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MIM-PS: A Mapping and Improvement Methodology for the Public Sector
MIM-PS: Uma Metodologia de Mapeamento e Melhoria para o Setor Público

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Abstract. *Continuous improvement in public institutions requires effective methods for process mapping and optimization but faces barriers such as bureaucracy, political changes, and stakeholder diversity. This paper presents the Process Mapping and Improvement Methodology for the Public Sector (MIM-PS), derived from the Business Process Management (BPM) cycle and tailored to the public context. The MIM-PS considers process maturity and complexity, enabling flexible application. Validated in three sectors of the Pernambuco State Court of Accounts, the methodology resulted in productivity and agility gains, demonstrating its applicability across different levels of organizational maturity. Beyond enhancing institutional efficiency, MIM-PS contributes to the field of Information Systems by integrating processes, data, and technology, strengthening the use of information in digital transformation and public governance.*

Keywords. *BPM; Process Mapping and Improvement; MIM-PS; Public Institutions.*

Resumo. *A melhoria contínua em instituições públicas requer métodos eficazes de mapeamento e otimização de processos, mas enfrenta barreiras como burocracia, mudanças políticas e diversidade de stakeholders. Este artigo apresenta a Metodologia de Mapeamento e Melhoria para o Setor Público (MIM-PS), derivada do ciclo de Gerenciamento de Processos de Negócio (BPM) e voltada ao contexto público. A MIM-PS considera a maturidade e a complexidade processual, permitindo uma aplicação flexível. Validada em três setores do Tribunal de Contas de Pernambuco, a metodologia resultou em ganhos de produtividade e agilidade, demonstrando sua aplicabilidade em*

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diferentes níveis de maturidade organizacional. Além de aprimorar a eficiência institucional, a MIM-PS contribui para o campo de Sistemas de Informação ao integrar processos, dados e tecnologia, fortalecendo o uso da informação na transformação digital e na governança pública.

Keywords. *BPM; Mapeamento e Melhoria de Processos; MIM-PS; Instituições Públicas.*

1. Introduction

Process management consists of practices aimed at improving organizational processes to enhance the company's performance and results [Gonçalves et al. 2021]. This approach has gained increasing importance in business due to its ability to provide innovative solutions and advances in management, enabling an integrated view of all organizational activities [Kanaane et al. 2012, Gonçalves et al. 2021]. A properly mapped process serves as a training guide for new employees and facilitates the identification and sharing of best practices, preparing the organization for potential changes [Gonçalves et al. 2021, Silva et al. 2023]. Moreover, the continuous improvement of processes is essential for organizations to adapt to the constant changes in their operational environment and maintain their market competitiveness [Paim et al. 2009]. Therefore, by investing in mapping and continuous improvement, organizations not only ensure operational efficiency but also build a culture of resilience and innovation, which is crucial for addressing future challenges [Nascimento et al. 2023, da Costa Almeida et al. 2019].

Both public and private institutions face challenges in process and information management [Aganette 2020]. One of these challenges is the centralization of responsibilities, which obstructs the proper transmission of information and increases the risks of inconsistencies and errors in documentation and mapping, especially in larger organizations where processes are more complex and involve multiple departments [Silva et al. 2024]. However, the public sector presents unique characteristics that differentiate it from the private sector, particularly in how its processes are structured and evolve over time. These differences arise from distinct developmental contexts, which vary between developed and developing regions, as well as from internal organizational dynamics that shape how processes are designed, mapped, and improved [Syed et al. 2018].

Public sector processes are often characterized by bureaucracy, rigidity, and complexity, typically influenced by factors such as public interest, changes in administrative tools, governmental transitions, and cultural dynamics [Papadopoulos et al. 2018]. The clients of these processes constitute a complex and diverse group of citizens [Syed et al. 2018], requiring an efficient allocation of public resources to adequately meet their needs. Additionally, public institutions have faced increasing demands for accountability to promote transparency, strengthen democracy, and improve public management [Filgueiras 2011]. Therefore, adopting an efficient methodology for process mapping and improvement is essential to adequately address these challenges.

In this context, approaches such as BPM (Business Process Management) are frequently used for process mapping and improvement in public and private institutions,

driven by the aim of achieving efficiency. This approach encompasses a set of techniques ranging from modeling to monitoring organizational processes, with the goal of guiding activities more efficiently and effectively [Silva et al. 2024]. Studies have proposed methodologies adapted to different contexts. For instance, in De Moura et al. (2019), improvements in business processes for Federal Institutes (Institutos Federais – IFs) were suggested using BPM and quality management. Similarly, in Silva et al. (2019), a process mapping and analysis model was developed for the private sector, also utilizing BPM. However, there remains a significant gap in the literature regarding methodologies that consider the specificities of the public sector, highlighting the need for new approaches designed to meet the unique characteristics of this sector.

This paper proposes the Mapping and Improvement Methodology for the Public Sector (MIM-PS), applied as a case study to the Pernambuco State Court of Accounts (TCE-PE). Integrating qualitative and quantitative elements, the methodology maps, analyzes, and improves processes through detailed interviews and problem analysis, following BPM cycle stages. This work is guided by the research question: "How can a process mapping and improvement methodology be adapted for the public sector to enhance efficiency and management?" Adopting an action research approach, MIM-PS was implemented across three TCE-PE sectors with varying levels of process maturity, ranging from well-established processes to those with undefined flows and others yet to be executed. This diversity emphasized the methodology's ability to adapt to different organizational contexts and requirements. In addition to describing each stage in detail, the study discusses the main challenges and solutions encountered during implementation, emphasizing how these findings contribute to the refinement of process management in the public sector. The main contribution to the field of Information Systems (IS) lies in integrating processes, data, and technology to strengthen the use of information in digital transformation and public governance. Furthermore, by mapping, documenting, and standardizing public organization processes, MIM-PS clarifies internal operations and promotes transparency, addressing one of the major challenges in Information Systems in Brazil [Boscarioli et al. 2017].

This work is organized as follows: in Section 2, in addition to a brief description of the institution where the work was carried out, the concepts and methods related to process mapping and improvement are presented. Section 3 provides a succinct overview of a set of related works, reporting their respective application contexts, the techniques developed, and the results achieved in each of them. The research method is detailed in Section 4. The proposed MIM-PS is presented in Section 5, followed by the results of its implementation in Section 6. Section 7 discusses the benefits and lessons learned during the implementation of the proposed methodology. Section 8 addresses the threats to validity faced during the execution of this study. Finally, Section 9 presents the final considerations.

2. Foundation

This section provides a brief description of the TCE-PE, as well as its role in Brazilian society. Additionally, basic concepts related to the BPM approach and BPMN (Business Process Model and Notation) are discussed.

2.1. Court of Accounts of the State of Pernambuco

The TCE-PE is an independent oversight body that operates as an auxiliary institution to the Legislative Assembly, with administrative and financial autonomy in relation to the Legislative, Judicial, and Executive branches [Nascimento et al. 2023]. Founded on December 12, 1967, its primary function is to audit and supervise accounting, financial, budgetary, and operational activities within Pernambuco's municipal and state public administration, covering both direct and indirect administration [Oliveira 2017]. The TCE-PE ensures compliance with legality, legitimacy, efficiency, and economic rationality in public financial management, identifying irregularities and promoting transparency in the use of public resources [Tribunal de Contas do Estado de Pernambuco (TCE-PE) 2024].

This investigation, conducted as an action research study, involved direct collaboration with public servants from these sectors to map, analyze, and implement process improvements. The findings reveal key challenges and insights within this institutional setting, contributing to a structured and adaptable methodology for improving public administration processes.

2.2. Business Process Management

The BPM approach evolved from the gradual merging of various process improvement techniques over the years, as described by Vom Brocke and Rosemann (2013). According to these authors, this methodology is defined as an integrated business performance management system designed to enhance end-to-end process management. In essence, BPM is a management method used to control an organization's processes. Although there are various proposals for process management implementation, the BPM models presented in the literature share a common feature: their cyclical nature. For this reason, it is common to refer to BPM cycles (or the BPM lifecycle) [da Cunha Bezerra et al. 2018].

The BPM lifecycle consists of a set of phases with a logical sequence, requiring continuity to ensure that business processes are aligned with the organization's strategy. Traditionally, the BPM lifecycle follows the typical phases of **analysis** (*As Is*), **redesign** (*To Be*), and **implementation** (*To Do*) of processes [Dias 2019]. However, the CBOK Guide (Guide for Process Management - Common Body of Knowledge from ABPMP) proposes a more detailed cycle that is adaptable to the needs of each organization, which can be summarized into up to six stages, as shown in Figure 1 [Cbok 2013]. The stages of this cycle are detailed as follows:

1. **Plan:** This stage involves identifying the processes and understanding how they are aligned with the organization's strategy and objectives. Additionally, it is the moment to understand how these objectives can be achieved through process management. Planning is commonly structured in a value chain that classifies processes into three categories: core processes, strategic processes, and supporting processes.
2. **Analyze:** This stage focuses on collecting comprehensive information about the current functioning of the process to gain a thorough understanding of its existing state (*As Is*). It involves performing detailed tasks such as reviewing

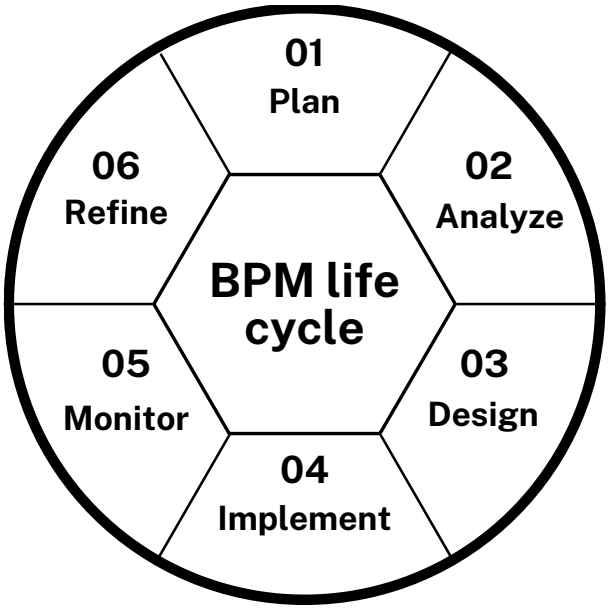

Figure 1. BPM Lifecycle.

documentation, conducting surveys and interviews with process participants, documenting the current process, and validating the findings. Additionally, the *As Is* process seeks to identify critical points that are negatively impacting the process's performance.

3. **Design:** Also known as Process Redesign or *To Be* Process, this stage focuses on the changes to be made to the process based on the previous stage. The goal of this stage is to create a future graphical representation of the process. All the problems identified during the analysis stage should be considered during the modeling or redesign of the process, aiming to eliminate them in this new version. Like the current model, the future model must be validated with the process participants.
4. **Implement:** This is the stage in which the redesigned process is implemented. There are two ways to execute this stage: (i) a systemic approach, utilizing specific technologies and software to assist the process, or (ii) a non-systemic approach, without relying on such tools. Regardless of the approach adopted, the objective remains the same: to operationalize the redesigned process as an effective workflow.
5. **Monitor:** With the goal of tracking and measuring performance, this stage involves the evaluation of 4 fundamental dimensions: (i) process duration; (ii) process monetary cost; (iii) capacity, which calculates the efficiency of the process production; and (iv) quality, which checks for the presence or persistence of errors and variations that negatively affect the process.
6. **Refine:** This stage aims to analyze the results obtained during the previous stage (monitor), compare them with the established goals, and ensure that the process is properly aligned and optimized. Essentially, this stage focuses on improving the process performance, evaluating the best way to execute it, and analyzing how its results are being achieved. In other words, it is related to the pursuit of efficiency

and effectiveness of the new version of the process.

This work proposes the MIM-PS methodology, which was adapted from the BPM lifecycle and validated through a case study conducted at TCE-PE. Due to the large number of processes analyzed and the limited project timeframe, only the first four stages—planning, analysis, design, and implementation—could be executed during the validation. In addition to being applied in three different sectors of the same institution, these four stages aim to redesign and implement improved versions of the analyzed processes. The redesigns are developed with the goal of eliminating critical problems that negatively impact the processes.

2.3. Business Process Model and Notation

By using a formal graphical notation to describe workflows or business processes, it is possible to represent them clearly and objectively. In many cases, this notation makes the process more intuitive and self-explanatory. Thus, in this study, we adopted BPMN due to its primary goal of providing a notation that is easily understood both by technical professionals responsible for process execution and by the management team in charge of implementation and monitoring [Chinosi and Trombetta 2012].

The BPMN notation is a widely adopted graphical model in the industry for representing business processes [Rebelo et al. 2020]. With a set of techniques and tools, BPMN allows internal (or external) organizational processes to be mapped in a formal and standardized manner. Moreover, BPMN notation offers a broad range of tools and resources applicable to various purposes, facilitating the structuring and understanding of the modeling performed while highlighting how the process unfolds from its beginning to its conclusion [Gallo 2012].

BPMN Elements: The BPMN uses four basic types of elements, as shown in Figure 2: flow objects, connecting objects, organizational elements, and artifacts. Flow objects represent the core components of a process, including activities to be performed, events occurring during the process lifecycle, and gateways, which serve as decision points in the process flow based on specific conditions [Kluza et al. 2017]. Connecting objects are used to link the main BPMN objects [Marchioni 2021], indicating the sequence between activities, message flow, and associations among elements. Organizational elements such as pools and lanes serve as tools for organizing activities and assignments within the process diagram [Marchioni 2021]. Artifacts, on the other hand, are used to provide additional information and are linked to flow objects through associations [Correia 2015].

3. Literature Review

Several studies have been conducted with the aim of mapping and improving processes to enhance operational efficiency and identify areas for improvement across various sectors. However, as highlighted in De Oliveira and Grohmann (2016), few works focus on proposing methodologies for process mapping and improvement with an emphasis on the public sector, as most studies are primarily oriented toward private organizations. To identify the related works, an exploratory literature review was conducted using Google

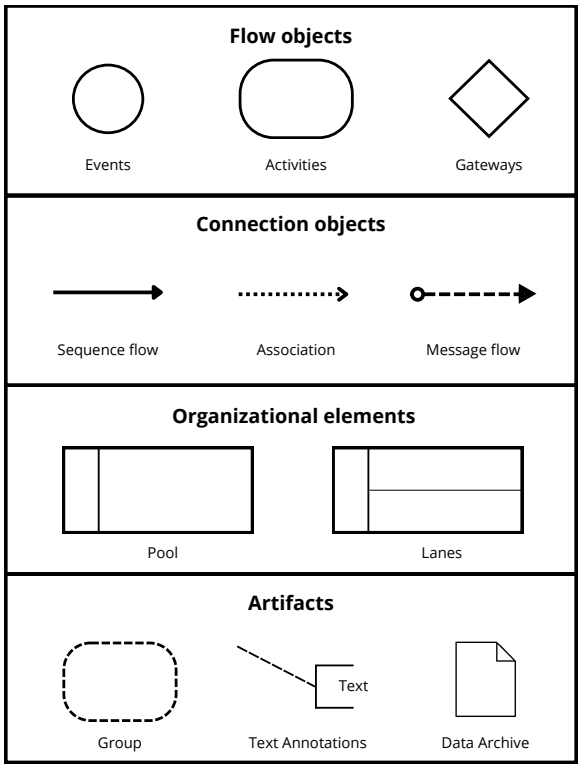

Figure 2. Elements of the BPMN.

Scholar as the main database. The search employed combinations of keywords such as "process mapping," "process improvement," "BPM," and "public sector." The titles and abstracts of the retrieved papers were screened, and those most aligned with the research objective were selected for full reading. Studies that addressed methodologies, techniques, or tools applicable to process mapping and improvement in public or private institutions were included. Based on this analysis, the studies considered most relevant by the authors were incorporated into this section, followed by a comparative discussion highlighting their main results and methodological approaches.

Among the studies on process mapping and improvement, Marcolin and De Deus (2018) analyzed the cost determination process of a meatpacking company using BPMN notation with Bizagi software. The study followed a structured method, starting with a preliminary process draft, followed by expert validation, software-based modeling, and proposed process enhancements. Beyond mapping, the study aimed to show inefficiencies and improve agility. The authors reported that the mapping process effectively identified bottlenecks and opportunities for operational streamlining.

In the study by Alcântara et al. (2021), process mapping was conducted in an architecture company using BPMN notation with Bizagi software. The approach involved information gathering, process mapping, and problem identification through interviews, document analysis, and activity monitoring. The objective was to provide a systemic analysis of the company's processes, identifying inefficiencies and waste points affecting operational performance. The results highlighted the fundamental role

of process mapping and critical analysis in improving workflow understanding and pinpointing areas for enhancement.

The study conducted by Da Costa Almeida et al. (2019) aimed primarily at identifying opportunities for improvement in the production process of a metalworking company. To achieve this, the researchers adopted an approach that combined quality management techniques with process modeling using the BPMN notation and Ishikawa diagrams (also known as fishbone diagrams). Initially, a brainstorming session was held with the process stakeholders to create the "*As Is*" model using BPMN and identify existing problems. This model was then validated, followed by the development of an Ishikawa diagram. By applying the Ishikawa diagram alongside the 5W1H method (Who, What, When, Where, Why, and How), the researchers identified the root causes of bottlenecks observed during the analysis. The study classified delays in project delivery as the primary improvement opportunity for the company. As corrective actions, the authors recommended investing in employee training and providing detailed procedural descriptions to minimize operational errors. Additionally, they proposed a redesigned operational flow through the development of a "*To Be*" version of the production process, incorporating improvements based on identified issues and their root causes.

After discussing some works addressing process mapping and improvement in a more general context, it is essential to explore studies that address specific methodologies. Among these, Silva et al. (2019) presented a methodology for mapping processes in a company located in the Naval Pole of shipbuilding and offshore construction in the city of Rio Grande, in southern Brazil, using the BPM approach. The authors employed interviews to understand the flow of activities and how they are performed, providing an overview of the studied process. Their work effectively detailed the process stages in the naval and offshore construction sectors, emphasizing value-adding steps.

The study conducted by Brodbeck et al. (2016) highlights the need and importance of conducting research on Process Management in public institutions. The authors developed and analyzed a methodology for implementing Process Management in public organizations using the Design Research approach. This methodology was applied in two IFs of Higher Education, and the results were compared betweent the two institutions, which were at different maturity levels in Process Management. In the context of public institutions, De Moura et al. (2019) introduced a methodology for business process improvement in IFs, based on BPM and quality management principles. This methodology was validated through a case study at the Federal Fluminense Institute. It involved the use of questionnaires, document analysis, and interviews with stakeholders to gather data for mapping and modeling both current and future processes. Additionally, quality tools such as brainstorming, the 5 Whys, Ishikawa diagrams, and 5W1H were applied to identify flaws and bottlenecks in the mapped processes. Key Performance Indicators (KPIs) were also proposed, and the discussed improvements were validated.

In another study focused on IFs, Fontes et al. (2020) conducted a case study in which they mapped and improved processes using the BPM approach for the enrollment and enrollment suspension processes at the Federal Institute of Sergipe. According to the authors, the mapping provided a more detailed view of the processes, facilitating

the recognition and understanding of the activities, the involved documentation, and the related sectors. Moreover, the investigation and modeling of the "*As Is*" processes allowed for a critical analysis that led to the identification of areas for improvement. One of the proposed enhancements in the "*To Be*" model included adding activities to the processes to notify students with specific information about the process they are undertaking. This, along with the potential to automate certain tasks for more agile and efficient execution through specialized systems, brought significant improvements. Another emphasized result was the notable enhancement in agility and the reduction of bureaucracy associated with the processes.

To provide a comprehensive and comparative view of the area of process mapping and improvement, and to demonstrate how this study contributes to addressing existing gaps in this field, a table was created containing a comparative analysis between this work and the previously mentioned studies. This analysis is presented in Table 1, which enables a detailed comparison of the key aspects of the discussed studies, including the application sector, adopted methodologies or approaches, techniques and tools used, scope of application, and main results obtained.

Table 1. Comparative analysis of literature review.

Studies	Sector	Methodology/Approach Adopted	Tools Used	Scope of Application	Main Results
[Marcolin and de Deus, 2018]	Private (Refrigeration Industry)	Drafting the process on paper, validating it with experts, modeling it in software, and proposing improvements.	BPMN (Bizagi Software).	Accounting process of cost determination.	Identification of points for improvement to make the process more agile and less operational.
[Alcântara *et al*., 2021]	Private (Architecture).	Information gathering, process mapping and problem identification.	Interviews, documentation studies, activity monitoring, BPMN (Bizagi Software) and Brainstorming.	Process of an architecture office.	Identification of inefficiencies and waste in work processes and methods.
[Almeida *et al*, 2019]	Private (Metalworks).	Conducting a literature review, modeling the "*As Is*" process, identifying problems and root causes, and developing the *To Be* process model.	Brainstorming, BPMN, Ishikawa diagram and 5 whys method.	Production process of a metalwork.	Designing the To Be process and identifying the root causes of the identified problems.
[Silva *et al*., 2019]	Private (Naval and Offshore).	BPM approach.	Interviews and ANSI flowchart modeling tool.	Process of receiving invoices and sales materials.	Analysis graphs of the researched process.
[Brodbeck *et al*., 2016]	Public (Education).	Implementation of Process Management (iGP) and BPM approach.	Observation protocols, interviews, questionnaires, focus groups and document analysis.	12 processes from the academic and management areas, with different levels of maturity.	Methodology implemented and evaluated.
[de Moura *et al*., 2019]	Public (Education).	BPM approach and quality management.	Questionnaires, document analysis, interviews, brainstorming, 5 whys, Ishikawa diagram, 5W1H, and BPMN (Bizagi Software)	Processes at the Federal Fluminense Institute.	*To Be* processes mapped and indicators proposed.
[Fontes *et al*., 2020]	Public (Education).	BPM approach.	Document analysis and interviews.	IF Sergipe registration and suspension processes.	*To Be* processes mapped and suggestions for improvement.
This Study	Public (Court of Audits).	MIM-PS Methodology.	Interviews, Ishikawa diagrams, a problem categorization map, a causes-versus-solutions spreadsheet, and BPMN modeling using Camunda software.	Processes from 3 different sectors of a Court of Auditors.	*To Be* processes mapped, suggestions for improvement, lessons learned and validation of the proposed methodology.

The previously presented works highlighted that most studies rely on the BPM approach or other approaches with very similar steps to map and improve their processes. Similarly, but adapted to the context of TCE-PE, this study is based on the BPM approach and BPMN notation to document, map, and identify opportunities for improvement in various sectors of a medium-sized public organization. This work provides significant contributions to the field. First, it offers a detailed description of the methodology employed for process mapping and improvement. Second, and more importantly, it

highlights the adaptation and flexibility of the MIM-PS methodology to the public context, demonstrating its ability to handle different levels of process maturity, from well-established processes to undefined or non-existent process flows, where the intermediate "Should Be" approach was applied. Finally, it discusses the lessons learned during the execution of the work, as well as providing a detailed description of the implementation and the results obtained.

4. Research Method

This study employs an action research approach to develop, apply, and evaluate the MIM-PS methodology. This iterative and collaborative research design is well-suited for addressing practical challenges in real-world scenarios while simultaneously advancing theoretical knowledge [Alves et al. 2018]. The central goal is to influence and modify aspects of the phenomenon under analysis, engaging researchers and public servants in the creation, implementation, and validation of the methodology [Robson and McCartan 2016]. Furthermore, action research integrates BPM concepts, which are essential for understanding how processes, people, and technologies interact to create value in the public sector. The approach follows a structured five-phase cycle, as shown in Figure 3, comprising the Diagnostic, Planning, Action, Evaluation, and Learning phases. If necessary, the cycle allows for refinement by returning to the Planning phase, which supports continuous improvement through iterative adjustments based on evaluation results.

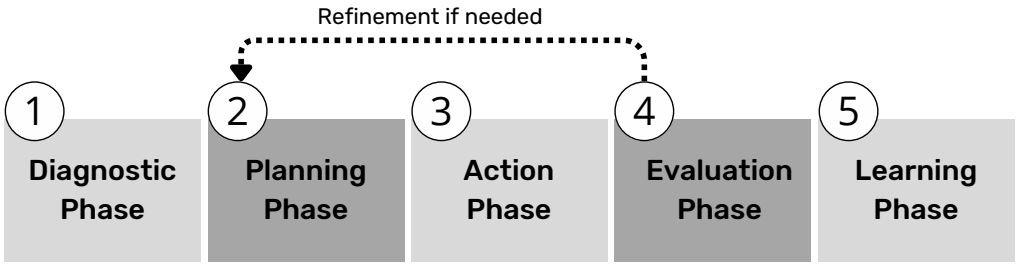

Figure 3. Action research cycle applied in this study.

The approach is divided into the following phases:

1. **Diagnostic Phase:** This phase focuses on identifying the challenges faced by the public sector in mapping and improving organizational processes. Among the aspects analyzed are the lack of clear and replicable methodologies capable of addressing the inherent bureaucracy of public institutions and the demands for efficiency and transparency. To validate the findings, a survey is conducted through discussions with managers, literature reviews, and analysis of process documents across different organizations, aiming to confirm the need for solutions tailored to the public sector's specificities.
2. **Planning Phase:** Based on the diagnosis, the MIM-PS methodology is developed with principles of flexibility, collaboration, and technological support. Flexibility ensures adaptability to diverse organizational contexts, while collaboration encourages active participation from team members, promoting acceptance and

ownership of changes. The integration of technological tools enhances process mapping and analysis, enhancing efficiency and precision. In this phase, success criteria are also established, such as reducing bottlenecks and improving workflow clarity, ensuring alignment with the objectives of the involved institutions.

3. **Action Phase:** In this phase, the MIM-PS methodology is applied as a case study across three distinct sectors, encompassing different types of organizational processes. Initially, mappings are conducted to identify critical points and bottlenecks, followed by collaborative workshops with public servants. In these workshops, participants share experiences and propose practical improvements, which are incorporated into process redesigns. Visual tools, such as BPMN diagrams, are used to facilitate understanding and engagement.
4. **Evaluation Phase:** In this phase, the methodology's effectiveness is evaluated. Data collection includes qualitative and quantitative information obtained through observations, collaborative meetings, and participant feedback. Metrics such as process reduction in specific sectors, increased self-awareness, and improved knowledge management are analyzed to measure the impacts generated. If the evaluation results indicate the need for adjustments, the methodology returns to the planning phase for refinements before further implementation, ensuring a structured and effective improvement process.
5. **Learning Phase:** The final phase consolidates the knowledge gained during the implementation of the MIM-PS methodology, highlighting best practices such as active staff participation, value chain identification, and the creation of a portfolio of essential processes. Challenges, such as the need for effective knowledge management to ensure continuity of improvements, balancing the number of participants in meetings, and risks associated with changes in management during the project, are also analyzed. Finally, the variable application of microsteps, depending on process complexity, is assessed as a key factor in strengthening the methodology's adaptability and effectiveness for future applications, without requiring immediate process adjustments.

5. Mapping and Improvement Methodology for the Public Sector (MIM-PS)

This study proposes the MIM-PS, a methodology that combines qualitative and quantitative elements to map, analyze, and improve the processes of public institutions. The proposal builds upon the best practices of BPM [Dumas et al. 2018] and on insights obtained from process mapping and improvement initiatives conducted in different areas of public administration. The MIM-PS was developed to adapt to the specific contexts and needs of each sector, ensuring flexibility, consistency, and applicability in real organizational environments.

The methodology integrates detailed interviews, problem analysis, and quantitative data evaluation. Its objectives are exploratory and descriptive, focusing on identifying key issues in different public-sector processes, understanding their causes, and proposing solutions to enhance efficiency and effectiveness. The methodology follows an adapted version of the six stages of the BPM lifecycle, covering the identification and mapping of existing processes (As Is), problem analysis, improvement proposal,

and process redesign (To Be). Unlike the traditional BPM cycle, the MIM-PS provides greater flexibility and is specifically adjusted to the characteristics of public institutions. Each phase of the methodology is described in detail, including practical guidelines and examples of artifacts that can be used, such as interview scripts, problem–cause matrices, and improvement prioritization forms, all aligned with the operational reality of public organizations. The proposed methodology was validated through a case study conducted at the TCE-PE, where the first four phases of the MIM-PS were applied across three distinct sectors, covering a wide range of organizational processes. This application demonstrated the methodology's applicability, usefulness, and flexibility in different institutional contexts. The six main phases of the MIM-PS are illustrated in Figure 4 and described in detail below.

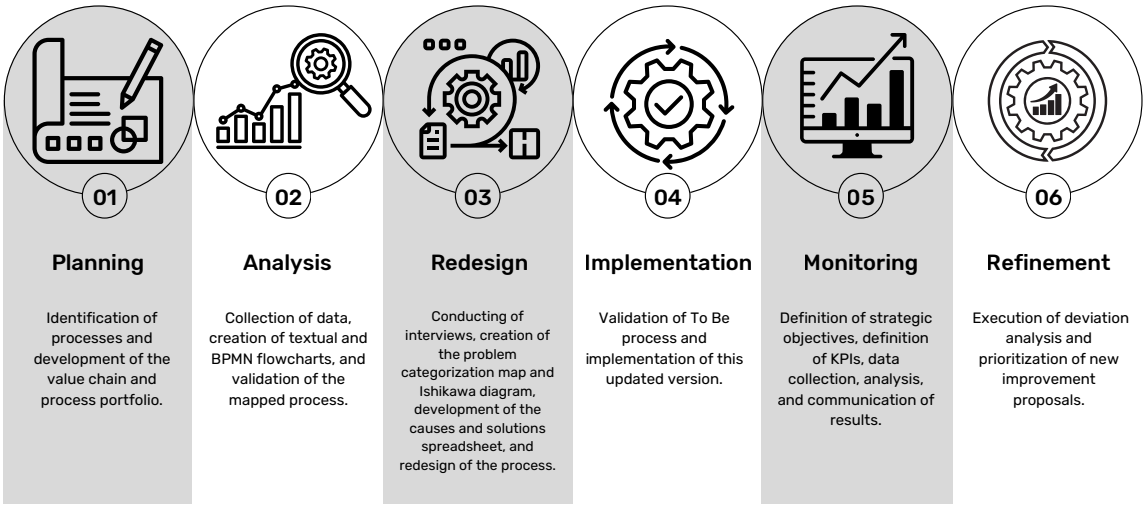

Figure 4. Main stages of MIM-PS.

5.1. Planning

The first stage begins with the identification of each sector's processes, conducted through the development of a value chain. The value chain is a set of activities that creates value for an organization, from raw materials to the final product delivered to the consumer [Govindarajan and Shank 1997]. It represents the implementation of the institution's operational strategy and provides an overview of the activities performed, as well as how these activities interrelate to generate and deliver value to society.

The proposed value chain structures processes into three categories: **core**, **support** (or sustaining), and **strategic**. This structure allows for enhanced visualization of the arrangement of work processes within the organization. The identification of processes and the development of the value chain represent the first stage of the BPM lifecycle. After the processes are identified, a portfolio spreadsheet is created to organize and track all mapping stages. This spreadsheet contains information such as the process name, the actors involved, the current stage of the mapping, and *links* to the generated flowcharts. In addition to enabling the tracking of all mapping stages, the portfolio organizes all

generated documentation into a single document, facilitating access and information sharing among public sector members.

5.2. Analysis

After defining the value chain and selecting the process for mapping, five main steps are typically executed to detail the selected process (see Figure 5). Not all processes may be mapped and improved, especially when dealing with a large number of processes. The selection of priority processes depends on the organization's specific objectives and the importance of each process. Initially, a **data collection** for the process is conducted, which can occur in two distinct ways: interviews, suited for highly complex processes involving multiple sectors and external agents, or through online questionnaires, designed for smaller and less complex processes. In both cases, the same set of questions is used, as presented in Table 2. These questions were based on the "Reflection Questionnaire for Process Mapping" from the Process Management Methodology of the Process Office of the National Council of the Public Ministry (CNMP) [Escritório de Processos do Conselho Nacional do Ministério Público – CNMP 2016], and were adapted according to the authors' prior experience and knowledge acquired through previous process mapping and improvement initiatives in public institutions. As shown in Table 2, these questions relate to the objective, start and end, artifacts, actors, activities, obstacles, deadlines, products, target audience, regulations, macro-activities, and indicators of the analyzed organizational process.

After the initial data collection, assuming the process is complex, the next step involves **creating a textual flowchart**, which primarily focuses on core processes. The flowchart is developed based on the information gathered in the previous step. This flowchart is used exclusively for processes identified through interviews to document the information in a textual and objective manner. The next step involves the **validation of the textual flowchart**, which is presented and reviewed with those responsible for executing the process. For processes identified via the form, no additional validation is required, as the process owners themselves completed the form. Both the textual flowchart and the *online* questionnaire aim to collect and organize information about the process's functioning.

The step prior to the final step involves the **creation of the process in a graphical format**, which facilitates visualization and understanding of the interactions between activities and the actors involved. With all process-related information (already validated), the *open-source* tool *Camunda Modeler* and the BPMN notation are utilized. In this way, the process is modeled in detail, including the description of activities, sectors, responsible parties, external agents, events, and exceptions.

Finally, the **validation of the process in graphical format** is performed through the presentation and evaluation of the flow with the individuals involved. The modeling rigorously reflects how the process is currently structured and executed (*As Is* process). Therefore, all steps of the methodology described so far correspond to the second stage of the BPM lifecycle, which includes information gathering and modeling of the current process.

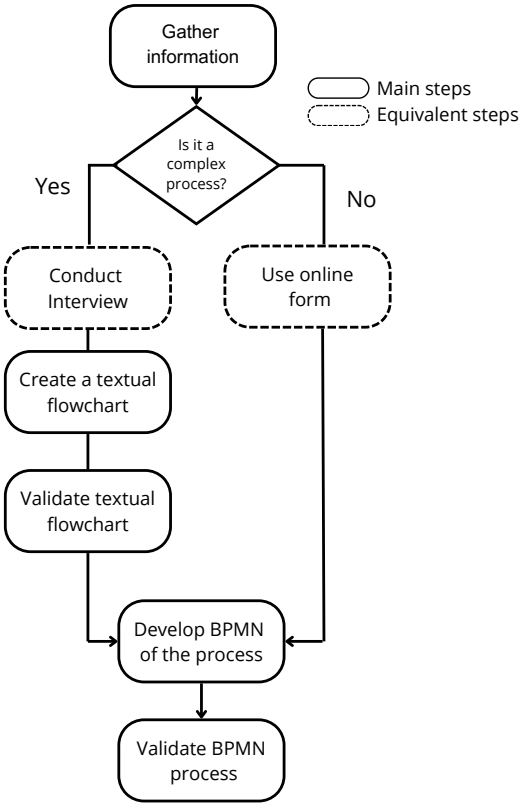

Figure 5. Main steps for process detailing.

5.3. Redesign and Implementation

This subsection presents the Redesign and Implementation stages of the MIM-PS methodology, beginning with the redesign phase. At this stage, priority was given to processes that presented the most critical issues identified in the analysis phase, focusing on developing improved versions capable of addressing these problems. Initially, we selected a process and interviewed those responsible about it to identify any issues affecting its functioning. Subsequently, these issues are analyzed, and a categorization map is created, grouping them into six different areas: Communication, addressing problems related to information exchange and clarity in communication; Legality, involving issues of compliance with laws and regulations; Standardization, referring to problems with uniformity and consistency of procedures; Deadline, encompassing difficulties in meeting established timelines; Quality, dealing with issues affecting the standard of delivered results; and Resources, involving problems with the allocation and use of necessary resources. This map facilitates the visualization of the identified issues and supports the organization of improvement actions. The six categories were defined based on established quality management frameworks and were subsequently adapted to reflect the areas of greatest impact and recurrence of problems observed in the public-sector context.

After identifying the problems, the causes and contributing factors (or root causes)

Table 2. Interview Guide.

No.	Questions Raised
Q1	What is your position within the institution?
Q2	What is the name of your process?
Q3	What is the purpose of the process? What value (benefit) does this process provide?
Q4	How does the process start? E.g., is there an event (e.g., receipt of a document or alert) or a timeline (e.g., every x months or every x day of the month) that triggers it?
Q5	How does the process end? E.g., is there an event (e.g., sending/uploading a document) that marks the process's conclusion?
Q6	What are the input and output artifacts (or documents) of the process? E.g., report, memo, etc. Which systems are used for process execution (e.g., electronic management system, audit system, etc.)?
Q7	Who are the process actors? Which units and/or staff are directly involved in the process? (Define the roles and the departments/sections).
Q8	After the start, what activities are carried out until the process ends? Describe the sequence of activities in the order they occur, indicating the people (roles, such as "coordinator," "director," etc.; not names like "Maria" or "Carlos"), the systems used (e.g., electronic management system, audit system, etc.), and the participating units (as per your institution's organizational structure, if possible).
Q9	For the activities raised in the previous item, are there any obstacles? E.g., (i) "Here, we only move forward if the process includes such a document; otherwise, it is returned to such area," or (ii) "In activities x and y, we use System Z."
Q10	For the activities raised in item 8, do they result in any product? E.g., "This results in an ordinance or we issue a technical note."
Q11	Are there time markers, deadlines, or specific dates that limit any activity in the process or the process as a whole? (Describe whether the process has a start or end date and whether any of the activities have a defined deadline.)
Q12	Who is the recipient of this process's outcome? Who does it serve? What is its target audience or client (e.g., audit or citizen)?
Q13	Is this process regulated by any norms, resolutions, etc.?
Q14	Who is the owner of the process? Who is the manager responsible for its outcomes and has the authority to change it? (Person who has the authority to modify how the process operates.)
Q15	What are its macro-activities? Is there any way the process can be divided (e.g., Planning/Execution/Monitoring)?
Q16	Are there any indicators designed to assist in measuring the process's effectiveness, efficiency, and/or impact?

are explored with the help of those involved in the identification process. For each problem, the **Ishikawa diagram**, also known as the cause-and-effect diagram, is applied. These diagrams are used only for the most significant problems prioritized by the sector

employees associated with the process. In the context of the application, Ishikawa diagrams are adapted to include the following categories: People, which encompasses issues related to individual performance and skills; Procedures and Regulations, referring to problems with established processes and guidelines; Technological and Physical Resources, covering issues with technology and equipment; Management, addressing administrative and leadership matters; Work Environment, which includes physical and social workplace factors; and External Factors, involving elements beyond the organization's control, such as regulations and market changes. These categories help identify and organize the causes of the identified problems. These categories were adapted from the classic 6M cause-and-effect framework (Manpower, Method, Machine, Material, Measurement, and Mother Nature) and adjusted to the specific context of public administration, emphasizing aspects such as "Procedures and Regulations" and "Management".

Subsequently, the next step is the **development of a causes and solutions spreadsheet** in collaboration with the employees responsible for executing the process. During a joint meeting, solutions are proposed and discussed for each cause related to the identified and prioritized problems, taking into account the perspectives of each team member. This approach ensures that the employees' experience is properly utilized, enriching the process of seeking appropriate and targeted solutions.

After completing the causes and solutions spreadsheet, the next step is the **process redesign**, during which the future version (*To Be*) is developed in a graphical format. In this phase, some of the proposed solutions for the prioritized problems are incorporated into the process. It is important to emphasize that certain solutions, such as training and reallocation, do not necessarily involve process redesign. The **validation of the new process** is conducted similarly to the previous stages, through meetings with process employees. Finally, after validation, the **implementation of the updated process version** into institution's workflow is undertaken. This new version aims to ensure the full integration of the proposed solutions, resulting in an enhanced process model for addressing the identified issues.

5.4. Monitoring

The monitoring phase of MIM-PS focuses on translating process objectives into measurable performance indicators that enable the assessment of the effectiveness of implemented improvements. This phase comprises four main stages: definition of strategic objectives, definition of KPIs, data collection, analysis, and communication of results.

The **definition of strategic objectives** stage establishes the main goals to be achieved by the process improvement initiative, ensuring alignment with the organization's overall mission and vision and providing clear direction for subsequent activities. These strategic objectives form the foundation for identifying the aspects of performance that require monitoring and enhancement, which leads to the **definition of KPIs**. At this stage, the specific indicators used to monitor process performance are selected in accordance with the previously defined objectives and proposed improvements, varying according to the nature of each process. The KPIs may address

dimensions such as execution time, quality of delivered services, operational efficiency, and activity productivity.

The subsequent stage, **data collection**, defines the methods and frequency for gathering the information required to monitor the previously established KPIs and targets. Data may be collected using Business Intelligence tools (such as interactive dashboards), spreadsheets, or manual observation. Once these parameters are defined, it is verified which data are already structured and which require improvement or integration into existing systems to ensure efficient and reliable collection. Finally, the **analysis and communication of results** stage establishes a systematic routine for examining collected data, comparing actual performance against defined targets, and communicating results transparently to the team and sector management. This stage ensures continuous process performance monitoring, facilitating ongoing refinement and improvement.

5.5. Refinement

The final stage of MIM-PS focuses on Process Refinement, which transforms the data obtained during the Monitoring phase into continuous improvement actions. This phase consolidates the cyclical nature of the methodology, ensuring that the insights derived from performance analysis lead to concrete adjustments and sustained process optimization. It encompasses two main stages: deviation analysis and proposal and prioritization of new improvements. The deviation analysis is conducted for processes that did not achieve the defined objectives, aiming to identify the underlying factors that limited performance and to support data-driven decision-making for further refinement. In this stage, process participants meet to discuss the monitoring data and identify the reasons that prevented the achievement of the established goals. This analysis seeks to determine the root causes of persistent problems, similar to what was performed in Section 5.3, but now based on quantitative evidence obtained during the monitoring phase.

Once the root causes have been identified, the proposal and prioritization of new improvements take place. Based on the deviation analysis, the team conducts brainstorming sessions to suggest appropriate solutions for the identified problems. The proposed actions may include task automation, adjustments to business rules, training programs, or other strategies aimed at optimizing process performance. In addition to the severity of each issue, the proposed improvements are prioritized according to their potential impact and required implementation effort. When additional opportunities for improvement are identified, MIM-PS can be reapplied from the beginning, reinforcing its iterative nature and establishing a sustainable cycle of evaluation, learning, and process optimization.

6. Results

This section presents a detailed, stage-by-stage overview of the results obtained during the case study conducted in the three sectors of TCE-PE. Each sector, referred to as Sector A, Sector B and Sector C to maintain confidentiality, was analyzed individually with specific adaptations and key points highlighted at each stage. The methodology's implementation across these sectors involved a heterogeneous group of participants, including coordinators, advisors, secretaries, technicians, and outsourced staff. The

involved personnel demonstrated distinct proficiency levels regarding their respective processes (ranging from deep understanding to limited mastery), while the facilitating team consisted largely of Information Technology (IT) professionals and business process specialists. As described in Section 5, the MIM-PS methodology comprises a complete six-stage cycle. However, in this case study, the large number of processes and the limited project timeframe allowed for the detailed application of only the first four stages: Planning, Analysis, Process Redesign, and Implementation.

6.1. Planning

During the planning stage, three value chains were created to identify the processes within each sector. The identification was conducted through meetings and discussions with the managers of each area, ensuring that the mapped processes accurately represented their operational reality. Each value chain encompasses all the sector's macroprocesses, along with its overall vision and key clients. Figure 6 presents a generic example of a value chain, highlighting strategic, core, and support macroprocesses, as well as the mission, vision, and clients. Specifically for the TCE sectors, a similar value chain was created. For Sector A, the value chain was divided into eight macroprocesses: one strategic, related to sector management activities; three core, focused on the execution and delivery of the institution's services; and four supportive, which support the final and strategic processes. These macroprocesses were subdivided into business processes, which represent the activity flows of Sector A, resulting in 31 identified business processes. The value chain for Sector B contains three strategic macroprocesses, one core, and four supportive, resulting in 14 business processes. For the value chain of Sector C, there is one strategic macroprocess, three core, and four supportive, resulting in 67 business processes. In all three sectors, the macroprocesses and business processes were identified through discussions with the respective managers. It is important to note that, although the value chains of Sectors A, B, and C coincidentally comprise eight macroprocesses each, this number may vary depending on the organizational structure and process configuration of each sector.

During this stage, a process portfolio was also created for each sector, as exemplified in Figure 7. The portfolio allowed us to organize and track the mapping stages of each process, categorizing them as: identified, mapped, detailed, monitored, or improved. Additionally, the process portfolio was also used as a repository for the links to the artifacts produced in subsequent phases, such as the textual flowchart and BPMNs of the *As Is* and *To Be* versions of the process.

> Regardless of the maturity or category of the sector, the identification of the value chain and the creation of a process portfolio are fundamental. These steps ensure a clear view of the macroprocesses and allow for detailed tracking of progress and improvements in the processes, serving as a solid foundation for effective management and continuous adaptation of organizational processes.

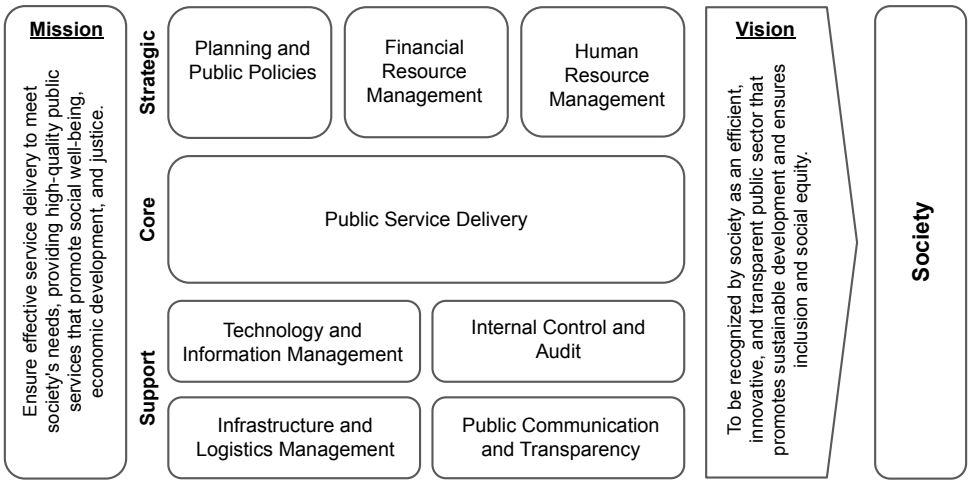

Figure 6. Generic Example of a Value Chain.

ID	MACROPROCESS	IDENTIFIED PROCESS	MAPPING STAGE	ACTORS	...
1	CORE	PROCESS A	IMPROVED	Public Servant 1, Public...	...
2	CORE	PROCESS B	MAPPED	Public Servant 1, Public...	...
3	STRATEGIC	PROCESS C	MAPPED	Public Servant 1, Public...	...
4	STRATEGIC	PROCESS D	IDENTIFIED	Public Servant 1, Public...	...
5	SUPPORT	PROCESS E	IDENTIFIED	Public Servant 1, Public...	...
...	...	...	...	...	...

Figure 7. Process Portfolio Template.

6.2. Analysis

This stage focused on gathering information about the current functioning of the processes *To Be* mapped. Each sector had a different level of knowledge about its own processes. Therefore, processes were identified at different levels of execution, such as: well-established processes operating as intended, processes being executed without a clearly defined flow, and processes that should exist but had never been implemented. It was necessary to adopt different strategies for each of these processes, depending on the

maturity level and the knowledge of the involved actors.

For processes of lower complexity, questionnaires were applied to the individuals responsible for their execution. For more complex processes, those not yet executed, or those in which the actors had little knowledge of the flow of activities, interviews were conducted with the main stakeholders. These interviews resulted in the creation of a textual flowchart for each process, detailing the operation, objectives, main inputs, outputs, and other relevant information. The flowcharts were validated with the same participants from the interviews. Then, BPMN models were created and validated, graphically representing the current flow of activities (*As Is*), from input to output. These models were presented to the responsible individuals, validated, and then archived in the process portfolio of their respective sectors. Along with the questionnaires and textual flowcharts, the models were later shared with the staff of each sector.

Figure 8 presents a generic example of a BPMN referring to a public sector process in its *As Is* version, called "Citizen Service for Public Service Requests". This process belongs to the group of core processes in the Public Service Delivery macroprocess, as shown in Figure 6. This process involves attending to citizens seeking public services, covering everything from receiving the request to providing the service and delivering the final response to the citizen. It is important to note that the proposed model is generic and aims to illustrate common activities in public agencies, not necessarily reflecting the specific reality of the sectors where the methodology was applied.

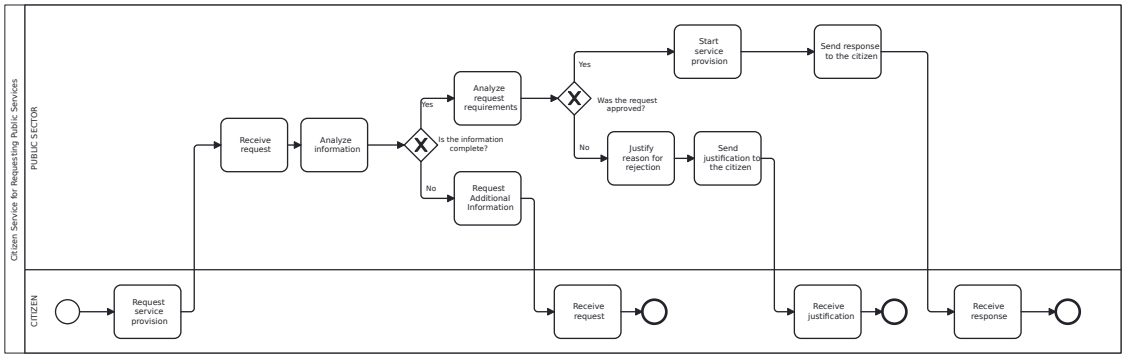

Figure 8. Generic example of an *As Is* BPMN of a public sector process.

In a specific case in one of the sectors, we decided to simplify the mapping process for complex processes that required interviews. We chose to use only the BPMN notation, rather than both the textual flowchart and BPMN, to speed up the mapping of activities, as the sector required quick results. Although some team members initially faced challenges with BPMN terminology, each new participant received a detailed explanation of the notation elements to ensure a shared understanding. This approach, designed to accommodate the frequent inclusion of new participants, proved effective in scenarios demanding greater agility.

The detailed analysis of the processes revealed different levels of maturity and knowledge, requiring distinct approaches.Well-established processes received questionnaires, while complex or underdeveloped processes were investigated through interviews, resulting in the creation of textual flowcharts and BPMN models. In a specific case, the decision to use only BPMN notation accelerated the mapping process. Although some team members faced initial challenges with the terminology, detailed explanations were provided to new participants, ensuring a clear understanding.

6.3. Process Redesign

This stage corresponds to the redesign of the processes as they should be (*To Be*), implementing changes related to identified problems and areas for improvement. Before the redesign, some microsteps were applied to identify these problems and develop proposed solutions. The first microstep involved creating a problem categorization map for each process. This map is a graphical diagram used to divide the identified problems into six categories: Communication, Legality, Standardization, Deadline, Quality, and Resources. Figure 9 presents a generic example of a problem categorization map for the process in Figure 8, with key problem priorities emphasized in bold. At the center of the map is the name of the problem, which in this example corresponds to the Citizen Service for Public Service Request process. On the left side are the issues of incomplete information and difficulty accessing communication channels, which belong to the Communication category; the non-compliance or incorrect interpretation of laws or regulations, related to Legality; and the lack of uniform procedures and the decentralization of the service, associated with Standardization. On the right side are the problems of delayed responses to citizens and the absence of defined deadlines, which fall under the Deadline category; the low quality and errors in service delivery, related to Quality; and the shortage of human resources and limited technological tools, associated with the Resources category. The figure also highlights, in bold, the problems selected for prioritization: the delay in responding to citizens and the low quality of services.

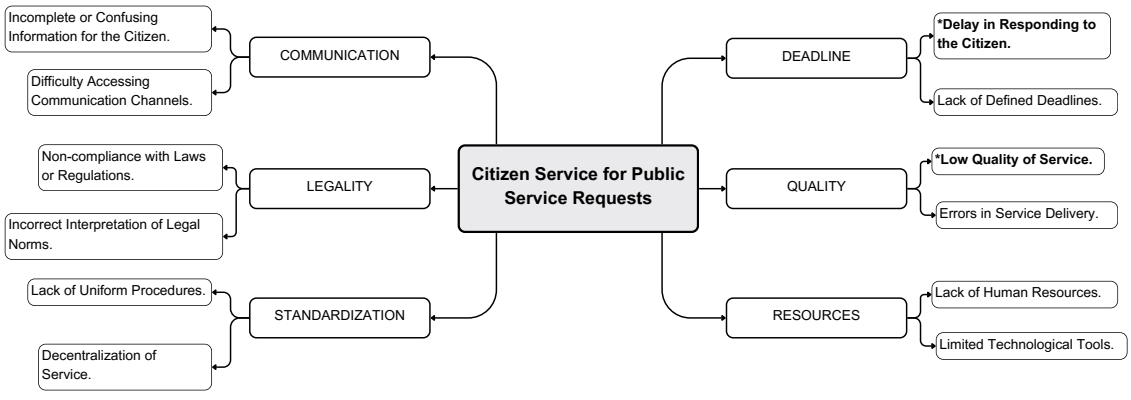

Figure 9. Generic Process Problem Categorization Map.

The second microstep involves the creation of Ishikawa diagrams for the problems identified as priorities. These diagrams were used to identify the causes and contributing

factors related to each of these problems. In the diagrams, the investigated problem is presented at the far right, while the levels and sublevels in each category represent the causes and contributing factors for the problem. The causes analyzed are divided into six main categories: Technological and Physical Resources, People, External Factors, Work Environment, Procedures and Regulations, and Management, with or without specific causes related to each.

Figure 10 presents the Ishikawa diagram created for the problem Delay in Citizen Response, based on the problem categorization map shown in Figure 9. At the "head" of the diagram is the name of the problem under investigation. From this central point, six categories are organized, each containing a main cause and its respective sub-causes. In Technological and Physical Resources, the primary cause is the outdated service system, detailed through sub-causes such as slowness, instability, lack of integration between service systems, and insufficient technological investment. In Procedures and Regulations, the lack of uniform procedures appears as the main cause, accompanied by issues such as the absence of a standard system configuration and difficulties in request tracking. In the People category, the main cause identified is the lack of training for public servants, associated with the lack of regular update programs and continuous training. In External Factors, frequent changes in laws and regulations constitute the primary cause, with sub-causes related to insufficient prior planning and limited time for internal adaptation. In Work Environment, an unfavorable work environment emerges as the main cause, including inadequate infrastructure, uncomfortable spaces, and high levels of stress. Finally, in the Management category, the main cause is the overwork of public servants, resulting from excessive demands, insufficient workforce, and the absence of human resource planning. This structure allows for a clear visualization of the relationship between the central problem and its origins, supporting the prioritization and definition of improvement actions. This diagram highlights the main causes and contributing factors of the issue. The identified causes and factors provide insights into the origins of the problem, facilitating the development of comprehensive strategies for resolution.

Following this, the third microstep is carried out, consisting of meetings with the team responsible for executing the process, with the aim of defining proposed solutions for the prioritized problems. Table 3 presents an example of a solution proposal table for the case shown in Figure 10. This table consists of four main columns: the first describes the nature of each cause (corresponding to the categories of the Ishikawa diagram in Figure 10), the second presents the main cause and the third lists its related subcauses. The fourth column brings together the proposed solutions for each identified cause and sub-cause. For Technological and Physical Resources, the suggested solution consists of modernizing the service system through the adoption of faster and more integrated technologies. In Procedures and Regulations, two complementary actions are proposed: the creation of a unified service manual, accompanied by training for public servants to ensure its consistent application, and the update of the system through configurations that enable proper tracking of requests. For the People category, the proposal includes offering regular training and refresher courses, focusing on service quality and the standardization of procedures. In Management, the solution involves developing a strategic human

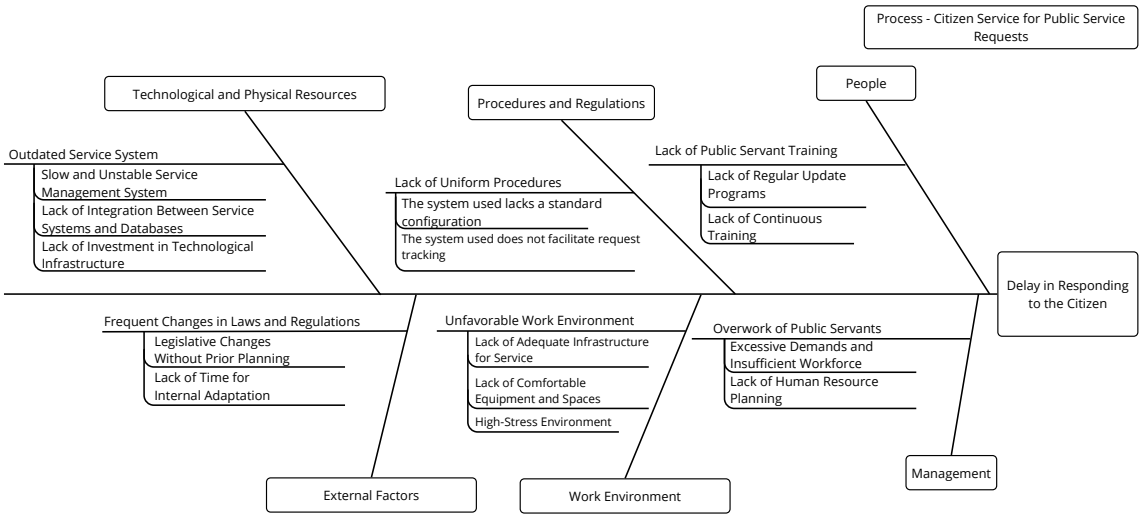

Figure 10. Generic Ishikawa diagram.

resources plan aimed at distributing demands more equitably. In the Work Environment dimension, it is recommended to improve both the physical infrastructure and the layout of service areas, as well as to adopt organizational measures to reduce workplace stress. Finally, for External Factors, the suggestion is to create a specialized team to monitor legislative and regulatory changes, ensuring rapid updates and the ability to adapt to new requirements. This structure enables a systematic treatment of the identified problems by addressing their causes and subcauses during the process redesign phase.

Table 3. Table of Causes and Solutions.

Nature of the Cause	Causes	Sub-Causes	Proposed Solution
Technological and Physical Resources	Outdated Service System	Slow and Unstable Service Management System.	Modernize the service system using faster and more integrated technologies.
		Lack of Integration Between Service Systems and Databases.	
		Lack of Investment in Technological Infrastructure.	
Procedures and Regulations	Lack of Uniform Procedures.	The system used lacks a standard configuration.	Create a unified service manual for all units and train public servants to follow it consistently.
		The system used does not facilitate request tracking.	Update the system by implementing a configuration to facilitate request tracking.
People	Lack of Public Servant Training.	Lack of Regular Update Programs.	Provide regular training and refresher courses for public servants focused on citizen service quality and procedural updates.
		Lack of Continuous Training.	
Management	Overwork of Public Servants.	Excessive Demands and Insufficient Workforce.	Develop a strategic human resource plan to distribute demands equitably.
		Lack of Human Resource Planning.	
Work Environment	Unfavorable Work Environment.	Lack of Adequate Infrastructure for Service.	Improve the physical infrastructure and layout of service areas.
		Lack of Comfortable Equipment and Spaces.	
		High-Stress Environment.	Reduce workplace stress through organizational measures.
External Factors	Frequent Changes in Laws and Regulations.	Legislative Changes Without Prior Planning.	Create a specialized team to monitor legislation and normative updates, with quick training for adaptation to changes.
		Lack of Time for Internal Adaptation.	

Finally, a new BPMN model and a process analysis document were created for each of the selected processes in the redesign phase. The process analysis document provides a detailed summary of all the previous microsteps described in this section, along with links to the corresponding artifacts. This document serves as a rationale for the changes to be implemented to improve the process. The new BPMN model represents the redesign of the *As Is* process, incorporating adjustments based on the solutions defined

in the previous microstep and other identified areas for improvement to enhance the process's efficiency and effectiveness. It is important to note that some solutions may not require process redesign, such as the creation of informational materials and the reallocation of staff. These newly developed models, also referred to as *To Be*, were validated by the team responsible for each process and made available.

Figure 11 presents a generic example of a BPMN in the *To Be* version for the process of "Citizen Service for Public Service Request" (see Figure 8). To incorporate some of the solutions, the process redesign established a maximum deadline of three business days for the analysis of information, which will contribute to a reduction in response time. Additionally, activities involving communication between the citizen and the public agency were automated, being replaced by system activities (represented by the gear icon), enabling execution via software. It is important to highlight that not all the solutions presented in Table 3 directly affect the process flowchart, as some are related to improvements in the organizational environment and staff training, for example.

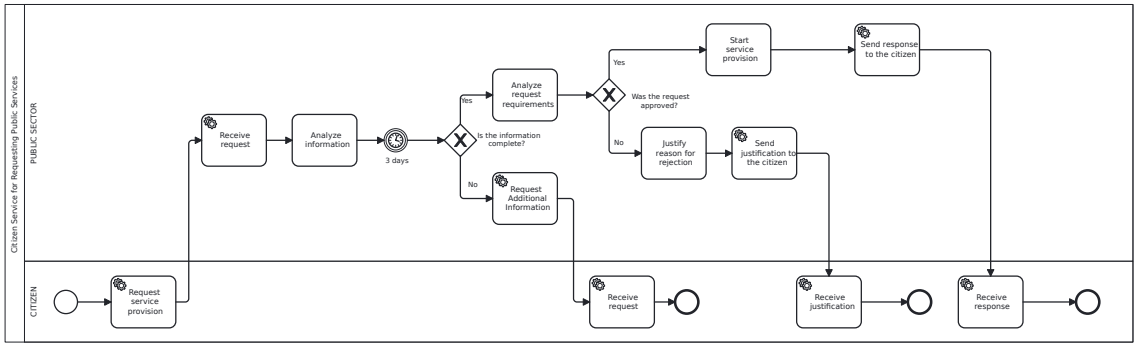

Figure 11. Generic example of BPMN *To Be* for a public sector process.

It is important to emphasize that the stages of the improvement life cycle were repeated for some processes, while others were not carried out, depending on the process and sector. For the three sectors analyzed in this study, only a portion of the processes mapped in the analysis phase progressed to the redesign phase, due to the large number of processes identified and the short project execution time. In Sector A, the processes selected for the redesign phase underwent all the microstages described. In Sector B, the use of the Ishikawa diagram and the Causes and Solutions Table was limited. It was decided to adapt it to a Problems and Solutions Table, as the causes were more evident and simple to resolve, making the use of Ishikawa diagrams unnecessary. In Sector C, due to even more limited time, none of the aforementioned microstages were carried out. Only the intermediate stage between *As Is* and *To Be* was executed, which we call Should Be, as this approach allowed for a more agile and feasible improvement within time constraints. This intermediate stage helped identify necessary improvements without the need for full detailing of the microstages, facilitating the transition and adjustments of the processes in a more efficient manner.

In the redesign stage, the microstages were applied variably according to the complexity of the processes. For complex and important processes, all microstages were followed. When the causes were evident and the solutions simple, the Ishikawa diagrams were omitted. In situations with time or resource constraints, an intermediate approach, called Should Be, was used for quick adjustments without complete detailing.

6.4. Implementation

The implementation of the redesigned processes represented a critical stage in validating the applicability of the MIM-PS methodology. This phase involved introducing the updated process versions within the institutional environment and observing how the proposed improvements were incorporated into daily activities. The redesigned processes were applied in three departments with distinct levels of process maturity, ensuring the methodology's adaptability to different operational contexts. The teams involved were oriented on the new process flows, responsibilities, and documentation created in the previous phases, and follow-up sessions were conducted to clarify procedures and support adaptation. Although quantitative indicators were not systematically collected due to time constraints and the large number of processes analyzed, qualitative observations indicated visible gains in efficiency, communication, and task understanding among participants. Examples of improvements included the simplification of approval flows, elimination of redundant activities, and clarification of responsibilities across hierarchical levels, which contributed to reducing rework and improving the flow of information between departments.

Feedback collected from participants after the implementation phase reinforced these findings. Users reported better communication between departments, greater clarity regarding their roles, and increased agility in performing tasks. These perceptions indicate that MIM-PS not only improved internal operations but also fostered stronger engagement among those responsible for executing the processes. The implementation phase demonstrated the practical applicability and adaptability of MIM-PS in public-sector contexts. The improvements observed, both in operational performance and user perception, provide strong evidence of the methodology's potential to enhance efficiency, collaboration, and transparency in diverse organizational scenarios.

Although improvements were observed in the processes, it was noted that some of the problems and proposed solutions for certain processes were not implemented. Since the project did not monitor these improvements after the results were released, a lesson learned is the importance of continuing to monitor the proposed improvements until they are fully implemented.

7. Benefits and Lessons Learned

Using the MIM-PS methodology in a case study at the TCE-PE, we identified and classified a total of 112 processes, distributed across the categories of core, strategic, and support processes. Among these, some were mapped and improved. From

this experience, benefits and important lessons emerged for the application of this methodology in future projects, highlighting the following points:

Effectiveness of MIM-PS: The applied methodology proved effective in several analyzed processes. In one of the processes of Sector A, for instance, a significant reduction in the number of requests was observed. Before the implementation of the improvements, 440 requests were recorded during the period from January to September 2022. In the same period in 2023, after the application of the methodology, the number of requests dropped to 347, representing a 23% reduction. This exemplifies the positive impact of the improvement actions applied to the processes.

Functionality and Adaptability: The adopted methodology proved to be flexible, allowing the acceleration of improvements by omitting certain steps or micro-steps when necessary, based on the needs of the sector. For example, Ishikawa diagrams are applied only when it is necessary to understand the nature of the problem. If a sector desires quicker results or if the causes of the problems are more evident, the use of these diagrams may be optional. Another example occurs when processes are not yet clearly defined. In such cases, the *To Be* process can be directly mapped without going through the stages of analyzing and mapping the *As Is* version, referred to as the Should Be version. It is important to note that by not skipping steps, all variables and nuances are carefully considered. The process of mapping and improvement follows a more thoughtful approach, contributing to more robust and sustainable results. Consequently, the methodology aligns with the dynamics of each sector, balancing efficiency and analytical rigor.

Knowledge Management: A detailed study and mapping of key processes within each sector were conducted to address a significant risk faced by the institution: knowledge limited to a few individuals. By applying MIM-PS's diagnostic and documentation stages, the use of standardized templates and process documentation ensured knowledge continuity and facilitated internal learning. Documenting the work practices that represent the functioning of these processes became an essential measure to ensure continuity and continuous improvement. This approach allowed for the sharing of process knowledge across the organization, promoting collaboration and sustained development.

Team Sizing: Through MIM-PS's detailed process modeling phase, it was possible to identify, with precision, the sectors, activities, and agents involved in each process. This enabled a more accurate diagnosis of areas with staff shortages or overloads. The methodology's structured approach to mapping flows and responsibilities provided visibility into where personnel should be reallocated, optimizing the distribution of human resources and improving operational efficiency. By ensuring the optimal allocation of human resources, process efficiency was enhanced, and each sector received the necessary support to perform its tasks effectively.

Sector Self-Understanding: The construction of value chains, as proposed by MIM-PS, offered stakeholders, both internal and external, a comprehensive view of each sector. For internal teams, the value chains provided a complete view of all processes, allowing them to understand how their sector operates, identify areas for improvement,

and align their activities with its mission and objectives. For the external public, the value chain offered a clear perspective on the sector's functioning, detailing its responsibilities, mission, and the main value it delivers to its target audience. In this way, the proposed value chains not only facilitated the implementation of internal improvements but also strengthened transparency and understanding of the sector's role in society.

Process Standardization: The lack of documentation on process functioning led some sectors to develop their own activity routines. This resulted in reduced standardization of work, making information sharing and the implementation of best practices more challenging. By applying the documentation templates and mapping procedures proposed in MIM-PS, consistent and uniform process standards were established, made accessible, and formally recognized across the organization. The use of standardized artifacts (such as BPMN diagrams, value chains, and process portfolios) ensured that all three sectors adopted a common notation and terminology, thereby facilitating integration and continuous improvement. This enhances process efficiency and effectiveness, while facilitating the easy exchange of information among employees and promoting a culture of collaboration and continuous learning within the institution.

Participants in Meetings: During the MIM-PS information-gathering sessions, it was observed that having too many participants could compromise the efficiency and dynamics of the discussions. Balancing the number of attendees is essential so that there are enough people to ensure diversity of perspectives and comprehensive information, but not so many that the meeting becomes difficult to manage. Participant selection should be meticulous, giving priority to those directly responsible for executing the process while still ensuring representation of different viewpoints. This balanced approach aligns with the collaborative principles of the methodology, promoting diversity without losing focus. As a result, the selection of participants was refined to include mainly process executors and decision-makers, leading to more productive and well-structured sessions.

Changes in Management: The MIM-PS methodology also revealed significant challenges related to management transitions, which occurred twice during its implementation. In one of these cases, the project was discontinued in a sector because the new management had different priorities and did not consider process improvement a focus area. In the other case, although the project continued, the team initially faced greater difficulty in obtaining accurate and complete information due to the transition period and the limited familiarity of the new staff with existing processes. These experiences highlighted how leadership stability can directly affect the continuity and quality of process mapping. They also reinforced the importance of early stakeholder engagement and systematic documentation, one of the core principles of MIM-PS, to preserve methodological consistency and sustain improvement efforts despite organizational changes.

8. Threats to Validity

Although the application of the MIM-PS methodology during a case study produced significant and positive results in the three analyzed sectors, some limitations and threats to the validity of the study must be acknowledged. These threats are related to four common categories: internal, external, construct, and conclusion validity.

Regarding internal validity, two main factors should be considered. First, management changes posed a risk to the continuity of the project. During implementation, leadership transitions occurred in two of the three sectors, potentially disrupting the process. Nevertheless, the methodology demonstrated flexibility by adapting to new management structures and sector-specific needs. Second, resistance to change among employees emerged as a challenge. Some staff members hesitated to adopt new methodologies and process improvements, which may have affected implementation effectiveness. To address this, engagement strategies and awareness initiatives were promoted, although the level of acceptance varied across sectors.

In terms of external validity, a key limitation is that the methodology was applied within a single public institution. This restricts the generalizability of the results to other government organizations. However, to reduce this limitation, the methodology was tested in three distinct sectors, each with different characteristics and varying degrees of process complexity. This internal diversity enhances the potential for broader applicability, though further testing in other institutional contexts is needed to confirm generalization.

Construct validity was influenced by the absence of the monitoring and refinement phases, which are essential to ensure the sustainability of process improvements. Although immediate benefits were observed, the lack of a formal follow-up stage limits the ability to assess long-term impact. Additionally, selection bias is a concern, as the sectors analyzed were those that voluntarily opted to participate. These may not fully represent the broader institution. Efforts were made to include sectors with different levels of process maturity to mitigate this risk.

Finally, with respect to conclusion validity, internal factors within TCE-PE that were beyond the researchers' control, such as changes in management, administrative restructuring or shifting institutional priorities, may have influenced how processes were executed and adapted.While the methodology's flexibility allowed it to adjust to varying conditions, these external elements remain a source of potential bias in the observed outcomes.

9. Conclusion

Understanding and mapping processes are fundamental for promoting continuous improvement within an institution. To achieve greater efficiency and effectiveness in these activities, the use of appropriate methodologies is indispensable. In this work, the MIM-PS methodology, based on the BPMN cycle and focused on public institutions, was proposed and validated through a case study in three distinct sectors of TCE-PE. By following the first four stages of the BPMN cycle, several processes of varying complexity levels were mapped and improved. At the conclusion of the project, significant improvements in sector productivity were observed, resulting in more agile and efficient execution of their processes.

In addition to the practical contributions to the institution where it was implemented, the main contribution of this work is the proposition of the MIM-PS methodology, adapted from the BPM cycle for process mapping and improvement in

public institutions. Its application in different sectors demonstrated the methodology's effectiveness and adaptability across various scenarios, suggesting it could be replicated in other public institutions. Alongside the detailed description of the methodology, this study also offered a series of lessons learned during its execution, providing valuable guidance for other institutions and sectors applying it in the future. Furthermore, MIM-PS contributes to the IS field by integrating processes, data, and technology, which strengthens the use of information in digital transformation and public governance. The adoption of MIM-PS in public institutions can also help mitigate one of the major challenges in Information Systems in Brazil: promoting transparency and clarity in organizational processes and information management.

However, this study faced some limitations, such as the non-execution of the last two stages of the BPM cycle and the inability to map all identified processes in the three analyzed sectors due to the limited timeframe for project execution in each sector. For future work, it is planned to fully implement the methodology, including the final two stages of the BPM cycle, and adapt it to other public institutions, such as other courts, IFs, Federal Universities, among others, to further validate its effectiveness and adaptability in different contexts. This work is intended to serve as a reference for process management and improvement in public institutions, providing relevant insights for future mappings and improvements. Additionally, the aim is that this study not only inspires other organizations to initiate their own process mapping and improvement projects but also provides solid support for the successful execution of these initiatives.

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