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Design Thinking to Support Digital Transformation in the Public Sector

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Dissertation presented to the Postgraduate Program
in Applied Informatics at the Federal Rural University
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the title of Master.

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Epigraph

"There is no tomorrow!"

— Apollo Creed, *Rocky III* (1982)

Resumo

Órgãos públicos precisam modernizar seus processos de gestão de pessoas e de conhecimento legislativo, mesmo sob fortes restrições legais e orçamentárias. Este estudo tem como objetivo investigar como a metodologia do *Design Thinking* pode apoiar a Transformação Digital (TD) ao ser aplicada sistematicamente para diagnosticar necessidades e cocriar soluções com os usuários que visem aprimorem os processos dentro da gestão pública. Para isso, foi utilizada a estratégia de pesquisa múltiplos estudos de casos por meio de entrevistas semiestruturadas, questionários e oficinas de cocriação. Os dados foram analisados por meio de codificação aberta, axial e seletiva, gerando insights para construções de protótipos iterativos. O diagnóstico apontou sistemas de gestão de pessoas fragmentados, ineficiência de ferramentas para planejamento de férias e controle incipiente de versões de atos normativos internos. Derivaram-se três artefatos: (i) um relatório de necessidades e dores dos usuários, (ii) um protótipo de gestão de férias que consolida o gerenciamento de solicitações e aprovações e (iii) um protótipo de gestão normativa que permite o rastreamento de emendas e busca textual. A combinação de técnicas de Design Thinking com uma estratégia de múltiplos casos gerou soluções contextuais validadas pelos usuários, aumentando a eficiência, a transparência e a segurança jurídica no TCE-PE. O protocolo e os artefatos resultantes oferecem um direcionamento replicável para instituições de controle que buscam Transformação Digital em condições semelhantes.

Palavras-chave: *Design Thinking*, Transformação Digital, Gestão de Pública, Setor Público.

Abstract

Public agencies need to modernize their people management and legislative knowledge processes, even under severe legal and budgetary constraints. This study aims to investigate how the Design Thinking methodology can support Digital Transformation (DT) when applied systematically to identify needs and co-create solutions with users aimed at improving processes within public management. To this end, a multiple case study research strategy was used, using semi-structured interviews, questionnaires, and co-creation workshops. The data were analyzed through open, axial, and selective coding, generating insights for the construction of iterative prototypes. The diagnosis revealed fragmented people management systems, inefficient vacation planning tools, and incipient version control of internal regulatory acts. Three artifacts were derived: (i) a report on user needs and pain points, (ii) a vacation management prototype that consolidates the management of requests and approvals, and (iii) a regulatory management prototype that allows for the tracking of amendments and textual search. The combination of Design Thinking techniques with a multiple-case strategy generated contextual solutions validated by users, increasing efficiency, transparency, and legal certainty at the TCE-PE. The resulting protocol and artifacts offer replicable guidance for oversight institutions seeking Digital Transformation under similar circumstances.

Keywords: Design Thinking, Digital Transformation, Public Management, Public Sector.

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Chapter 1

Introduction

Governments around the globe are pressed to deliver faster, more transparent and citizen-centred services as part of an ongoing *Digital Transformation* agenda. The latest OECD review shows that digitally mature administrations can reduce service-delivery costs by up to 65 % while raising citizen satisfaction indices by 20 % on average (OECD, 2019). Nevertheless, Brazil still ranks only 18th among upper-middle-income countries in the 2024 UN E-Government Development Index, signalling room for institutional modernization (United Nations Department of Economic and Social Affairs, 2024).

The public sector here understood as the set of entities under direct or indirect state control—performs essential regulatory and service-delivery functions (LANE, 1993). Precisely identifying the needs of those entities is vital for formulating effective public policies and targeting limited resources (NIGRO, 1984). Yet, endemic bureaucracy often translates into slow, siloed and paper-based workflows that erode organizational effectiveness (CARDOSO, 2011b). Digital technologies promise to counteract such inertia by introducing agility, traceability and data-driven decision-making (OLIVEIRA; MOTTA; OLIVEIRA, 2012; HAUG; DAN; AND, 2024); however, technology alone is insufficient when user needs remain poorly understood.

Recent scholarship increasingly reframes public-sector innovation through a *service-dominant logic* (SDL) that foregrounds *value co-creation* with citizens and civil servants (HARDYMAN; KOSHY, 2022; VIRTANEN; STENVALL; RÖNNBERG, 2024). This paradigm shift reinforces the need for open, participatory and collaborative design approaches in the public sector (TRISCHLER; SCOTT, 2016; DUDAU; KOMINIS, 2023; JANSSEN; LIESHOUT, 2023). Among these, *Design Thinking* stands out for combining empathetic research, iterative prototyping and interdisciplinary collaboration—elements shown to unlock innovation in complex, highly regulated domains (BROWN, 2009b; BASSON, 2018). Yet empirical evidence of Design Thinking being applied *systematically* inside Brazilian oversight bodies, especially for people-management and legislative-knowledge processes, is still scarce (HANELT et al., 2021). Such a gap limits our understanding of how Design Thinking can tangibly support Digital Transformation in contexts marked by

legal constraints and accountability demands.

To address this gap, the **Court of Auditors of Pernambuco (TCE-PE)**—responsible for auditing public-resource management in the state—entered into a technical-cooperation agreement with the Federal Rural University of Pernambuco (UFRPE) with the aim of answering the following research question: how the Design Thinking methodology can support Digital Transformation by being applied systematically to diagnose needs and co-create solutions that enhance people-management and legislative-knowledge processes at the Court of Auditors of Pernambuco (TCE-PE) ? an interdisciplinary innovation team of researchers and civil servants set out to re-engineer two strategic areas within the Human Resources Department (*Departamento de Gestão de Pessoas*, DGP):

- (a) **People-management workflows**, notably vacation planning and allocation of competencies, which were dispersed across legacy systems and spreadsheets;
- (b) **Legislative-knowledge management**, dependent on hundreds of internal normative acts stored in heterogeneous repositories with minimal version control.

This dissertation consolidates three research efforts: (i) a mixed-methods needs assessment of DGP workflows, (ii) a DT-driven prototype and validation of an automated vacation-management platform, and (iii) a DT-based legislative-knowledge management system. Together, these studies demonstrate—through scientific rigor and user-centered innovation—how Design Thinking can catalyze Digital Transformation in Brazilian public-sector organizations.

Thus, the following research question emerges:

How can Design Thinking be systematically applied to diagnose needs and co-create digital solutions that drive digital transformation in internal people management and legislative knowledge processes at a Brazilian Court of Auditors ?

This question reflects some of the initial concerns that motivated this study. Aligned with the defined research question, the general and specific objectives are outlined below.

1.1 Research Objectives

1.1.1 General Objective

The general objective of this dissertation is to investigate how the Design Thinking methodology can be applied to identify needs and co-create digital solutions that promote Digital Transformation in the internal processes of the Court of Auditors of the State of Pernambuco.

1.1.2 Specific Objectives

To achieve the general objective, the study pursues the following specific objectives:

- SO1: **Establish** a comprehensive theoretical framework by analyzing key literature on public-sector digital transformation, service-dominant logic, Design Thinking, and knowledge-management systems;
- SO2: **Characterize** the current state of selected workflows (HR and normative-management) at TCE-PE, identifying critical pain points, constraints, and opportunities for digital enhancement through a mixed-methods needs assessment;
- SO3: **Develop and co-design** a proof-of-concept digital solution for the HR vacation-management workflow, leveraging the insights gained from the Design Thinking process;
- SO4: **Formulate** the conceptual architecture and functional requirements for a legislative knowledge-management system capable of centralizing, versioning, and enabling intelligent search of internal regulations;
- SO5: **Evaluate** the efficacy, usability, and strategic fit of the developed prototypes with real end-users and subject-matter experts via robust validation methods;
- SO6: **Produce** a validated set of actionable guidelines and lessons learned for public-sector organizations intending to leverage Design Thinking to drive digital transformation initiatives;
- SO7: **Contribute** new, applicable knowledge to the academic literature on Design Thinking, digital transformation, and innovation within public audit institutions.

1.2 Justification

Contemporary public administration faces the constant challenge of adapting to rapid social, technological, and cultural transformations. In this context, there is a growing demand for more open, collaborative, and citizen-centered models, especially in light of the limitations of the traditional policy-making approach (CAVALCANTE; MENDONÇA; BRANDALISE, 2019). *Design Thinking* has emerged as a promising approach for fostering innovation in this sector, as it enables a deeper understanding of public problems and the construction of more effective, user-oriented solutions.

Governments around the world have adopted methodologies based on *Design Thinking* and co-creation to redesign public services (VOORBERG; BEKKERS; TUMMERS, 2015). In Brazil, notable initiatives include that of Santos and Hoffmann (SANTOS;

(HOFFMANN, 2016), who proposed a methodology based on *Service Design* and project management for municipal public services, and the studies related by (CAVALCANTE; MENDONÇA; BRANDALISE, 2019), which compiled innovative experiences in the national public sector. However, despite these advances, structured knowledge of how co-creation can be systematically applied within Brazilian public organizations remains scarce (ROMÃO; MAIRA, 2025).

Moreover, there is a gap in the literature regarding the practical application of *Design Thinking* allied with scientifically rigorous methodologies in the development of digital solutions for human-resources management. This research is therefore justified by the need to develop replicable models that integrate user-centered innovation with robust research methods, thereby promoting tangible improvements in public administration.

Therefore, Design Thinking can accelerate digital-transformation programs in the public sector by promoting an iterative, empathic, and collaborative approach to process redesign, ensuring that technological solutions grow out of real user needs—those of both civil servants and citizens—rather than solely out of technical or legal requirements (MERGEL, 2019; BASON, 2018). By engaging multidisciplinary teams and encouraging experimentation, DT helps break organizational silos, lowers resistance to change, and increases the adoption and sustainability of the solutions developed (OECD, 2019; JANSSEN; LIESHOUT, 2023).

Yet the literature still lacks empirical studies that combine DT with scientifically rigorous methods in the development of digital tools for public sector internal processes. This research is therefore justified by the need to provide a replicable model that integrates user-centered innovation with a robust multi-case protocol, ultimately providing tangible improvements in the efficiency, transparency, and legal certainty of the public sector.

1.2.1 Dissertation structure

This dissertation is organized into six chapters. Chapter 1 introduces the research topic, contextualizes its relevance within the public sector, and outlines the central and specific objectives of the study. Chapter 2 presents the background and related work, highlighting the theoretical foundations and prior studies that inform this research. Chapter 3 describes the research methodology, detailing the multi-case study design, data collection procedures, and analytical strategies employed. Chapter 4 presents the results and illustrates the practical application of the Design Thinking approach across two key domains: the construction and validation of a digital solution for vacation management, and the development of an internal legislation management system. Together, these initiatives span the entire innovation cycle—from needs assessment to high-fidelity prototyping—offering a replicable model of digital transformation in the public sector. Chapter 5 provides a critical discussion of the findings, mapping them to each phase of the Design Thinking

methodology and drawing theoretical and practical insights. Finally, Chapter 6 presents the final considerations, highlighting the main contributions, lessons learned, limitations, and directions for future work. The dissertation also consolidates key academic outputs, including the articles “Development of a Human Resources Management Platform at TCE-PE: A Needs Assessment Report” and “Application of Design Thinking in Digital Transformation in Human Resources in the Public Sector.”

Chapter 2

Background and Related Work

This chapter is organized into seven sections, covering the organizational and policy context, digital-government initiatives to promote digital transformation, the application of Design Thinking in government, including the tools and techniques employed, the digitalization of human resources management, and legislative knowledge-management systems.

2.1 Organizational and Policy Context

Brazil's *Digital Government Strategy 2020–2022* (EGD 2020) establishes a comprehensive framework to guide public-sector digital transformation at the federal and sub-national levels (Ministério da Economia, Brasil, 2020). More recently, the federal government instituted the *Estratégia Federal de Governo Digital 2024–2027* (EFGD/ENGD 2024–27), via Decreto nº 12.198/2024 and Decreto nº 12.069/2024, which updates and extends the agenda for inclusive, effective, proactive and sustainable digital government (REPÚBLICA, 2024). At its core (in the earlier strategy) were eight interdependent strategic axes that collectively define the government's modernization agenda:

- (i) **Digital-by-default services** – migrate high-volume services to end-to-end digital channels;
- (ii) **Service integration** – bundle life-event services and enable single-sign-on authentication;
- (iii) **Government as a platform** – offer shared components (APIs, payments, notifications) for reuse across agencies;
- (iv) **Data governance and analytics** – promote interoperable data standards, open data and AI-driven decision support;

- (v) **Open government and civic engagement** – expand transparency and participatory mechanisms;
- (vi) **Security and privacy** – strengthen cyber-resilience and data-protection compliance;
- (vii) **Digital skills and culture** – upskill civil servants and foster innovation mindsets; and
- (viii) **Enabling infrastructure and regulation** – modernize ICT infrastructure and update the legal framework to support digital initiatives.

These axes mirror OECD recommendations for agile, evidence-based public management that puts users at the center of service design (CO-OPERATION; DEVELOPMENT, 2020). Sub-national oversight bodies such as the Court of Auditors of Pernambuco (TCE-PE) are mandated to align with the EGD while navigating three constraints that are specific to the audit domain: (i) judicial independence, (ii) highly formalized procedures, and (iii) the need to manage large volumes of internal normative acts. Because TCE-PE has embraced the EGD’s vision — most notably through its *Programa de Transformação Digital 2021-2025*, which prioritizes process automation, data analytics and transparency portals — it offers an ideal setting for examining how the federal strategy’s principles and axes play out in practice. The institution’s mission, legal mandate and IT landscape therefore provide the empirical backdrop against which this study explores Design Thinking as a catalyst for digital transformation in both people-management and legislative-knowledge workflows.

2.2 Digital Government Initiatives To Promote Digital transformation

OECD member states increasingly frame digital transformation as a strategic imperative, emphasizing user-centered design, data interoperability and agile delivery models (CO-OPERATION; DEVELOPMENT, 2020). Brazil follows the same trajectory through its *Digital Government Strategy 2020–2022* (EGD 2020) and Decree 10.332/2020, which mandate that all high-volume public services migrate to the federal *gov.br* platform and adopt a single digital identity by 2025 (ROCHA; ALBUQUERQUE, 2021). Key federal initiatives include the *gov.br* one-stop portal, the *Plataforma de Cidadania Digital*—a catalogue of reusable APIs for payments, notifications and authentication—and *Dados.gov.br*, Brazil’s open-data repository (BRITO, 2022). These programs seek to lower transaction costs, improve transparency and facilitate evidence-based policy making. At the sub-national level, several states have launched complementary projects—for example, São

Paulo’s *Poupatempo Digital* app, which bundles life-event services, and Rio Grande do Sul’s *rs.gov* portal with more than 600 digital services (PIMENTA; CARDOSO, 2020). Audit courts have also begun to digitize internal workflows: the Federal Court of Accounts (TCU) replaced paper processes with the *e-TCU* system, while TCE-MG pilots blockchain for procurement audits (UNIÃO, 2021). Despite such advances, comparative studies show that state and municipal agencies often lag behind federal bodies because of tighter budgets, legacy systems and rigid procedural norms (JANSSEN; HOVEN, 2018; HEEKS, 2020).

Concrete examples illustrate these constraints: (i) in the city of Recife, an attempt to integrate payroll data with the federal *gov.br* API stalled for nine months owing to incompatible data schemas (COSTA; GONÇALVES, 2023); (ii) the INSS digital-benefit platform experienced a backlog spike of 28 % when older case files stored in COBOL systems could not be migrated automatically (SILVA; BORGES, 2022); and (iii) several audit courts still rely on e-mail threads to circulate draft rulings, undermining version control and institutional memory (RICCI; ORELLI, 2023).

These mixed results suggest that the EGD’s national principles require local adaptation and strong user-centered methods to overcome organizational resistance and technical debt. Because the Court of Auditors of Pernambuco (TCE-PE) has formally embraced the EGD—yet operates under the typical constraints of audit institutions—it offers an ideal setting to examine how Design Thinking can bridge the gap between federal policy ambitions and on-the-ground digital-transformation challenges.

2.3 *Design Thinking* in the Public Sector

Design Thinking (DT) has become a reference approach for user-centered innovation in government because it couples empathetic fieldwork with rapid, iterative experimentation (BROWN, 2009b; BASON, 2018). Systematic reviews highlight tangible gains—broader *stakeholder* engagement, faster *prototyping*, higher perceived service quality—yet also note two recurring barriers: cultural resistance in bureaucratic settings and the difficulty of measuring long-term impact (MERGEL, 2019; CLARKE; CRAFT, 2021). Brazilian municipalities have begun to apply DT to redesign frontline services (MELO; SILVA, 2015).

2.3.1 Tools and Techniques

Operationalizing the five iterative DT phases—*empathize*, *define*, *ideate*, *prototype*, and *test*—requires a practical toolkit. The list below shows the main tools adopted in this study and indicates the phase(s) they support, thus illustrating how abstract DT principles translate into concrete research activities within TCE-PE:

- **Collaboration & Ideation:** *Miro*¹ for online co-creation sessions and *draw.io* for process modeling (empathize/ideate).
- **User-research artifacts:** personas (COOPER, 1999) and empathy maps (GRAY, 2010) (empathize/define).
- **Analysis & Synthesis:** Ishikawa cause-and-effect diagrams (ISHIKAWA, 1985) (define).
- **Concept Evaluation:** weighted decision matrix (Pugh matrix) (PUGH, 1991) (ideate).
- **Prototyping:** paper sketches, mid-fidelity wireframes in *Figma*², and interactive high-fidelity mock-ups (HOUDE; HILL, 1997) (*prototype*/test).
- **Data Capture & Analysis:** Microsoft Forms for questionnaires, digital voice recorders for interviews, manual coding and descriptive statistics in Excel following (MILES; HUBERMAN; SALDAÑA, 2014) (empathize/test).
- **Documentation & Versioning:** version-controlled artifacts stored in a private Nextcloud instance; L^AT_EX for all academic writing (cross-phase).

2.4 Digital transformation of Human-Resources Management

Digital transformation human-resources (HR) platforms are widely expected to boost process efficiency, enable real-time analytics, and support evidence-based decision making (DAVENPORT; HARRIS, 2010). In the private sector, cloud systems such as SAP Success Factors and Workday have reduced payroll-processing time by up to 35% and improved workforce-planning accuracy (MARLER; FISHER, 2017). Governments seek similar gains, hoping to redirect administrative effort toward higher-value public services.

Translating that promise to the public sector is, however, far from trivial. Legacy databases, heterogeneous payroll engines, and legally mandated paper archives constrain modernization efforts (BAKAR et al., 2022). Latin-American case studies show that unified leave-management modules can increase transparency—e.g., the Peruvian *Sistema Único de Licencias* cut approval times from ten to three days—but also reveal persistent bottlenecks when such modules must interoperate with payroll and calendar systems built on different data schemas (LUNA, 2023).

¹Disponível em: <https://miro.com>.

²Disponível em: <https://www.figma.com>.

Brazil mirrors that mixed picture. São Paulo’s *SIGRH Digital* migrated 140 000 civil-servant records to the cloud but still exchanges vacation data with the legacy payroll engine via nightly batch files, delaying real-time monitoring (SILVA; PEREIRA, 2021). The Federal Court of Accounts (TCU) introduced an electronic leave-booking tool, yet auditors report manual rekeying whenever travel allowances are involved (UNIÃO, 2021).

These examples highlight two structural challenges: (i) tight coupling between HR subsystems developed at different times and (ii) highly formalized rules that require fine-grained parameterization. The Court of Auditors of Pernambuco (TCE-PE) faces the same constraints: vacation requests travel through e-mail threads, a spreadsheet logs leave balances, and approvals are finally recorded in a COBOL-based payroll system. Such fragmentation not only consumes staff time but also obscures the data needed for strategic workforce planning.

Addressing this gap therefore demands a method capable of reconciling legal strictures with user-centered requirements—a niche where Design Thinking can provide the iterative, cross-functional collaboration lacking in traditional, top-down IT projects.

2.5 Legislative Knowledge-Management Systems

Audit institutions are required to monitor thousands of internal regulations, ranging from plenary rulings to administrative ordinances. International experience shows that making these documents *searchable* and *version-controlled* improves decisional accuracy and reduces audit-cycle time (SNIDER; FARIA, 2022). European supreme audit offices, for example, cut the average time needed to locate precedence from forty minutes to under five after deploying unified legislative databases.

Translating those gains to the Brazilian context has proven difficult. The Federal Court of Accounts (TCU) still stores amendments to its *Normas de Auditoria Governamental* in separate PDF files, forcing auditors to reconcile multiple versions manually (UNIÃO, 2021). At the state level, TCE-SP’s *repositório de atos* tags each document but offers no lineage view, making it hard to verify whether a resolution has been partially repealed (LOPES; FERREIRA, 2022). Municipal chambers face the same problem: a 2023 study of the Recife City Council found that 71% of ordinances lacked explicit repeal information, generating conflicting legal interpretations (COSTA; GONÇALVES, 2023).

These shortcomings point to two structural gaps—(i) weak version control and (ii) limited amendment traceability—that hamper institutional memory and legal certainty across Brazilian oversight bodies. The legislative-management system prototyped for TCE-PE (Chapter 4.3) addresses both gaps by storing each normative act as a metadata-rich record linked to its full amendment history and by offering faceted, full-text search filters.

By grounding design decisions in the documented pain points above, the prototype

demonstrates how user-centred, iterative development can bridge the disconnect between policy requirements and day-to-day information needs.

2.6 Related Works

This section presents a critical analysis of prior research aligned with the scope of this dissertation. Unlike the background section, which outlined institutional drivers and implementation challenges for digital government, the aim here is to examine academic studies that inform the scientific positioning of this work. Four research streams are reviewed: (i) Design Thinking in the public sector, (ii) digital transformation in human-resources management, (iii) legislative knowledge-management systems, and (iv) synthesis and research Gap. Together, they reveal gaps in the literature that this dissertation addresses.

2.6.1 Design Thinking in the Public Sector

Design Thinking (DT) has gained traction as a methodological approach for public-sector innovation due to its emphasis on empathy, iteration, and co-creation (BROWN, 2009b; BASON, 2018). Systematic reviews such as (MERGEL, 2019) and (CLARKE; CRAFT, 2021) confirm its potential to improve public-service design but also point to limitations, including difficulty in measuring long-term impact and resistance in hierarchical organizations. In the Latin American context, applications of DT remain concentrated at the municipal level, particularly within local innovation labs and city administrations (VALENÇA; CAVALCANTE, 2023). For instance, (MELO; SILVA, 2015) used DT to improve frontline services in Porto Alegre, while (SANTOS; HOFFMANN, 2016) proposed a service design model for small and medium-sized municipalities. Although promising, these experiences are rarely documented in environments with high legal rigidity—such as audit institutions.

In Brazil’s federative structure, municipalities and states are autonomous government entities that execute policies and deliver public services under the broader coordination of the federal government. Municipal administrations typically manage frontline services such as education, health, and urban mobility—areas where DT projects have been most visible. In contrast, state-level audit institutions such as *Tribunais de Contas* (courts of accounts) occupy a constitutionally independent role focused on external control, fiscal oversight, and compliance auditing. These bodies operate under strict procedural law, with decisions subject to legal scrutiny and formal accountability requirements. Such institutional rigidity and judicial independence make them distinct from executive agencies, offering a challenging yet analytically rich environment for studying how DT can adapt to rule-bound, high-compliance settings.

2.6.2 Digital Transformation in the Public Sector

Digital transformation in the public sector has become a central agenda for improving efficiency, transparency, and user experience in government operations. While private-sector initiatives often demonstrate measurable productivity gains through data integration and process automation (DAVENPORT; HARRIS, 2010; MARLER; FISHER, 2017), public organizations face a more complex landscape. Legacy systems, fragmented databases, and legally mandated procedures frequently constrain modernization efforts (BAKAR et al., 2022). These challenges are particularly evident in administrative domains that combine strict legal compliance with high documentation demands, such as human-resources management and legislative governance.

In Latin America, several studies highlight progress in the digitalization of leave-management systems, which exemplify the potential and the limits of transformation efforts (LUNA, 2023). The Peruvian *Sistema Único de Licencias* reduced approval times by more than 60%, yet integration barriers with payroll and time-tracking subsystems persisted. In Brazil, (SILVA; PEREIRA, 2021) examined São Paulo’s *SIGRH Digital*, showing that despite migrating more than 140,000 employee records to the cloud, the system continues to rely on nightly batch exchanges with a legacy payroll engine—preventing real-time monitoring and analytics. Such experiences reveal that process automation alone does not guarantee digital transformation when institutional workflows remain fragmented.

A similar modernization gap exists in the management of internal regulations and normative acts. International research shows that searchable, structured legislative repositories enhance compliance and institutional learning (SNIDER; FARIA, 2022). However, Brazilian oversight bodies still struggle with document lineage, amendment traceability, and version control. The Federal Court of Accounts (TCU), for instance, stores updates as separate PDF files without unified referencing (UNIÃO, 2021). The São Paulo State Court of Accounts (TCE-SP) lacks mechanisms for cross-referencing related documents (LOPES; FERREIRA, 2022), while a study on Recife’s municipal repository found that 71% of ordinances lacked repeal or modification metadata (COSTA; GONÇALVES, 2023). These deficiencies not only hinder transparency but also limit strategic analysis of legal frameworks.

Together, these cases illustrate how digital transformation in the public sector extends beyond technology deployment: it requires redesigning processes, ensuring interoperability, and aligning digital tools with institutional mandates. Addressing such complexity demands approaches that integrate technological modernization with user-centered innovation—an area where Design Thinking provides a promising methodological bridge between compliance-oriented bureaucracy and agile, citizen-centered service delivery.

2.7 Synthesis and Research Gap

Comparative evaluations show that digital platforms supported by Design Thinking can cut public-service transaction costs by up to 40% and raise citizen-satisfaction scores by 15 pp on average (CO-OPERATION; DEVELOPMENT, 2020). Yet the **Inter-American Development Bank’s 2023 GovTech Index** reports that only 14% of Latin-American audit courts operate fully digitized workflows, with most relying on stand-alone HR and document systems (BANK, 2023). Recent case descriptions from European supreme audit institutions confirm benefits—greater transparency, faster deliberation—but also highlight unresolved issues of version control for internal regulations (RICCI; ORELLI, 2023). Within Brazil, empirical studies remain concentrated in municipal service labs, while peer-reviewed analyses addressing state-level courts of accounts are limited to exploratory pilots (LUNA, 2023; CUNHA; BARROS, 2024).

Taken together, prior work exposes **three critical gaps**:

- G1: Limited empirical evidence on Design-Thinking–driven digital transformation in oversight and accountability institutions.** While Design Thinking has been widely applied in public-service design, few empirical studies address its implementation within audit bodies or courts of accounts, where procedural rigidity and independence create distinct innovation constraints (MERGEL, 2019; CO-OPERATION; DEVELOPMENT, 2020; VALENÇA; CAVALCANTE, 2023; RICCI; ORELLI, 2023).
- G2: Fragmented treatment of administrative domains.** Existing research typically isolates either human-resources digitalization (LUNA, 2023; SILVA; PEREIRA, 2021) or legislative-knowledge management (SNIDER; FARIA, 2022; COSTA; GONÇALVES, 2023; LOPES; FERREIRA, 2022). No studies to date have examined both processes within a unified organizational transformation journey, despite their shared dependence on compliance, documentation, and workflow traceability.
- G3: Scarcity of rigorous multi-case analyses.** Systematic reviews consistently highlight the lack of methodologically robust, comparative research capable of generalizing insights across different administrative domains while accounting for contextual and legal constraints (VOORBERG; BEKKERS; TUMMERS, 2015; CLARKE; CRAFT, 2021; MERGEL, 2019).

Chapter 3

Methodology

This chapter details how the research was designed and executed to answer the central question: *How can Design Thinking be systematically applied to diagnose needs and co-create digital solutions that drive digital transformation in internal people management and legislative knowledge processes at a Brazilian Court of Auditors ?*

The study follows a **qualitative multi-case design** (YIN, 2018). Three interrelated cases inside the Court of Auditors of Pernambuco (TCE-PE) share a common organizational context, enabling literal and theoretical replication (EISENHARDT, 1989).

3.1 Overview of the Multiple-Case Procedures

To guide the investigation, Figure 3.1 presents a visual overview of the data collection and analysis procedures adopted in the study. The figure outlines the main activities, their chronological sequence, and the artifacts produced in each case.

In Case 1, the emphasis was on planning and conducting a diagnostic workshop aimed at eliciting pain points from stakeholders, which resulted in a categorized set of needs.

Case 2 and 3 built upon these findings, employing semi-structured interviews, survey rounds, and co-creation activities to refine the scope, validate insights, and develop digital prototypes.

Collectively, these steps constituted the foundation of the multi-case research protocol.

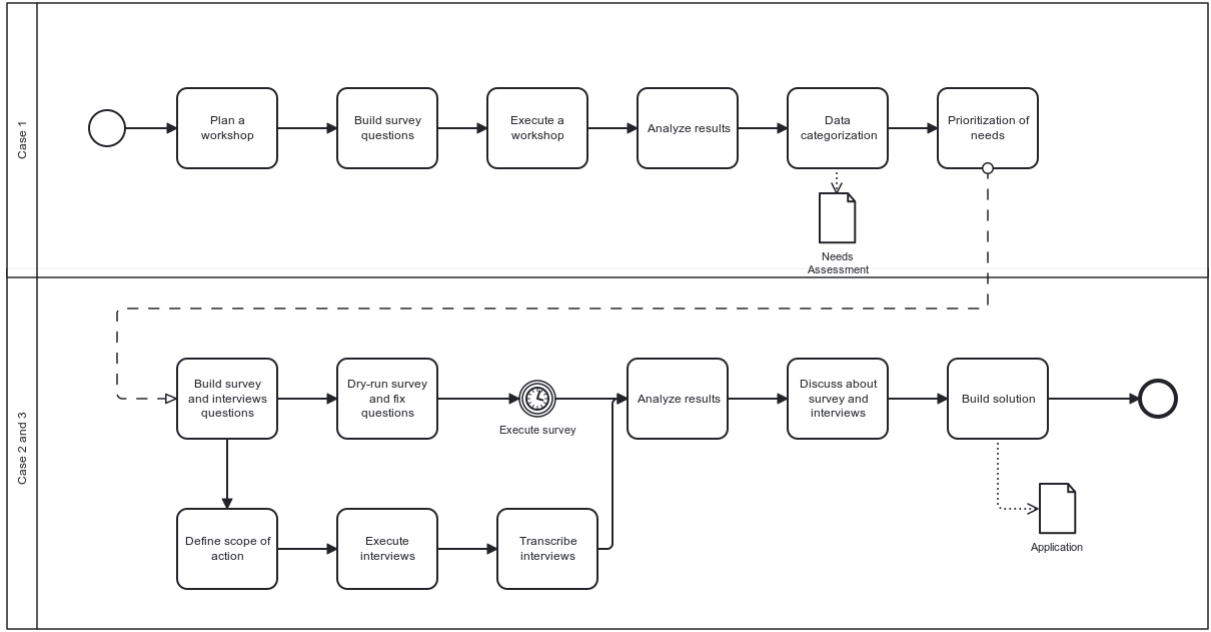


Figure 3.1: Procedural flow across the three cases in the multiple-case study

3.2 Empirical methods in public sector Information Systems research

Public-sector information systems (IS) studies commonly employ qualitative or mixed methods, with *multi-case study* designs favored for building externally valid explanations (YIN, 2018). This study adopts an **interpretivist** stance, viewing organizational reality as socially constructed. Rich, contextual description is therefore favored over statistical generalization (SILVERMAN, 2006; MYERS, 1997). Guidelines by (RUNESON; HÖST, 2009) and (EASTERBROOK et al., 2008) advocate methodological triangulation—interviews, document analysis, surveys—to enhance construct validity. Recent work pairs DT with multi-case protocols to balance user-centered exploration and scientific rigor (HEEKS, 2020). This dissertation follows that approach, applying literal and theoretical replication logic across three cases within TCE-PE.

3.3 Unit of Analysis

Founded in 1891, TCE-PE is the audit body responsible for external control of public expenditure in the State of Pernambuco. Its mandate covers financial, budgetary, operational, and patrimonial audits of state and municipal entities. The institution employs roughly 900 civil servants—70 % of whom are career auditors and analysts—and processes more than 20 000 audit cases per year (Tribunal de Contas do Estado de Per-

nambuco, 2024). Over the past decade, TCE-PE has launched several modernization programs, most notably the *Programa de Transformação Digital 2021-2025*, which prioritizes process automation, data analytics, and citizen-facing transparency portals. These characteristics define the single **unit of analysis**: TCE-PE and its internal HR and legislative-management processes.

3.4 Case Selection

Three cases were selected to compose this multiple-case study: (i) needs assessment, (ii) vacation management, and (iii) legislative knowledge management. Each case reflects a critical process within the Court of Auditors of Pernambuco (TCE-PE) and was chosen based on a combination of methodological and practical criteria recommended by Yin (YIN, 2018) and Eisenhardt (EISENHARDT, 1989).

- C1: Relevance to the research question:** all three cases directly relate to the central objective of investigating how Design Thinking can support digital transformation in people-management and knowledge-management workflows.
- C2: Organizational and technical complexity:** each selected case involves multi-departmental coordination, legal constraints, and reliance on legacy systems—making them fertile ground for examining real-world challenges in public-sector innovation.
- C3: Process maturity and visibility:** the chosen cases represent processes that are either well-documented (e.g., vacation requests) or undergoing strategic review (e.g., legislative knowledge), thus offering sufficient historical data and stakeholder awareness to support meaningful analysis.
- C4: Access and availability of participants:** TCE-PE granted full access to key personnel and process documentation across all three areas, ensuring the feasibility of in-depth data collection through interviews, surveys, and workshops.
- C5: Replicability logic:** the cases were selected to enable both literal and theoretical replication (YIN, 2018)—that is, while some processes share common patterns (e.g., workflow bottlenecks), others contrast in scope and function, allowing the study to test whether findings can be generalized across varied administrative domains.

This careful selection strategy ensures that the cases are both representative of real digital-transformation challenges and aligned with the theoretical goals of the study. Each case serves as a unique lens through which to observe how user-centered innovation can unfold in legally constrained, high-accountability settings like audit institutions.

3.5 Data Collection

As an outcome of the interviews, we obtained recording files, some with only audio and others with both audio and video. These recordings were manually transcribed, ensuring accuracy and preserving contextual nuances from the conversations. After transcription, the texts were reviewed and then imported into *Obsidian*, where the qualitative analysis process began.

The collected data was analyzed following the guidelines defined by the Grounded Theory (GLASER; STRAUSS; STRUTZEL, 1968). The first step consisted of line-by-line coding to identify concepts and key sentences, followed by grouping into categories and sub-categories, allowing comparison of data from each participant to detect similarities. The second step involved axial analysis, in which relationships among the defined categories were identified. The final step, selective coding, aimed to determine the core category and methodically relate it to other codes.

Regarding the survey, all responses were collected via Google Forms. Each response was organized into a spreadsheet, which facilitated the creation of descriptive graphics and supported the identification of relationships within the data.

3.5.1 Preparation for Data Collection

This subsection outlines the preparatory steps undertaken for the design of both interviews and surveys used during the research execution.

As presented in Appendix B, each interview question is identified by a code. The code structure uses the prefix **IQ** (Interview Question), followed by a two-digit sequential number to distinguish individual questions (e.g., IQ01 represents the first question from the interview protocol). These codes are referenced throughout this dissertation to link findings directly to the data collection instruments. The interviews were designed to explore in depth the workflows, challenges, and expectations of stakeholders involved in human resources and legislative management processes. While survey questions offered structured, quantifiable insights, interviews provided qualitative depth, uncovering nuances that structured questions could not capture. The interview was divided into distinct sections: for the interviews, IQ01-IQ05 for Case 1, IQ06-IQ10 for case 2 and IQ11-IQ17 for case 3.

Similarly, Appendix A details the survey instruments, where each question is identified by the prefix **SQ** (Survey Question) and a two-digit sequential number (e.g., SQ07 represents the seventh survey question). By defining and coding each question in advance, we ensured consistency across data collection instruments and facilitated systematic referencing during the analysis phase. This preparation also supported methodological transparency and reproducibility of the research process. This coding facilitates traceability

between analysis and the original data source. The survey was divided into three distinct sections, each with a specific purpose: for the surveys, SQ01–SQ02 for Case 1, SQ03–SQ13 for case 2.

3.5.2 Data-Collection Instruments

Interview guides: Two guides—HR and legislative—were developed (17 and 14 core questions, respectively). Questions probed workflow bottlenecks, integration pain points, and desired features; probes ensured depth without leading respondents. Appendix [B](#) reproduces the full guides.

Survey: The 28-item questionnaire measured perceived usefulness, ease of use, and change readiness. Items were adapted from validated IS-impact instruments and pilot-tested with five civil servants for clarity. The final instrument is in Appendix [A](#).

3.5.3 Data Processing and Analysis

Qualitative data: The collected data were analyzed using **Grounded Theory** procedures ([GLASER; STRAUSS; STRUTZEL, 1968](#)). First, each transcript line was open-coded to identify concepts and key sentences. Codes were grouped into categories and sub-categories, comparing data across participants for similarity. Second, an axial analysis examined relationships among categories. Finally, selective coding identified a core category and related all other codes to it.

Quantitative data: Survey responses captured via Google Forms were exported to spreadsheets. Simple descriptive statistics (frequency, mean, standard deviation) and cross-tabulations were generated to explore relationships among variables.

3.6 Research Procedures

The study unfolded in six stages:

- P1 Planning & Access** – entry negotiation, ethics approval, and protocol definition.
- P2 Needs Assessment** – interviews, document review, and diagnostic survey to map pain points.
- P3 Conceptual Design** – co-creation workshops, idea generation, and option prioritization via weighted decision matrix.
- P4 Prototype Development** – creation of low-, mid-, and high-fidelity mock-ups for vacation and legislative systems.

P5 Evaluation – qualitative walkthroughs and post-test questionnaire; descriptive statistics produced in spreadsheets.

P6 Cross-Case Synthesis – within-case coding followed by cross-case comparison using Miles & Huberman’s cycle (data reduction, display, conclusion verification) (MILES; HUBERMAN; SALDAÑA, 2014).

3.7 Validity and Reliability

To ensure methodological rigor, the study adopted a set of strategies addressing the four main dimensions of research quality. **Construct validity** was strengthened through data triangulation, combining interviews, surveys, and documentary analysis to capture a comprehensive understanding of the phenomena under investigation (YIN, 2018). In addition, preliminary findings were submitted to key participants for *member checking*, enabling them to validate interpretations and reduce the risk of researcher bias (LINCOLN; GUBA, 1985).

Internal validity was pursued by actively searching for rival explanations during the cross-case synthesis stage, a process that supports the identification of alternative interpretations and helps ensure that observed patterns are genuinely linked to the studied phenomena (MILES; HUBERMAN; SALDAÑA, 2014). This reflexive approach enhanced the credibility of causal inferences and minimized the influence of confounding variables.

External validity was addressed through the logic of literal and theoretical replication across the three selected cases (YIN, 2018). By selecting cases with both shared and contrasting characteristics, it was possible to assess the consistency of findings across different contexts within the same organization, thereby increasing the transferability of insights to similar public-sector environments.

Finally, the **reliability** was ensured through detailed research and the maintenance of a comprehensive audit trail, including raw data, peer review, and analytical memos, all securely stored. This documentation facilitates transparency and allows other researchers to replicate the procedures, in line with recommendations for qualitative case study research (RUNESON; HÖST, 2009; SILVERMAN, 2006).

3.8 Artifact Development

The study produced three artifacts:

A1 Needs-Assessment Report – personas, pain points, and user stories for HR and legislative workflows.

A2 Vacation-Management Prototype – web application integrating leave requests and approval dashboards.

A3 Legislative Knowledge-Management Prototype – system with metadata-rich storage, version tracking, and full-text search.

3.9 Ethical Considerations

All participants signed informed-consent forms approved by TCE-PE’s ethics committee. Data were anonymized, and raw transcripts are restricted to the research team.

3.10 Summary

By combining Design Thinking techniques with a rigorous multi-case-study protocol, the research delivers context-rich evidence and digital artifacts that advance both theory and practice in public-sector Digital Transformation.

Chapter 4

Results

By conducting three interrelated case studies at the Court of Auditors of Pernambuco (TCE-PE)—one for a needs assessment, one focused on HR processes, and one focused on legislative knowledge management—this dissertation addresses all three gaps. The research provides cross-sectional evidence on user-centered innovation strategies in a hybrid legal-bureaucratic environment, thus expanding the literature on digital government and offering a replicable roadmap for oversight bodies facing similar challenges. The results of this study demonstrate the effectiveness of applying design thinking methodology to innovate the internal processes of the Court of Auditors of Pernambuco. The approach allowed for a deep understanding of the needs and challenges faced by the department, promoting user-centered solutions that aim to increase the efficiency and effectiveness of the activities carried out.

4.1 Identification of weaknesses in the internal processes of the public management area

4.1.1 Discovery

In total, we received 103 qualitative contributions from TCE employees. Of this amount, 36 contributions were obtained during the workshop, through forms and audio recordings (A.1 and B.1), while another 67 contributions were received through the online form after the event ended.

The collected data was subjected to a thorough qualitative analysis, using the Thematic Synthesis technique, which included rounds of discussion and validation among researchers. This approach resulted in a pragmatic categorization of data, using relevant keywords applicable to the context of employees' expressions, providing valuable information about specific areas that require attention and improvements.

Theme	Synthesis
Integration	Create a platform that integrates all people-management systems, organizing them by interests and customized access profiles according to employee roles. It should consolidate procedures uniformly, allowing easy and centralized access to all DGP information and services.
Vacations and Leave	Create an integrated system that centralizes all leave-related information, letting employees check balances, deadlines and leave types. It must show planned and unplanned vacation periods, remaining days and deadlines for employees and supervisors.
Management and Information	Provide quick access to managerial reports, leave balances, team field days and vacation schedules. Offer comprehensive data on employees, payroll, vacations and leaves, and enable goal tracking to monitor team productivity daily or monthly.
Training	Make it easy for employees to register training needs, automatically integrate completed courses (internal and external) and suggest structured learning paths.
Communication	Create a space for official announcements and add a chatbot to streamline information flow. Offer direct access to People-Management policies, system guides and pension legislation.
Work Schedule	Enable employees to report absences, simplify the turnstile system and e-mail alerts for record inconsistencies to avoid salary surprises.
Assignment of Activities Document (AAD)	Make the impact of AAD evaluations on performance scores transparent by listing normative criteria and letting summaries be sent to employees.
Accessibility	Let users reach DGP systems via internet and mobile app, using single sign-on for a unified experience.
Process	Simplify people-management processes by means of an intuitive, accessible system.

Table 4.1: Main challenges identified

After intense deliberations and adjustments, nine main problems were identified and categorized, each representing a significant aspect of organizational dynamics and the difficulties faced by employees. These results were presented to stakeholders, including institutional leaders and team members, for validation and further discussion.

To ensure classification accuracy and consistency, the categories were subjected to an inter-researcher agreement analysis. During this phase, constructive debates took place and refinements were made, aiming to ensure that the classification faithfully reflected the diversity and complexity of the challenges faced at TCE-PE.

Based on feedback received and stakeholder validation, a priority scope was established. This scope directed the focus of improvement initiatives, allowing the team to begin working strategically and efficiently on the problems identified as most urgent and impactful.

The workshop and online form enabled us to obtain and classify relevant evidence from TCE-PE employees (cf. Table 4.1 above). This structured outcome was the basis for extracting early requirements for the future platform, revealing how such techniques can be useful during business analysis activities from an information systems development project.

The nine identified issues cover a broad spectrum of issues, ranging from integration and communication to process optimization and accessibility. Each problem area represents a critical aspect of people management within the organization, highlighting the complexity and multifaceted nature of the challenges faced.

Integration emerges as a fundamental requirement, calling for the creation of a cohesive platform that consolidates disparate systems and streamlines access to essential information and services. This integrated approach not only improves operational efficiency but also promotes a more integrated user experience, aligning with modern expectations for centralized data management.

The need for a comprehensive leave management system highlights the importance of transparency and accessibility in HR processes. By providing employees with real-time access to leave balances, deadlines and relevant policies, organizations can empower individuals to make informed decisions while minimizing administrative expenses.

Likewise, the emphasis on training and development reflects a strategic imperative to invest in employee growth and skills improvement. By simplifying the process of expressing training requirements and tracking progress, organizations can nurture a culture of continuous learning and professional development, ultimately driving performance and innovation.

Effective communication emerges as an axis for organizational cohesion and alignment, requiring the establishment of robust channels to disseminate information and facilitate dialogue. The proposed platform for official announcements and automated chatbot support represents a proactive step toward improving internal communication and promoting transparency.

Furthermore, the focus on accessibility highlights the importance of meeting the diverse needs and preferences of users, especially in an increasingly digital landscape. By offering seamless access to internal systems across web and mobile platforms, organizations can ensure inclusion and flexibility, thereby increasing employee engagement and satisfaction.

4.2 Application of Design Thinking in Digital Transformation in Human Resources in the Public Sector

To achieve the objectives proposed in this study, an approach based on design thinking will be adopted, a human-centered methodology that promotes innovation through multidisciplinary collaboration, empathy and iterative experimentation (BROWN, 2009b). Design thinking is composed of a series of interconnected steps, which will be followed in this project to guide innovation in the Human Resources Department of the Court of Auditors of Pernambuco. Figure 4.1 illustrates the application of Design Thinking to promote Digital Transformation.

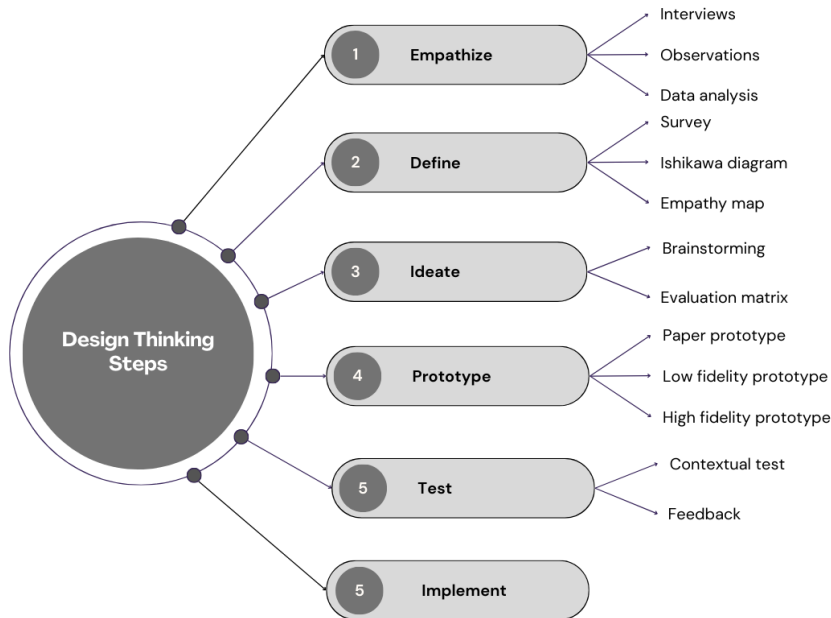


Figure 4.1: Stages in the Development of Design Thinking.

4.2.1 Empathic Understanding.

Preparatory phase: Relevant information about the organization was gathered to understand the activities provided, the organizational structure, the organization of workflows, and the management maturity of the agency. The research team conducted an initial survey with the main stakeholders in order to understand the organizational problems and the context of the work of the employees, as well as the suggested units. From this meeting, it was possible to identify the scope of the main problems faced by the DGP management, as well as to prioritize them.

Kick off: After defining the scope and confirming the research schedule, data collection activities were formally initiated through meetings that would initially take place biweekly, but could be scheduled weekly as needed. This meeting was attended by the project coordinators from UFRPE, the agency to be scaled (TCE-PE), and the units involved, and was held from March to August 2024. During these meetings, in addition to presenting the objectives and the planned data collection schedule, the agency and UFRPE teams asked the managers of the selected organizational units to nominate a supporter for their teams. This supporter facilitated contact during the data collection process and will serve as a collaborator formally appointed by the manager to assist with subsequent tasks.

Issue	Description
Process Complexity	The existence of many steps and signatures in the leave-request workflow makes the process bureaucratic and time-consuming, causing delays and employee frustration.
Lack of Integration with Work Calendar	Without integration between the leave system and employees' calendars, paid-leave calculations can be wrong, leading to rework and manual adjustments.
Difficulties in Leave Accounting	Failures to record employees' return dates may trigger incorrect payments and inconsistent records, with financial and administrative impacts.
Accumulation of Employee Leave	Leave accumulation—although prohibited—still occurs, creating future labour liability risks and undermining leave management.
Inadequate Communication	Poorly communicated rules and procedures generate doubts and misunderstandings, hampering compliance with leave policies.

Table 4.2: Issues in the Leave Management System

In order to ensure the efficiency of the meetings, the team from the organizational unit that will be present at the interviews may be composed only of the manager and the designated supporter. Alternatively, other people from the unit may participate, as long as they are appointed by the manager and there is an explicit justification for the need for their support. The presence of these individuals will be conditioned on the justification presented by the manager.

During the closing of the inaugural meeting, the manager of the organizational unit will be asked to fill out a document, with or without the support of members of his/her team, within the deadline agreed upon during the meeting, not exceeding seven days. This document aims to collect preliminary information about the processes and deliverables carried out by the organizational unit. This information will be analyzed by the researchers to optimize the next meetings and guide the next steps of the research process.

This stage consisted of 4 meetings and the table 4.2 illustrates the main issues faced in the process were identified. The empathetic understanding phase was crucial to identify the particularities of the Court of Auditors of Pernambuco. The initial research and interviews allowed for a detailed diagnosis of the organization, facilitating the classification of the agency and the definition of the units and services to be dimensioned. This initial diagnosis guided all subsequent steps, ensuring that the solutions developed were appropriate to the specific context of the organization.

4.2.2 Problem Definition.

From the empathy phase, we moved on to problem definition, where the main objective of this stage was to clearly and objectively establish the scope of the problem to be solved, ensuring alignment among all those involved in the process. An in-depth understanding of the problem is essential for us to be able to develop effective solutions that are in line with the reality of the users.

To structure the analysis of the problem, we used the Ishikawa Diagram, also known as the cause and effect or fishbone diagram. This tool allowed us to map the possible causes of the problem in a visual and organized way, identifying factors such as processes, people, tools, methods and environment that directly impacted the situation under study. This artifact made it possible to prioritize the most relevant causes and helped in formulating initial hypotheses for the next stage.

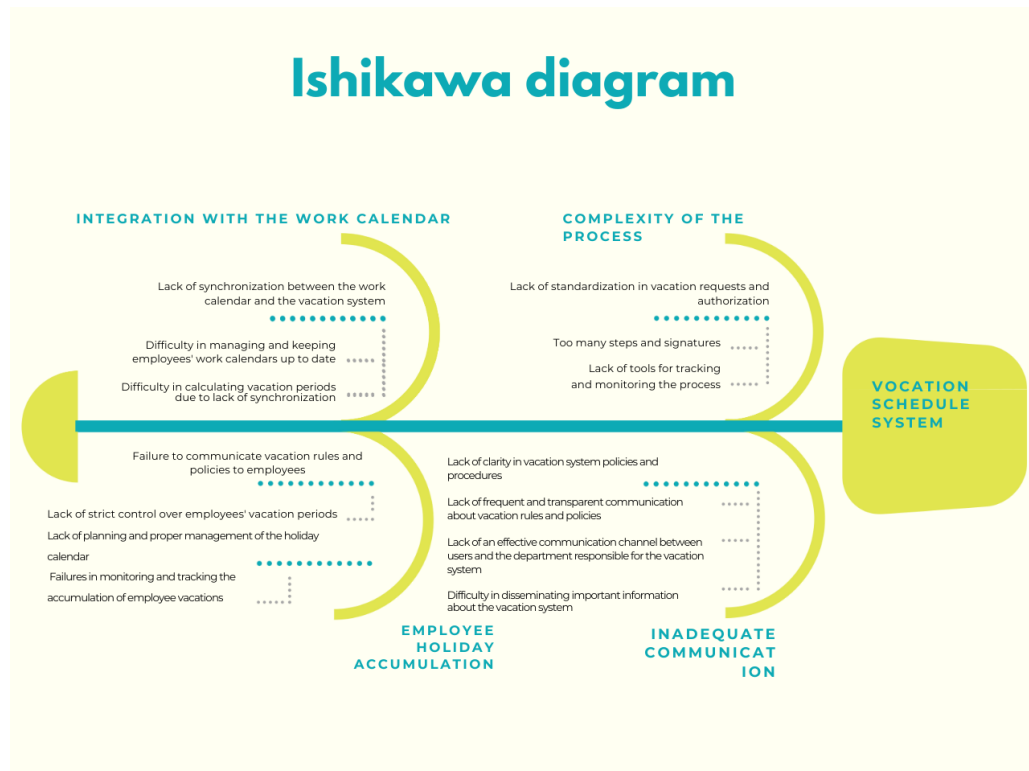


Figure 4.2: Ishikawa Diagram

In addition, we turned our attention to a more in-depth understanding of the users impacted by the process under study. The focus was to consolidate the information collected and validate whether the initial perception of the problem corresponded to the reality of all those involved.

We began this process with users from the DGP (Human Resources Management Department), where we created an Empathy Map and a Persona to represent this group. These two artifacts were essential to understanding their pain points, needs, expectations and behaviors in relation to the problem.

User Type	Stakeholders Summary
HR Personnel (DGP)	Maya hears that due to the low effectiveness of the current system, vacation days are accumulating. She feels frustrated with the rigid process and wants improvements. She constantly reviews requests and deals with heavy rework. She sees that technology in other areas is effective. Maya, 27, works in HR. She manages vacation requests and needs to integrate them with payroll. She ensures compliance with regulations and avoids excessive vacation accumulation. She is tech-savvy and aims to make the tool more user-friendly.
Employee	Lisa desires system integration and a mobile app for vacation tracking. She values flexibility and clear rules but struggles with the current complex system. She seeks an intuitive interface and shared calendars. Lisa, 27. She wants a simpler vacation request process, mobile access, and notifications. She struggles with process complexity and unclear information but sees opportunities in system improvements.
Manager	Carla hears employee concerns about work-life balance. She wants better internal communication about vacation policies. She feels pressure to manage requests fairly and is frustrated by the lack of clear visibility on vacation balances. Carla, 42, is a team manager. She needs detailed reports on vacation balances, efficient request coordination, and compliance with labor laws. She values technology solutions to automate notifications and decision-making.

Table 4.3: Stakeholders Summary

To validate this understanding, we created a form (A.2 and B.2) with pertinent questions, seeking to understand whether the DGP's perceptions were shared by others in-

volved in the vacation request and management process. The form was widely distributed among employees and managers, and its analysis generated two new Empathy Maps and two new Personas, expanding our view of the problem and ensuring that the proposed solutions were based on different perspectives.

The problem definition stage was essential to synthesize the information collected and identify the main challenges to be addressed. The collective interviews and the analysis of the documents submitted by the managers of the organizational units provided a clear overview of the internal activities and processes. This detailed understanding allowed the formulation of well-defined problems, which served as a basis for the ideation of innovative solutions. These artifacts were essential to deepen our understanding of the problem and ensure that the proposed Digital Transformation was truly user-centric, meeting their needs and resolving the identified pain points.

4.2.3 Ideation.

In this stage, a collaborative brainstorming session was held to generate a wide variety of creative ideas to solve the identified problem. All ideas were welcomed and explored without initial criticism, encouraging innovation and creativity. This phase focused on generating ideas and solutions to the identified problems. Initially, we held a group brainstorming session, in which we discussed various possible disruptions to solve the challenges faced. During this session, we explored different approaches and considered different perspectives to ensure a wide variety of ideas.

To evaluate the generated ideas, we constructed a solution matrix(see tab. 4.4). In this matrix, the Y-axis represented the expectations gathered from customers and stakeholders, while the X-axis represented the overall proposals developed by the team. Each idea was evaluated and scored according to its feasibility and alignment with the expectations of those involved. Based on the selected ideas, we moved forward to creating a prototype. The prototype served as a tangible representation of the proposed solution, allowing for a better visualization and understanding of how the solution would work in practice. This artifact was fundamental in directing the subsequent development of the solution, ensuring that it met the needs and expectations of end users.

	Current system	BPMN	Application
Feasibility	x	o	o
Usability	x	x	o
Maintainability	x	o	o
Monitoring	x	x	o

Table 4.4: Evaluation Matrix

The collaborative brainstorming session generated a wide variety of creative ideas to solve the identified problems. The use of a solution matrix allowed the evaluation and prioritization of the ideas based on feasibility and alignment with the expectations of the stakeholders. This process ensured that the selected solutions were not only innovative, but also practical and aligned with the needs of the end users.

4.2.4 Prototyping

The low and high fidelity prototypes developed during the prototyping phase were essential to test and refine the generated ideas. The use of mood boards and the incorporation of elements from existing tools, such as Google Calendar, ensured that the prototypes were intuitive and familiar to the users. This iterative approach allowed the prototypes to evolve based on employee feedback, resulting in solutions that were well-tuned to the real needs of the organization.

4.2.5 Testing and Evaluation.

In the testing and validation phase, the developed prototype underwent a series of rigorous evaluations to ensure its effectiveness and usability. These tests were conducted with users representative of the target audience, allowing the identification of possible flaws and areas that needed improvement. In addition, the prototypes were evaluated in a simulated or pilot environment with the collaboration of the Human Resources Department. User feedback was carefully collected and analyzed to measure the effectiveness and usability of the proposed solutions. Based on the results obtained, the prototypes were adjusted and refined as necessary until the final version of the product was reached.

4.2.6 Implementation and Iteration.

After the successful validation of the prototype, the project was forwarded to the software factory for the development of the final solution. This stage marked the transition from the design and prototyping stage to the practical implementation of the solution, where developers would work to transform the prototype into a functional and robust application. The involvement of the software factory at this stage would ensure that the prototype specifications and requirements are properly translated into code, culminating in the delivery of a final solution aligned with the expectations and needs of the end users and stakeholders involved in the project. Finally, the validated solutions will be implemented in the HR department's work environment. During this phase, special attention will be given to employee training and the integration of new practices into the existing workflow. In addition, a continuous monitoring and evaluation plan has been established to identify opportunities for improvement and iterate on solutions as needed.

4.3 Application of Design Thinking in Digital Transformation on legislative Management System for the Brazilian Court of Accounts

In order to fulfill the objectives outlined in this research, a design thinking-based framework was employed. This methodology, which is human-centered by nature, fosters innovation through multidisciplinary collaboration, empathetic understanding, and iterative prototyping (BROWN, 2009b). Design thinking consists of a structured sequence of interrelated phases, which will be systematically applied throughout this project to drive innovation within the Human Resources Department of the Court of Accounts of Pernambuco. Figure 4.3 depicts the implementation of the Design Thinking methodology as a catalyst for Digital Transformation.

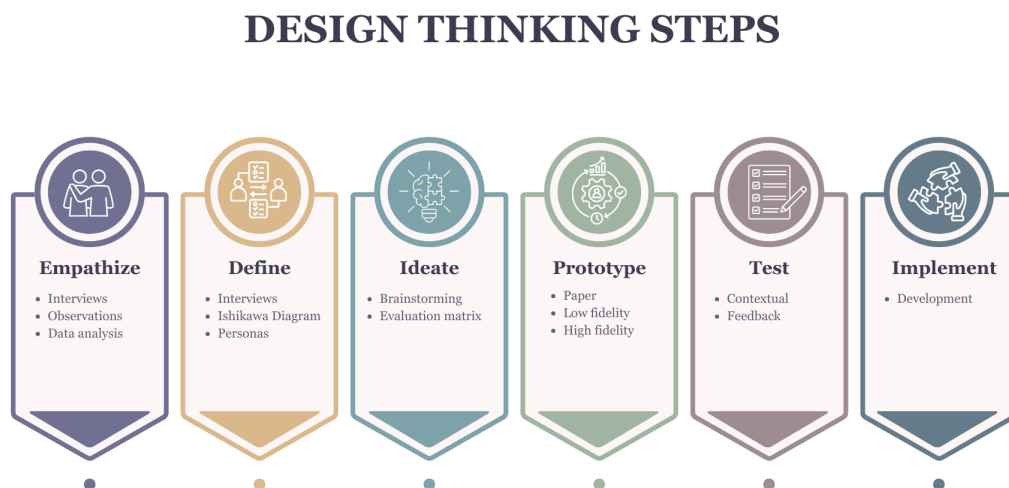


Figure 4.3: Stages in the Development of Design Thinking.

4.3.1 Empathic Understanding

Preparatory Phase: This initial phase focused on the systematic collection and analysis of organizational data to construct a holistic understanding of the institution's core functions, structural arrangements, workflow configurations, and managerial maturity. To this end, the research team conducted exploratory interviews with strategic stakeholders, aiming to surface perceptions of existing challenges and to contextualize the institutional environment, including the identification of relevant operational units. These engagements enabled the formulation of an initial problem framework and informed the prioritization

of critical issues to be addressed in the subsequent stages of the design process.

Kick-off Phase: Following the definition of the project scope and the confirmation of the research schedule, data collection activities were formally initiated through coordination meetings scheduled to occur biweekly, with the possibility of weekly sessions as needed. These meetings involved project coordinators from UFRPE, representatives from the Court of Accounts of Pernambuco (TCE-PE), and members of the selected organizational units. The engagements were conducted between October 2024 and April 2025, in alignment with the overall timeframe of the study.

During the inaugural session, the research objectives and the data collection timeline were presented. At that time, the coordination teams requested that each unit manager appoint a focal point—referred to as a supporter—who would act as a liaison between the research team and the organizational unit. This individual, formally designated by the manager, was responsible for facilitating communication and supporting the organization of the interviews throughout the research process.

To ensure the effectiveness and agility of the interviews, participation was generally limited to the unit manager and the designated supporter. Additional team members could be included, provided that their involvement was deemed necessary and explicitly justified by the manager based on the specific demands of the unit.

Issue	Description
Manual Legislative Registration	All legislative documents are registered manually and stored in physical folders, making the process slow, error-prone, and inefficient for consultation.
Low Traceability	The absence of a digital repository limits the ability to monitor updates and changes over time, hindering transparency and version control.
Difficulty in Information Retrieval	Information is accessed through a glossary-like paper filing system, which delays retrieval and increases the risk of misinterpretation.
Integration Challenges	The current workflow is not integrated with other tools or systems, making it difficult to incorporate automation or AI-driven solutions.
Knowledge Gaps	Users face difficulties in understanding the legislative process and tools, pointing to the need for training and clearer guidance.
Usability Constraints	The existing (manual) structure does not support intuitive navigation, automated queries, or user-friendly interaction.

Table 4.5: Identified Issues in the Legislative Management Process

All information regarding internal processes and deliverables was gathered directly through semi-structured interviews, eliminating the need for written documentation by the participants. This approach allowed the research team to capture rich, contextualized insights to guide the following stages of the study. The table [4.5](#) illustrates the main issues in the legislative management process.

4.3.2 Problem Definition

Following the empathy phase, we moved on to the problem definition stage, whose main objective was to clearly and objectively define the scope of the issue, ensuring a shared understanding among all participants. A well-defined problem is essential for the development of effective and realistic solutions, especially in public sector contexts where complexity and formal constraints are significant.

To support this analysis, we used the Ishikawa Diagram (Figure [4.4](#)), also known as the cause-and-effect or fishbone diagram. This visual tool allowed us to map the primary contributing factors to the inefficiencies identified in the management of internal legislation

at TCE-PE. The diagram organized potential causes across categories such as methods, infrastructure, people, documentation, and governance. It enabled the prioritization of root causes and informed the formulation of hypotheses that guided subsequent design phases.

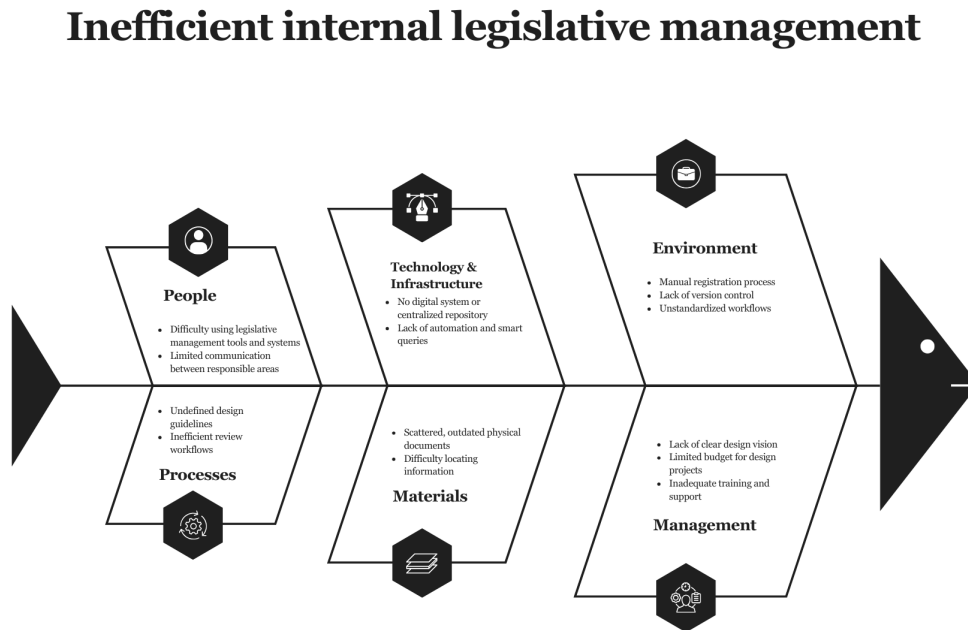


Figure 4.4: Ishikawa Diagram – Causes of Inefficient Legislative Management

In parallel, we developed a Persona (see [4.5](#)) to synthesize the characteristics, needs, and challenges of the main user involved in the legislative management process. This persona—Maya, 27 years old, a public servant who works directly with legislative documents—was built based on qualitative data collected through interviews with key actors.

Maya represents a proactive and adaptable professional, familiar with IT tools and open to adopting innovations. She seeks solutions that allow for better organization, automation, and retrieval of legislative information, while also ensuring security and traceability. Her main challenges include the limited integration of tools, manual routines, difficulty in performing automatic queries, and the need for a more user-friendly interface.

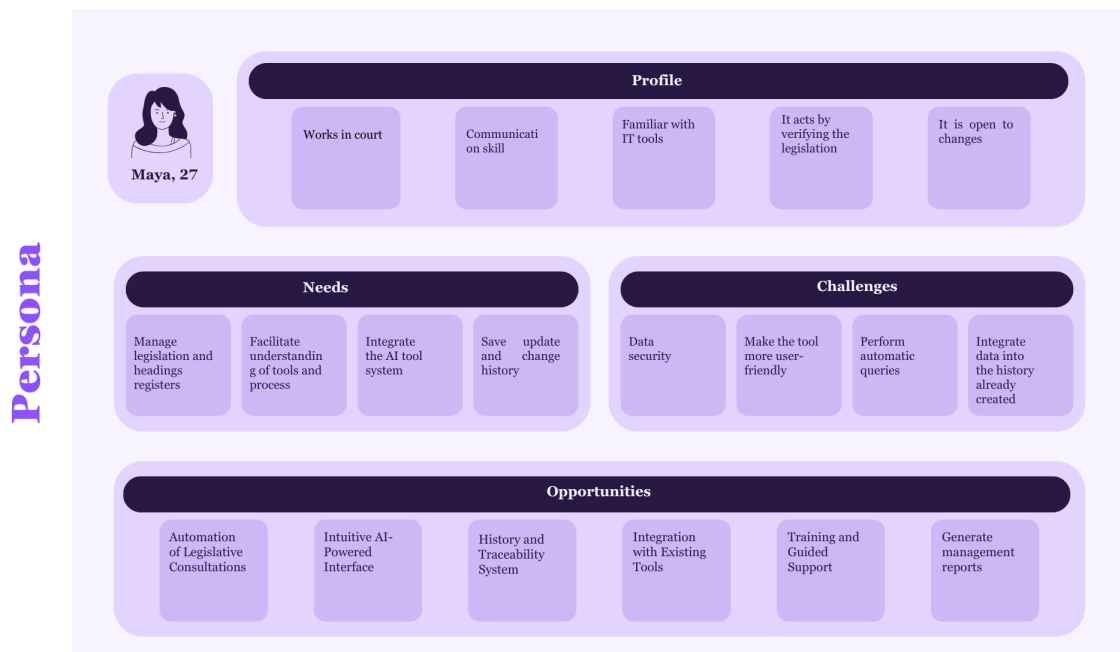


Figure 4.5: Persona – Maya, representative of the legislative documentation user profile

The persona proved to be a critical artifact to align design decisions with real user expectations and to maintain a user-centered focus throughout the innovation process. Unlike broader diagnostic studies that cover entire departments, our approach centered on a single persona, reflecting the project’s scope and targeted objective: rethinking the management of internal normative documentation within a specific institutional unit.

4.3.3 Ideation

In this phase, the focus was on exploring concrete alternatives to address the challenges identified in the legislative management process at TCE-PE. Rather than conducting an open-ended brainstorming session, the ideation stage was based on the evaluation of three targeted options: two existing tools available in the market, *Obsidian*¹, *Notion*² and a third option involving the development of a custom application tailored to institutional needs.

These alternatives were analyzed based on their potential to resolve pain points reported by users, particularly in terms of information organization, traceability, integration with existing workflows, and adaptability to the institutional context.

¹Disponível em: <<https://obsidian.md>>.

²Disponível em: <<https://www.notion.so>>.

Criteria	Obsidian	Notion	Custom Application
Usability	o	o	o
Customization	x	x	o
Institutional Integration	x	x	o
Maintainability	x	x	o
Learning Curve	o	o	x
Collaboration Capabilities	x	o	o
Security and Access Control	x	x	o

Table 4.6: Evaluation matrix comparing proposed tools and the custom solution

A solution matrix (Table 4.6) was constructed to support the decision-making process. The matrix used evaluation criteria such as usability, customization, institutional integration, maintainability, and learning curve. Each option was assessed in terms of its advantages (marked as "o") and limitations (marked as "x") in relation to the expectations of end users and technical feasibility.

Although Obsidian and Notion demonstrated certain strengths—especially in usability and documentation structuring—they lacked critical features such as deep customization, institutional data governance, and secure integration with legacy systems. These constraints reinforced the value of building a custom application from scratch, designed specifically to accommodate the organizational and technical requirements of TCE-PE.

This analysis helped simulate real usage scenarios and supported a more informed, evidence-based selection of the path to be prototyped in the next phase.

4.3.4 Prototyping

Based on the insights gathered in the previous phases, a prototype of the proposed legislative management system was developed, following an iterative process from low to high fidelity. The objective was to visualize the solution in practice, evaluate its usability, and ensure alignment with user expectations and institutional demands.

The prototyping process was conducted using the collaborative design platform Figma, with progressive refinements guided by user feedback. For the purpose of this dissertation, we present three key screens from the final version of the system, which was later implemented and validated:

The **Figure 4.6** shows the main interface for browsing internal legislative acts. It allows users to view a list of documents with color-coded status indicators (e.g., “Revogada” or “Vigente”) and access the full content of each law.

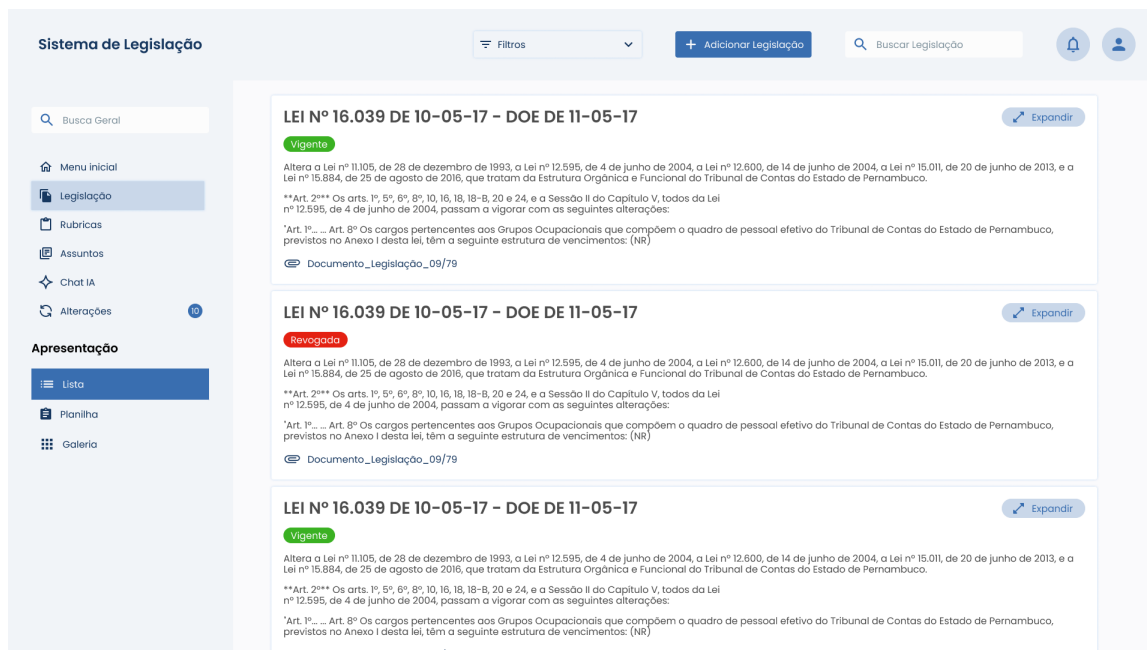


Figure 4.6: Main legislation list interface, with status markers and summarized excerpts

The **Figure 4.7** illustrates the detailed view of a legislative act. This interface provides access to metadata such as publication dates, legal references, and associated attachments. It also includes links to related rubrics and allows users to edit or update the information if authorized.



Figure 4.7: Detailed view of a selected legislative document, including metadata and historical tracking

The **Figure 4.8** presents the integrated AI assistant interface. The assistant responds

to users’ natural language queries, offering contextualized summaries and links to relevant documents based on keywords or expressions. It exemplifies how conversational interfaces can enhance accessibility and legislative understanding.

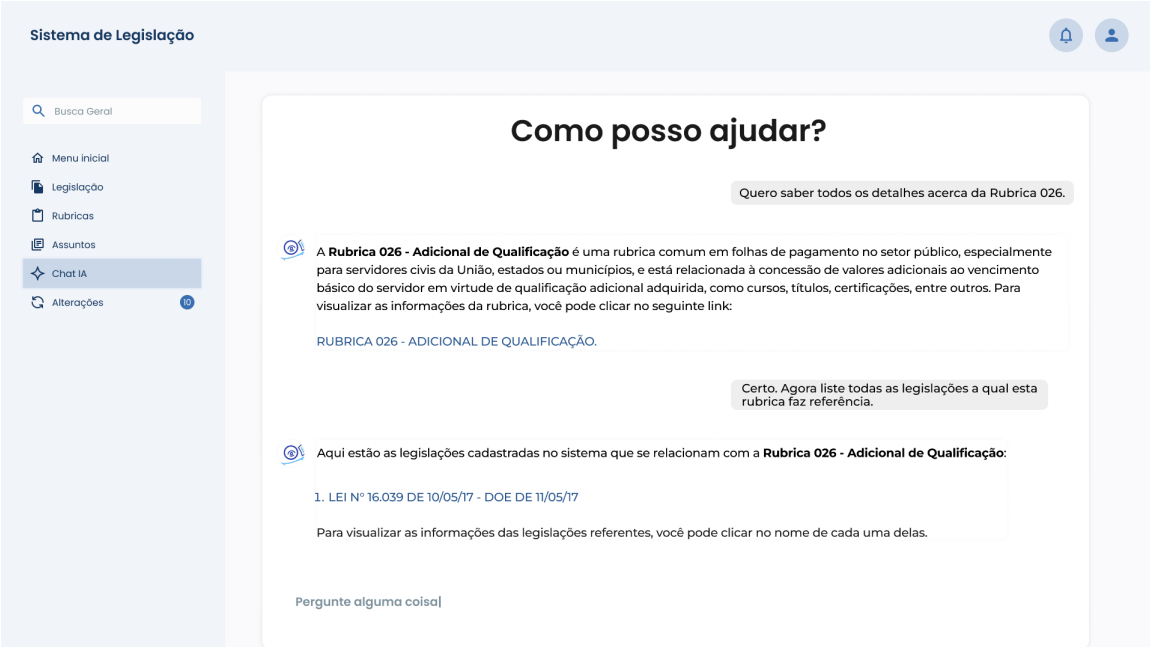


Figure 4.8: Integrated AI assistant interface, responding to user queries and suggesting legislation

As the process evolved, the prototype was refined into high-fidelity interfaces that reflected the system’s visual identity, interactive behavior, and detailed functionalities. Updates were made based on feedback collected during previous rounds, always grounded in the needs identified during the empathy and problem definition stages. Particular attention was given to aspects such as information architecture, search and filtering features, document versioning, and overall usability.

Throughout the prototyping phase, several feedback cycles were conducted, both asynchronously through comments made directly in the prototype and synchronously in live usability testing sessions. This iterative approach ensured that the solution remained user-centered, feasible, and closely aligned with the institutional context. Although the system contains additional features—such as different types of listings, legislation registration, update control, editing history, and attachment management—these three screenshots were selected for practical presentation purposes. Together, they provide a representative overview of the platform’s core functionalities and user-centered design. The final prototype served as a communication tool between stakeholders and development teams, and as a foundation for future implementation.

4.3.5 Testing and Evaluation

In the testing and evaluation phase, the high-fidelity prototype was subjected to a series of validation activities with users directly involved in the legislative documentation process. These users were selected for their familiarity with the daily operational challenges and contributed critical insights regarding the system’s usability, clarity, and alignment with institutional needs.

The tests were conducted in both synchronous sessions—such as virtual walkthrough and screen sharing demonstrations—and asynchronous evaluations, where users explored the prototype independently and submitted structured feedback. Emphasis was placed on assessing how well the solution supported activities such as document consultation, version control, and metadata management.

Feedback from these sessions was carefully compiled, categorized, and analyzed to identify usability issues, unmet requirements, and improvement opportunities. Based on this input, refinements were made to interface elements, navigation logic, and functionality prioritization. This evaluation loop ensured that the final version of the prototype not only adhered to design principles but also reflected the lived experiences of the target users.

4.3.6 Implementation and Iteration

Following successful validation, the project entered the implementation phase. The refined prototype served as the foundation for the technical specification and handoff to the software development team responsible for building the final system. The transition from design to development was supported by well-documented user flows and interface models produced in the prototyping stage.

Throughout implementation, the design team remained engaged to ensure that key usability aspects and functional priorities were preserved during development. The solution was deployed in the working environment of the relevant unit, with special attention given to onboarding sessions and initial technical support for staff members.

An iterative model was adopted to monitor system use and address unforeseen issues post-deployment. Continuous feedback mechanisms—such as check-in meetings, usage metrics, and user suggestions—were put in place to guide future improvements. This approach ensured that the implemented system would evolve in response to real-world demands and support sustainable innovation within the institution.

Chapter 5

Discussion

This chapter synthesises the findings from the three case studies conducted at the *Tribunal de Contas do Estado de Pernambuco* (TCE-PE) and interprets them in light of extant literature on Digital Transformation, Design Thinking (DT) and public-sector innovation. The discussion is structured around the five DT phases—empathize, define, ideate, prototype, test/implement—followed by practical implications and avenues for further research.

5.1 Empathize: Contextual Insights

The initial phase of the research emphasized understanding user needs and organizational pain points through structured qualitative inquiry. As detailed in Article 4.1, a needs-assessment workshop involving cross-functional stakeholders generated **103 qualitative contributions**, which exposed critical bottlenecks in HR workflows—including fragmented data flows, manual rework in leave requests, and low system integration.

These findings were reinforced through semi-structured interviews conducted with seven H managers (Article 4.2) and fifteen legislative staff members (Article 4.3). While focused on distinct domains, both groups reported similar difficulties in locating up-to-date information—be it for vacation planning or normative-document retrieval. This consistency across contexts suggests systemic gaps in information traceability, user autonomy, and process alignment.

The triangulation of insights across these exploratory activities reflects the core of the “empathize” phase in Design Thinking, which prioritizes the construction of shared understanding and a sense of ownership among participants. By foregrounding the lived experiences of end-users, the study operationalizes the principles advocated by (BROWN, 2009a) and further explored by (MARIANI; PEREIRA, 2025), who argue that successful public-sector innovation depends on deep contextual knowledge and early stakeholder engagement.

These insights laid the groundwork for subsequent phases, enabling problem definitions and design solutions that were both technically feasible and socially embedded.

5.2 Define: Converging on Root Problems

Building on the insights gathered during the empathize phase, the research moved toward the synthesis and interpretation of recurring patterns through structured analytical tools. Using Ishikawa diagrams and affinity mapping, four cross-cutting pain points were identified across the domains studied. These included process fragmentation, limited data integration, normative complexity, and gaps in search and traceability.

This analytical convergence reflects the “define” stage in Design Thinking, where loosely articulated user concerns are translated into clear, actionable problem statements. Such framing is particularly critical in public-sector contexts, where bureaucratic inertia and competing institutional agendas often make it difficult to build consensus around innovation priorities.

By operationalizing these tools, the research responded to the call for “bounded experimentation” in government innovation—i.e., designing interventions that are both feasible and minimally disruptive to organizational routines (LIEDTKA, 2023a). The conceptual clarity achieved at this stage proved essential not only for aligning stakeholders but also for securing executive sponsorship and establishing shared criteria for solution evaluation. It marked a turning point in the process, transforming divergent pain points into a coherent foundation for ideation and prototyping

5.3 Ideate: Generating and Evaluating Alternatives

The ideation phase focused on collaboratively exploring solution directions grounded in the previously defined problem statements. Through structured brainstorming sessions with multidisciplinary stakeholders, more than 40 raw ideas were generated—ranging from off-the-shelf tools to fully customized systems.

To evaluate and prioritize these alternatives, a weighted decision matrix was applied. This analytical step enabled participants to assess each option against predefined criteria, such as feasibility, user familiarity, integration potential, and auditability.

Ultimately, stakeholders favored the custom solution due to its alignment with existing authentication systems, ability to enforce audit trails, and potential for incremental refinement. This decision-making process mirrors recent frameworks that categorize public-sector innovation pathways into “reuse, adapt, or build” strategies (BRINKMAN; SILVA, 2023), while highlighting the importance of co-creation and technical fit in government settings.

Rather than treating ideation as a creative exercise detached from implementation constraints, the study embedded critical feasibility thinking into the innovation cycle—balancing aspiration with operational realism.

5.4 Prototype: From Low-Fi to High-Fi

The prototyping phase followed an incremental fidelity strategy, aimed at rapidly validating concepts while minimizing development overhead. Initial paper sketches were used to simulate key interactions and gather early feedback from stakeholders in an informal setting. These low-cost artifacts accelerated feedback loops and reduced resistance by allowing users to comment on structure and logic without being distracted by aesthetics.

Building on this foundation, mid-fidelity wireframes were developed in Figma and presented to 48 professionals in a series of guided walkthrough sessions. These interactions revealed usability barriers, clarified data-flow expectations, and prompted adjustments in screen layout and terminology—particularly in vacation-management features.

For the final validation stage, high-fidelity prototypes were constructed, incorporating interface elements modeled after familiar tools. For instance, Google-Calendar-like interactions facilitated intuitive leave scheduling, while metadata-rich cards enhanced the search and retrieval of legislative content. These design choices aimed to reduce cognitive load and increase user acceptance, especially in a context where bureaucratic rigidity and legacy systems often hinder digital tool adoption.

This layered prototyping strategy aligns with established best practices for public-sector innovation, as outlined by (MERGEL, 2019), who emphasize that progressive validation and early user involvement are key to achieving meaningful digital transformation in complex institutional environments.

5.5 Test & Implement: Validating and Scaling

The final phase of the innovation cycle involved validating the usability and performance of the developed prototypes, followed by small-scale implementation within the host institution.

In parallel, a pilot deployment of the vacation-management system was carried out within the HR department. Operational metrics collected before and after implementation indicated a reduction in average leave-approval time—from five to two working days. This performance improvement echoes findings from other Latin-American e-HR modernization efforts, which also report significant gains in process efficiency through digital workflow consolidation (LUNA, 2023).

While these early outcomes are promising, long-term success depends on sustained managerial engagement and the establishment of feedback mechanisms to support con-

tinuous improvement. This remains a critical challenge in many public-sector contexts, where digital systems are often launched without sufficient support for adaptation or iteration (HEEKS, 2020). Institutionalizing user-centered innovation requires not only technical deployment, but also cultural change—embedding co-creation practices into everyday decision-making and governance structures.

The study thus underscores that testing and implementation should not be treated as an endpoint, but rather as the beginning of a continuous transformation cycle.

5.6 Practical Implications

The findings of this study offer practical implications for public-sector organizations seeking to overcome institutional inertia and advance digital transformation through user-centered innovation. By addressing long-standing challenges such as bureaucratic fragmentation, information traceability, and process opacity—issues widely reported in the literature on digital government and HR modernization (CARDOSO, 2011a; LUNA, 2023; SNIDER; FARIA, 2022)—this research provides a concrete example of how Design Thinking can be operationalized in high-accountability environments.

- **Scalable DT practices.** The staged prototyping approach—moving from low-fidelity sketches to high-fidelity digital solutions—demonstrates a practical pathway for gradual implementation, enabling early feedback and alignment with institutional constraints. This method can serve as a replicable blueprint for audit courts and other oversight bodies looking to modernize workflows without risking operational disruption, as emphasized by recent frameworks on public-sector innovation capacity (BRINKMAN; SILVA, 2023; MERGEL, 2019).
- **Data-driven HR.** The integration of leave data with broader workforce metrics lays the foundation for evidence-based decision-making in human-resources management. This supports talent-analytics frameworks (DAVENPORT; HARRIS, 2010) and directly responds to the common bottlenecks in fragmented HR systems reported across Latin America (LUNA, 2023).
- **Legislative traceability.** The metadata-rich legislative repository enhances normative version control, improves searchability, and reduces interpretive ambiguity—addressing a frequent pain point in Brazilian audit institutions. These improvements align with transparency mandates and accountability requirements, echoing findings from European models of legislative knowledge management (SNIDER; FARIA, 2022).

Taken together, these contributions show that public-sector digital transformation depends not only on deploying new systems, but also on adopting participatory, iterative,

and context-sensitive design practices that align technical innovation with institutional realities.

5.7 Lessons Learned

This study validates the transformative potential of Design Thinking in the public sector and offers practical insights for institutions aiming to restructure internal processes through user-centered innovation. The following lessons summarize key takeaways that can inform future digital transformation initiatives, especially in bureaucratic and high-compliance environments such as audit courts.

- **Start small, iterate fast.** Addressing a focused and bounded challenge—such as legislative knowledge management—enabled rapid experimentation, minimized resistance, and delivered early value. This reflects the concept of “bounded experimentation” in public innovation contexts (LIEDTKA, 2023b);
- **Ground design in real personas.** Anchoring the process around a representative persona (e.g., Maya) helped maintain alignment with user needs across all phases, ensuring coherence in design decisions;
- **Technology is an enabler, not the solution.** While tools like Obsidian and Notion informed early ideas, success depended on translating user needs into customized functionalities rather than relying on off-the-shelf features;
- **Stakeholder engagement drives relevance and adoption.** Active involvement of end users, managers, and IT staff from the outset ensured contextual alignment, encouraged ownership, and strengthened institutional buy-in—echoing Brinkman et al.’s emphasis on collaboration for effective digital delivery (BRINKMAN et al., 2023);
- **Institutionalization is key to sustainability.** For Design Thinking to generate lasting impact, it must be embedded into the organization’s culture, routines, and governance structures—not confined to innovation labs or one-off projects (MARIANI et al., 2025);
- **Diverse data collection improves diagnosis.** Combining interviews, surveys, and focus groups enabled a multidimensional understanding of pain points and priorities—capturing both the operational and emotional dimensions of the problems;
- **Rigorous analysis ensures clarity.** The use of Thematic Synthesis and Grounded Theory principles allowed for the emergence of patterns and causal relationships, guiding more precise and targeted solution development.

- **Interdisciplinary collaboration adds depth.** Involving experts from HR, IT, psychology, and public administration brought diverse perspectives, resulting in more robust, realistic, and creative problem-solving;
- **Stakeholder feedback increases solution fit.** Iterative feedback loops improved the relevance and usability of the final artifacts, fostering acceptance and trust among users.
- **Strategic prioritization optimizes effort.** Focusing on high-impact issues first enabled more efficient allocation of resources, avoiding dispersion and generating meaningful early wins;
- **User experience drives engagement.** Centering design on usability and accessibility resulted in higher adoption rates and better alignment with user expectations—essential for digital transformation in legacy-driven environments;
- **Continuous improvement sustains relevance.** Embedding iterative evaluation mechanisms ensures that systems remain responsive to evolving organizational needs, enabling adaptation over time.

Together, these lessons reinforce that Design Thinking, when applied with methodological rigor and contextual sensitivity, is not only a tool for innovation but also a strategic enabler of digital transformation and cultural change in public administration.

5.8 Limitations

Although this dissertation was successfully applied within the context of the Pernambuco Court of Accounts (TCE-PE), its generalisation to other settings should be undertaken with caution. The foremost limitation concerns the organisational and cultural specificities of the environment studied. The institutional nature of TCE-PE, as well as the structure of its human-resources team, directly influenced both the needs-assessment phase and the development of the solution.

- L1. Single-organisation scope.** All three case studies were conducted within one audit institution. Organisational culture, legacy systems and governance structures may differ significantly in other courts of accounts or public agencies, limiting external validity (YIN, 2018).
- L2. Sample size and selection.** Purposive sampling yielded 22 interviewees and 115 survey responses, sufficient for exploratory insights but not for inferential statistics across demographic sub-groups. Future work should employ stratified sampling or increase participant numbers to enhance representativeness.

- L3. Short evaluation window.** Performance indicators—e.g. 60 % reduction in leave-approval time and measured during a three-month pilot. Long-term adoption patterns, maintenance costs and organisational learning effects remain unexamined.
- L4. Limited indicator depth.** The study tracked aggregate approval time and perceived usability, but did not collect fine-grained metrics such as task-completion time, error rates or Net Promoter Score. A richer dashboard of quantitative indicators would allow stronger causal inferences and benchmarking against other e-HR initiatives (BROOKE, 2019).
- L5. Researcher bias and reflexivity.** The first author facilitated workshops and coded qualitative data, raising risk of confirmation bias. Peer debriefing and an audit trail were employed, yet dual-coding of the entire dataset was not feasible, leaving residual subjectivity (MILES; HUBERMAN; SALDAÑA, 2014).
- L6. Technological constraints.** Prototypes were developed with tools already licensed by TCE-PE (Figma, Excel, Nextcloud). Alternative stacks (e.g. open-source CMS, advanced analytics) were not evaluated, which may limit portability to organisations with different toolchains.
- L7. Regulatory and policy dynamics.** Ongoing reforms in Brazil’s digital-government legislation could alter legal requirements for data protection, accessibility and audit traceability, potentially affecting the relevance of the proposed artefacts over time.

In addition, the long-term impacts of the proposed solutions could not be fully assessed. Longitudinal studies are required to verify the sustainability of the improvements implemented, as suggested by authors who discuss Digital Transformation in the public sector (JONATHAN, 2020; OTIA; BRACCI, 2022).

5.9 Future Work

Future research should apply the methodology developed in this study to other public-sector organizations in order to validate its adaptability to diverse institutional contexts. Extending the multi-case approach to different administrative domains—such as education, health, or public safety—could test its scalability and highlight potential adjustments needed to accommodate varying levels of digital maturity, organizational culture, and legal constraints.

Another promising direction involves deepening the integration between Design Thinking and agile development practices. Iterative prototyping cycles, combined with mechanisms for real-time feedback and incremental delivery, may enhance the responsiveness and sustainability of digital solutions in government settings.

Additionally, future studies could explore the use of emerging technologies—such as artificial intelligence, natural language processing, and semantic search—to improve information retrieval and decision-making in both human-resources and legislative processes. These technologies may help address long-standing challenges related to unstructured data and fragmented systems.

Finally, a longitudinal evaluation of the digital-transformation initiatives piloted at TCE-PE is recommended. Tracking key performance indicators—such as process efficiency, system usability, data transparency, and user satisfaction—over time could generate robust evidence about the long-term impacts of user-centered innovation in audit institutions.

Chapter 6

Conclusion

This dissertation contributes to the field of public-sector innovation by demonstrating how user-centered methodologies can drive digital transformation in legally constrained and bureaucratic institutional settings. By combining Design Thinking (DT) with a multi-case study protocol, the research provides both theoretical and practical insights into how public organizations can structure their innovation efforts around the needs of real users.

From a scholarly perspective, this work advances the literature by detailing the end-to-end process—from diagnosis to solution delivery—across three complementary cases. The first case focuses on organizational needs assessment, revealing structural barriers in leave-management processes through the use of both qualitative and quantitative methods. These findings illuminate issues related to system fragmentation, approval bottlenecks, and lack of data integration (CARDOSO, 2011b; LANE, 1993; NIGRO, 1984). The other two cases illustrate how Design Thinking can be used to co-create and validate digital solutions through iterative prototyping, stakeholder engagement, and feedback loops—highlighting empathy, ideation, and usability testing as essential stages in public-sector digital innovation (BROWN, 2009b; MELO; ABELHEIRA, 2015; SILVA et al., 2012).

Recent studies reinforce this view: Gemser *et al.* (2025) show how design-thinking-mediated co-creation improves multistakeholder project outcomes (GEMSER; CALABRETTA; KARPEN, 2025); Mariani *et al.* (2024) explore how design practices can translate into long-term capability-building in public-sector digital transformation ecosystems (MARIANI et al., 2024); and Petzolt & Seckler (2025) emphasize the human dimension of digital transformation through tools that support the identification of innovation champions (PETZOLT; SECKLER, 2025).

Importantly, this research shows that digital transformation must go beyond the digitization of existing procedures. It must promote structural changes aligned with the lived experiences of users—whether civil servants or citizens—by fostering collaborative design, data-informed decisions, and iterative experimentation (HANELT et al., 2021; MERGEL et al., 2018). In this sense, the methodology and artifacts developed at the Court of

Auditors of Pernambuco (TCE-PE) serve as a replicable example of how Design Thinking can catalyze sustainable transformation in people-management and legislative-knowledge systems. By aligning technological solutions with user needs, the study contributes to more effective, transparent, and adaptable public services.

6.1 Published Articles

6.1.1 Papper 1 - Development of a Human Resources Management Platform at TCE-PE: A Needs Assessment Report

Title: Development of a Human Resources Management Platform at TCE-PE: A Needs Assessment Report

Event: Workshop on Applied Computing in Electronic Government (WCGE 2024)

Status: Published

This article presents a diagnostic investigation conducted at the Court of Auditors of the State of Pernambuco (TCE-PE), whose objective was to identify weaknesses in the internal processes of the people management area, such as excessive bureaucracy, disintegrated systems and communication failures.

6.1.2 Papper 2 - Application of Design Thinking in Digital Transformation in Human Resources in the Public Sector

Title: Application of Design Thinking in Digital Transformation in Human Resources in the Public Sector

Event: 26th Annual International Conference on Digital Government Research (dg.o 2025)

Status: Published

This article describes the practical application of the Design Thinking approach to the construction and validation of a digital solution focused on vacation management. Together, the studies complement each other by covering, respectively, the identification of needs and the prototyping of innovative user-centered solutions, offering a replicable model of Digital Transformation in the public sector.

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Appendix A

Surveys

Code	Question
SQ01	What needs do you have?
SQ02	What problems do you see with DGP systems and services?

Table A.1: Survey questions – Case 1

Code	Question
SQ03	What is your department?
SQ04	What is your current position at the TCE?
SQ05	On a scale of 1 to 4, how would you rate your overall satisfaction with the current vacation request process?
SQ06	What features do you miss in the vacation request process?
SQ07	What are the main difficulties you face in the vacation request process?
SQ08	What would you like to see improved in the vacation request process?
SQ09	How often do you need to check your team's vacations?
SQ10	On a scale of 1 to 4, how would you rate your satisfaction with your team's vacation authorization process?
SQ11	What information is important for you to consider when approving a vacation request?
SQ12	What are the main challenges you face when managing your team's vacation requests?
SQ13	What would you like to see improved in your team's vacation request process?

Table A.2: Survey questions – Case 2

Appendix B

Interviews

Code	Question
IQ01	What are the biggest challenges you currently face in human resources management?
IQ02	At which stage of the HR process do you observe most rework or delays?
IQ03	How are HR information recorded and shared across departments?
IQ04	Which systems or spreadsheets do you consider critical but in need of improvement, and why?
IQ05	If you could change one aspect of the HR process, what would it be and why?

Table B.1: Interview questions - Case 1

Code	Question
IQ06	Could you describe the step-by-step workflow you follow when an employee requests vacation?
IQ07	Where do errors or inconsistencies most frequently occur in this routine?
IQ08	How do you check for overlapping vacations within your team?
IQ09	Which indicators or reports would be useful to monitor leave balance and planning?
IQ10	In your opinion, the ideal system would need to integrate with which tools or data sources?

Table B.2: Interview questions - Case 2

Code	Question
IQ11	When you need to locate an internal normative act, what steps do you usually take?
IQ12	Do you encounter difficulties determining whether an act is current or has been amended or repealed?
IQ13	How are versions or amendment histories of these documents recorded today?
IQ14	Which type of search (subject, number, date, keyword) do you use most often?
IQ15	How does the absence of a central repository impact your daily work?
IQ16	If you have tried other tools (e.g., Notion, Obsidian), what worked well and what did not?
IQ17	What alerts or notifications would be useful (e.g. normative change, review deadlines)?

Table B.3: Interview questions - Case 3