of understanding of the requirements and Requirement changes during development.

2.3. Related Work

This section provides a review of previous research related to the theme of this work. Various approaches integrating agile requirements engineering and Human-Centered Design (HCD) have been discussed in the literature, describing their relationships, challenges, and difficulties.

The study by Kusuma et al. (2024) proposes the Emotion Map to capture emotions during requirements elicitation, contributing to more adequate specifications. Another study by the same authors highlights methods such as interviews and usability testing to integrate UX into requirements engineering, emphasizing the benefits of reducing errors and improving software quality (Kusuma et al., 2023).

Techniques like lean persona, addressed by Teixeira and Zaina (2022), help document requirements in both startups and established companies. (Martinelli et al., 2022) show the importance of clear and measurable acceptance criteria to ensure user satisfaction. A. B. Marques et al. (2022) analyze the incorporation of usability into user stories in remote agile environments, highlighting communication and collaboration challenges.

Approaches such as those by Keshk et al. (2022) integrate prototypes and user stories into the agile flow to improve the clarity of requirements. Parizi et al. (2022) explore the application of Design Thinking (DT) in defining requirements, facing challenges in integrating with agile methods. Studies by Zorzetti et al. (2022), Zorzetti et al. (2020), and Machado et al. (2020) discuss the combination of HCD and Lean Startup with agile methodologies, promoting rapid adaptation and continuous feedback.

Other works, such as those by Bjarnason et al. (2021) and Pereira et al. (2021), propose frameworks and standards to guide teams in incorporating UX into agile requirements. Souza et al. (2020) present a recommendation tool to support the teaching of DT in requirements elicitation. Almeyda et al. (2021) analyze the integration of UX with agile methods, highlighting benefits such as more intuitive products and challenges such as resistance to change.

Parizi et al. (2021) and Carlos Filho et al. (2021) propose tools to recommend DT techniques and improve the specification of requirement scenarios. L. Marques et al. (2020) explores the post-interaction journey to map the user experience and identify improvements. Cleto Filho and Zaina (2020) discuss the integration of UX into user stories in remote agile environments. Studies also address how clients can contribute to defining requirements through proto-personas, enriching communication between stakeholders (Pinheiro et al., 2019). The studies presented explore how Human-Centered Design (HCD) practices can mitigate challenges

found in agile requirements engineering. This work distinguishes itself by analyzing the context of government projects, which bring specific challenges and scenarios.

The previously mentioned works do not consider the environment of a large public enterprise. In the case of agile process models, organizational culture influences the effectiveness of applying agile practices (Looks et al., 2024). Moreover, in the public sector, software development often occurs through external contracts (Looks et al., 2024).

3. Methodology

This work was conducted in 2024 at an information technology company within the Brazilian Federal Public Administration. The company has national presence, a robust technological infrastructure, and extensive experience with large systems. For over 50 years, it has developed solutions that enable control, transparency, and simplify the relationship between society and the government. Information was collected to assess the company's current scenario regarding the use of HCD techniques in the requirements engineering (RE) process, through the application of a questionnaire.

The questionnaire was developed based on the perceptions collected by the author in the daily work environment. The main objective was to assess the application of the studied techniques and the value perceived by participants in relation to them. To achieve this, questions were formulated to capture both the frequency of use of the techniques and the perception of their usefulness and impact. The questions are driven by the goal of understanding the adoption of the investigated practices within the participants' context.

To ensure that the questionnaire items adequately cover the construct we aim to measure, it was reviewed by two expert professors who are co-authors of this study. Additionally, it underwent a preliminary validation with a colleague from the company, who assessed the clarity and comprehensibility of the questions. The questionnaire was approved by the Research Ethics Committee with Human Beings. The academic research was authorized by the company.

3.1. Questionnaire design

The instrument used for data collection was a structured questionnaire with both closed and open-ended questions, divided into two sections: demographic information and participants' perception of the use of Human-Centered Design techniques. Below are the main questions:

- Demographics (Years in the company, Gender, Age)
- What role do you perform in your team?
- How much experience do you have with Requirements Engineering activities?
- How much experience do you have with User Experience activities?
- Have you applied or used the results of any of the following techniques: Persona Creation, User Journey, Design Thinking, Prototyping, User Testing, UX Writing, or Plain Language?
- Which of these techniques have you applied or used the results of?
- To what extent do you find these techniques valuable when used in the requirements engineering process?
- What benefits did you observe from applying these approaches?
- What limitations/drawbacks did you observe in these approaches?

The data analysis scope for this article focuses exclusively on the closed-ended questions. We invited software engineering practitioners to participate. The target population comprised 200 employees, with invitations sent via email. The research received 166 responses.

3.2. Data analysis

The data description utilized frequency tables displaying absolute values, percentages, and response rates by category for variables allowing multiple selections. To verify the relationship between team roles and the use or non-use of the studied techniques, a logistic model was constructed due to the possibility of multiple roles

within the team. The goodness of fit was checked using the Hosmer and Lemeshow Test, and the explanatory power was assessed using the Nagelkerke coefficient.

To check the association between categorical variables, the Chi-square Test was used, followed by a post hoc multiple comparisons test with Bonferroni adjustment to identify differences in variables with more than two levels. To verify the relationship between the values assigned to the techniques and other variables, the Cochran-Armitage Test (linear trend test) was used, as both the response and explanatory variables are ordinal. In cases of statistically significant differences, the Kendall Tau Correlation Coefficient was also calculated to identify possible monotonic trends in the levels of the explanatory variable. IBM SPSS Statistics 20 was used for the analysis. Due to the exploratory nature of the study in the field, where the effects may be subtler, the significance level adopted throughout the analysis was 10%.

3.3. Participants and sampling

In order to characterize the sample and examine the behavior of categorical variables, Table 1 presents the absolute and relative frequencies. Table 1 describes the participants' profile, highlighting that the majority have been with the company for more than 10 years (61.45%). The predominance of men (75.90%) is evident. Regarding age, the most represented range is between 36 and 45 years (34.34%). Nearly half of the respondents (47.59%) hold more than one role in the team. The "Implementer" role is the most common, practiced by 61.45% of individuals, followed by "Requirements Analyst" with 40.96%.

Tab. 1 – Data description.

Variables	Freq. Absolute	Freq. Percentage	Respondents (%)
How many years have you been with the company?			
Less than 1 year	63	37.95	-
From 1 to 2 years	1	0.60	-
More than 10 years	102	61.45	-
Gender			
Man	126	75.90	-
Woman	38	22.89	-
I prefer not to say	2	1.20	-
Age			
18-25	12	7.23	-
26-35	30	18.07	-
36-45	57	34.34	-
46-55	39	23.49	-
Over 55	28	16.87	-
Do you take on more than one role on the team?			
Yes	79	47.59	
No	87	52.41	
Role in the team			
Requirements Analyst	68	21.05	40.96
Function Point Estimator	38	11.76	22.89
Manager	27	8.36	16.27
Implementer	102	31.58	61.45
UX Designer	25	7.74	15.06
Tester	52	16.10	31.33
Other	11	3.41	6.63

4. Results

Table 2 presents the description of the variables related to the design capabilities studied. Based on the analysis of Table 2, it is highlighted that 63.25% of participants have applied or used the results of design techniques, with "Prototyping" (59.64%) being the most used, followed by "User Testing" (34.34%). Regarding experience, 43.37% have no experience in UX activities. For Requirements Engineering, 30.72% have more than 10 years of experience.

Tab. 2 – Description of data related to the design capabilities studied.

Variables	Freq. Absolute	Freq. Percentage	Respondents (%)
Time of experience with Requirements Engineering activities			
None	54	32.53	-
Up to 2 years	32	19.28	-
3 to 5 years	16	9.64	-
6 a 10 years	13	7.83	-
More than 10 years	51	30.72	-
Time of experience with User Experience (UX) activities			
None	72	43.37	-
Up to 2 years	55	33.13	-
3 a 5 years	32	19.28	-
6 a 10 years	5	03.01	-
More than 10 years	2	1.20	-
Which techniques below have you already applied or used the results?			
Personas	54	17.03	32.53
User Journey	48	15.14	28.92
Design Thinking	27	8.52	16.27
Prototyping	99	31.23	59.64
User Testing	57	17.98	34.34
UX Writing	11	3.47	6.63
Plain Language	21	6.62	12.65
Value Personas			
Very low	4	4.21	-
Low	25	26.32	-
High	41	43.16	-
Very high	25	26.32	-
Value User Journey			
Very low	3	3.23	-
Low	4	4.30	-
High	40	43.01	-
Very high	46	49.46	-
Value Design Thinking			
Very low	2	2.38	-
Low	8	9.52	-
High	38	45.24	-
Very high	36	42.86	-
Value Prototyping			
Very low	1	0.97	-
Low	0	0.00	-
High	23	22.33	-
Very high	79	76.70	-
Value Testing with Users			
Very low	2	2.20	-
Low	4	4.40	-
High	23	25.27	-
Very high	62	68.13	-
Value UX Writing			
Very low	4	5.71	-
Low	17	24.29	-
High	34	48.57	-
Very high	15	21.43	-
Value Plain Language			
Very low	2	2.70	-
Low	14	18.92	-
High	36	48.65	-
Very high	22	29.73	-

To identify which roles within the company might be linked to a higher use of the discussed methods, Table 3 was developed. The logistic model displayed below models the variable "Uses any of the mentioned techniques?" based on variables related to the roles held within the company. Table 3 shows that the majority of individuals, regardless of the role assumed, have used or applied the results of some HCD technique. It can also be observed that some roles significantly alter the likelihood of being classified as a user of the mentioned techniques. Individuals who are Requirements Analysts are twice as likely to be users of these techniques (compared to those who do not hold this role). Similarly, Function Point Estimators are 3.239 times more likely, and Managers are 2.987 times more likely to be users of some of the techniques. On the other hand, Implementers are 61.4% less likely to use the aforementioned techniques. The model shows a good fit (p-value = 0.922) and explains 38.7% of the variability in the response variable.

Tab. 3 – Logistic Model with explanatory dummies defined based on the variable "Role in the team".

Role in the team	Use techniques		( )	DP	P-value	Exp( )
	Yes	No				
Requirements Analyst	54	14	0.693	0.411	0.092	2.000
Function Point Estimator	34	4	1.175	0.633	0.064	3.239
Manager	22	5	1.094	0.519	0.035	2.987
Implementer	54	48	-0.488	0.246	0.047	614
UX Designer	25	0	20.326	7327.391	998	> 100
Tester	39	13	0.206	0.440	0.640	1.228
Percentage of correct predictions	76.2	62.3	Média = 71.1			
Nagelkerke = 0.387						
P-value = 0.922 (Hosmer test and Lemeshow)						

To verify the relationship between the use or non-use of the studied techniques and other categorical variables, Table 4 was developed. It is important to note that one individual was excluded from the analysis when crossing "How many years have you been with the company?" with "Uses any of the mentioned techniques?", as they were the only representative of their level in the table, which did not provide useful information, violated the test assumptions, and inflated the p-value.

We observed that individuals with more than 10 years in the company are more likely not to use the techniques (71 out of 102). Individuals in the age range of 26 to 35 years are more likely to adopt the techniques. Those who perform more than one role in the team significantly use the techniques more ($p < 0.0001$). In this context, potential relationships between the assigned values and other variables of interest were analyzed. No relevant associations were identified between team roles and the value assigned to the techniques of Design Thinking, User Journey, User Testing, UX Writing, Plain Language, and Persona Creation.

However, Table 4 reveals a significant association for the Implementer role with the Prototyping value ($p = 0.026$; Tau = -0.216). This suggests that implementers are less likely to value this technique. On the other hand, Requirements Analysts show a positive trend, although marginally significant ($p = 0.084$; Tau = 0.237), indicating a higher valuation of this technique.

5. Discussion

5.1. Demographic Data

The respondent profile is predominantly male, in the age range of 36 to 45 years. The male predominance may reflect a historical pattern in the Information Technology field, where men have traditionally occupied most positions. Despite efforts to increase diversity, female representation is still lower in many parts of the world. The age range of 36 to 45 years may indicate a significant presence of professionals with established experience. This result could lead to discussions about workplace diversity, as well as gender and age.

The high frequency of the "Implementer" role may indicate that the organization is focused on technical execution and software development. This suggests that the organization places emphasis on the technical delivery

Tab. 4 – Relationship between use of techniques and other variables of interest.

Variable	Use techniques Yes	No	P-value	Groups**
How many years have you been with the company?				
Less than 1 year	30	33	0.0393*	-
More than 10 years	31	71		-
Age range				
18-25	5	7	0.0132*	ab
26-35	18	12		b
36-45	18	39		ab
46-55	8	31		a
Over 55	12	16		ab
Has more than one role in the company?				
Yes	63	16	<0.0001*	-
No	42	45		-

of solutions, with a workforce concentrated on "making things happen."

The high incidence of Requirements Analysts may point to a concern with the elicitation and definition of requirements. This is a positive sign of maturity in software development processes, as it indicates attention to the early stages of the system life cycle, when requirements are gathered, analyzed, and validated. The relevance of requirements analysts may signify that the organization recognizes the importance of understanding the client's problem.

5.2. Use of HCD Techniques

Table 2 shows the design techniques adopted by the participants. The analysis of some aspects is as follows:

High adoption of design techniques (63.25%). An adoption rate above 60% indicates that the techniques are relevant and applicable to the participants' work.

Prototyping as a highlight (59.64%). The use of prototyping as the most applied technique is a positive indicator, as it allows for the quick visualization and testing of solutions, reducing risks in development and improving the quality of deliveries as pointed out by Bjarnason et al. (2021).

User Testing (34.34%). Although less used by participants than other techniques, user testing is a relevant technique for validating designed solutions based on real feedback. Its adoption demonstrates that participants are also concerned with the end-user experience. These findings are consistent with the studies by Kusuma et al. (2023). However, the significant difference between the use of prototyping (59.64%) and user testing (34.34%) may indicate barriers to implementing user testing. Possible reasons could include: (i) difficulty in accessing representative users; (ii) additional costs and resources required to organize tests; (iii) lack of familiarity or confidence in the technique as listed in the challenges of the work by Kusuma et al. (2023).

Moderately used techniques. Results placing Persona Creation (32.53%), User Journey (28.92%), and Design Thinking (16.27%) at a moderate level suggest some reflections on their application. Some participants are applying the Persona Creation and User Journey techniques, indicating recognition of their value, but the percentages suggest that not all projects or teams see them as essential. Their application might be viewed as relevant only in specific contexts. The even lower adoption of Design Thinking suggests difficulties in its incorporation into daily work. These techniques may be seen as time-consuming or complex, especially in contexts with tight deadlines and lean teams. There may be a misalignment with the reality of the projects, which requires adaptations to make them more relevant, as proposed by Pereira and Marczak (2020).

Less used techniques. The fact that the least used techniques are UX Writing (6.63%) and Plain Language (12.65%) may indicate challenges in their application. These techniques have a qualitative impact (improved communication, greater clarity for users), which may make it harder to prioritize them compared to techniques with a more direct impact, such as prototyping. Below is the analysis of some of these challenges:

- **Limited familiarity with the techniques.** These techniques may be less known to the participants, making their application in daily work more difficult.
- **Perception of relevance.** Participants may not perceive the relevance of these techniques for their activities and may be unaware of the results they can yield.
- **Lack of resources.** Implementing these practices may require cultural or organizational changes, such as greater collaboration between teams or process adaptations.

5.3. Perception of Value of HCD Techniques

The percentages presented for the value attributed to the techniques reflect the different impressions participants have about their importance. The main points are as follows:

High Perception of Value for Prototyping and User Testing. Prototyping (76.70%) is the technique with the highest perceived value, indicating that participants recognize the effectiveness of visualizing and testing solutions before implementation as addressed by Keshk et al. (2022). This result aligns with its high adoption rate (59.64%), reinforcing the connection between perceived value and actual use. The perception of value is also high for User Testing (68.13%), suggesting that participants recognize its impact. Despite this, its practical adoption (34.34%) is lower, implying that there may be barriers to its implementation.

Intermediate Perception of Value for Persona Creation and User Journey. The perception of value for Persona Creation (26.32%) may indicate that participants struggle to directly link personas to project outcomes. Some may view it as a theoretical exercise. The User Journey (49.46%) is rated higher than Persona Creation. This could be because mapping the journey provides more visible insights into touchpoints and opportunities for improvement.

Low Perception of Value for UX Writing and Plain Language. The values attributed to UX Writing (21.43%) and Plain Language (29.73%) suggest that participants may not fully understand the importance of these techniques in creating clear and effective communication.

5.4. Use of HCD Techniques According to the Role in the Team

Regarding the use of HCD techniques based on the role within the team, there is high adoption among Requirements Analysts, Function Point Estimators, and Managers. However, there is low adoption among Implementers. Below is an analysis of the results:

High Adoption Among Requirements Analysts, Function Point Estimators, and Managers

- Requirements Analysts (2x more likely). Since these professionals are directly involved in the elicitation, definition, and documentation of requirements, it is natural for them to see more value and applicability in design techniques, especially those focused on the user, such as prototyping, persona creation, and user journey. This suggests that the techniques align well with the responsibilities of those in this role.
- Function Point Estimators (3.239x more likely). This group is often involved in measurements that assess complexity and development effort. Design techniques can be seen as useful tools for refining requirements, making estimates more accurate. The high adoption rate may indicate that these professionals recognize the impact of these techniques on scope definition and reducing ambiguity.
- Managers (2.987x more likely). Managers tend to value tools that help align expectations with stakeholders, reduce risks, and improve value delivery.

Low Adoption Among Implementers (61.4% less likely)

- Distance from the design process. Implementers may feel less connected to the design process or view these techniques as outside their main responsibilities. This could reflect a traditional division between design and implementation, where implementers are more focused on technical execution.
- Lack of visibility of the impact. These professionals may not perceive how design techniques can directly benefit their work.
- The data highlights that design techniques are more widely used by those directly involved in defining requirements or managing projects, while those focused on implementation tend to underuse them.

5.5. Factors Influencing the Application or Use of Technique Results

Table 4 provides insights into the factors influencing the adoption of design techniques. The analysis is divided into three main perspectives: age group, role accumulation, and years with the company.

1. Greater Adoption in the 26 to 35 Age Group

- Possible correlation with experience and flexibility. Individuals in this age group may be at the beginning or peak of their careers, where: (i) they are more exposed to new trends, practices, and work methodologies, and (ii) they demonstrate a greater willingness to experiment and apply innovative techniques.
- Recent academic training. This generation may have had more exposure to design techniques during their education, making them more familiar with them.

2. Greater Use of Techniques by Those Playing Multiple Roles

- Holistic view of the project. Individuals with multiple roles have a broader understanding of the processes and needs of the project, which facilitates the adoption of techniques that connect different areas.
- Need for adaptation. The multiplicity of functions requires these professionals to seek more efficient solutions.
- Autonomy and decision-making. These professionals likely have more responsibilities within the project, motivating them to adopt tools that can generate better results.

3. Lower Use of Techniques Among Individuals with More Than 10 Years in the Company This presents an interesting contrast with the previous results. We suggest some possibilities for this difference:

- Resistance to change. Professionals with more years in the company may be more accustomed to established practices, showing resistance to adopting new approaches. This may include the perception that the proposed changes are unnecessary in relation to what already works well.
- Less exposure to recent training. Individuals with more time in the organization may have had less access to recent training that emphasizes these techniques.

5.6. Factors Influencing the Perception of Value of the Techniques

The result that implementers are less likely to value the technique and that requirements analysts show a positive trend may indicate:

Differences in Responsibilities and Focus of Roles. Implementers are more focused on the technical execution of solutions and code implementation rather than delving into user-centered design practices or early planning stages. Since these techniques are applied during the initial phases of the development cycle, implementers may view them as less relevant to their work.

Role of Requirements Analysts. Requirements analysts play a key role in translating user needs into technical requirements. This makes design techniques directly applicable to their work. Design techniques help better understand user requirements, aligning well with their responsibilities. This alignment tends to promote the appreciation of these techniques. The "marginally significant" trend may suggest that, while they recognize the benefits, the adoption of these techniques might not be as robust. Other more traditional approaches may still be perceived as sufficient or more practical.

These results indicate that, while requirements analysts recognize the utility of design techniques, implementers may need more convincing regarding the importance of these techniques in the development cycle. Thus, the findings of this research are consistent with the related works previously discussed, reaffirming the relevance of HCD techniques in supporting Agile Requirements Engineering. However, this study advances the field by deepening the analysis of how these techniques are used and perceived, specifically considering the role taken by each team member within the projects. Furthermore, it contributes by discussing the factors that influence this usage and the perceived value attributed to the techniques, framing these analyses within the specific context of governmental projects. It is therefore expected that the results presented here can support both theoretical reflection and practical application in similar environments, broadening the understanding of HCD implementation in complex and challenging organizational contexts.

6. Conclusion

The research revealed significant adoption of Human-Centered Design (HCD) techniques in the organization analyzed, demonstrating that these methods are considered relevant and applicable to the participants' work and can bring substantial improvements to digital government initiatives. Among the techniques, prototyping emerged as the most widely used, reinforcing its effectiveness. User testing also shows good usage, although there may be barriers to its broader implementation.

Techniques such as Persona Creation, User Journey Mapping, and Design Thinking showed moderate usage, while techniques like UX Writing and Plain Language had low application, indicating opportunities for greater dissemination and training in these areas. The perception of the techniques' value was aligned with their frequency of use, highlighting a direct relationship between practical application and recognition of benefits.

The analysis also revealed that the adoption of techniques varies depending on the roles played within the team. Requirements Analysts, Function Point Estimators, and Managers demonstrated high adoption, while Implementers showed lower application, likely due to differences in responsibilities and focus. In addition, factors such as age, role accumulation, and time in the company influence the application of the techniques.

In summary, the results reinforce the importance of expanding HCD training, particularly for groups with lower adoption and promoting underutilized techniques to maximize benefits in the Agile Requirements Engineering process. Aligning responsibilities, demonstrating how each role within the team can benefit from HCD techniques, fostering a collaborative environment, and reinforcing how these practices contribute to the entire development cycle can encourage broader adoption.

In future work, we propose to conduct focus groups to deepen the discussions based on the responses obtained from the questionnaire, allowing for a more comprehensive understanding of the investigated aspects. The composition of these groups should consider the diversity of participants—in terms of roles, experiences, and organizational contexts—to ensure multiple perspectives on the topics addressed. Additionally, we intend to further explore the specificities of agile methodology adoption, emphasizing the analysis of the integration between HCD practices and agile principles in governmental projects.

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