






Implementing IT Enterprise Architecture to Improve the Provision of IT Resources for Public Sector

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Abstract: This research explores the implementation of IT Enterprise Architecture (ITEA) within a Brazilian public administration office, focusing on enhancing the provision of IT resources and services. Utilising the Action Research methodology, the study developed and implemented an ITEA framework and platform tailored to the specific needs of an IT organisation managing shared services across multiple federated agencies. The findings highlight the potential of ITEA to systematically integrate and optimise organisational processes, improve collaboration, and enhance information flow. Despite the benefits, challenges such as the traceability of business and IT alignment and a significant skills gap among IT professionals were identified. The study underscores the need for competency development programmes and a review of recruitment and training policies to ensure the sustainability and effectiveness of EA practices in the public sector.


1 INTRODUCTION


Enterprise architecture (EA) has been adopted by governments worldwide as a solution to systems integration, interoperability and innovation challenges (Afarani and Hindarto, 2023; Ramos, de Sousa and Rosa, 2019). Despite the importance of Enterprise Architecture (EA) in the public sector, there is a scarcity of studies that identify and evaluate the factors influencing its implementation across various organisational and sectoral contexts. Each study tackles this issue from different angles, including human, technological, and organisational factors (Afarani and Hindarto, 2023; Sharma and Mehra, 2021; Chitsa and Iyamu, 2020; Mokone et al, 2019; Sallehudin et al., 2019; Bakar and Hussien, 2018; Mdimba et al, 2017). Moreover, research focusing on the development of new technologies for the execution of EA is considerably more challenging


to find in public sector (Windolph et al., 2023; Mdimba et al, 2017).


In the Brazilian public sector, the primary obstacles to the implementation of EA include issues related to data and information management, difficulties in fundamental decision-making processes, challenges in distinguishing between important and urgent tasks, problems in promoting interoperability, difficulties in engaging with society, and a lack of support from top management, among other factors (Ramos, Oliveira, França and Montezano, 2019). Generally, EA in Brazil remains in its nascent phase, as indicated by the NASCIO maturity scale (Ramos, França, Oliveira and da Silva, 2019). The most recent initiative to define an EA framework in the Brazilian public sector, known as FACIN (Nunes, Cappelli and Costa, 2017), was discontinued due to a lack of sponsorship from the Brazilian public administration. It is important to note that this research was unrelated to the FACIN project. Furthermore, the FACIN project only implemented

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generic reference models without any technological development.

However, on 21 December 2023, the federal public administration of Brazil initiated a new model for sharing services among offices and their federated agencies. The objective of this initiative is to promote cooperation, integration, and the sharing of data, solutions, and technologies to enhance the governance and management of public services (Brazil, 2023). Given this complexity, EA was identified as the optimal solution to optimize the management of this collaborative arrangement (Afarini and Hindarto, 2023).

The research question thus arises: How can the implementation of Enterprise Architecture optimize the management of this new model for sharing services, with the aim of improving cooperation, integration, and the sharing of data, solutions, and technologies within the federal public administration of Brazil?

This article aims to describe an implementation of IT enterprise architecture (ITEA) in a Brazilian public administration office, an IT organization. It utilizes EA structures to design business elements, ensuring integration and modeling, and serves as a guide to structuring information and enhancing user interface and experience through implementation, considering stakeholders' perceived value.

2 THEORETICAL BACKGROUNDS

This section introduces the key concepts guiding this research. Our objective is to elucidate the primary tools necessary for the implementation of IT Enterprise Architecture.

2.1 Enterprise Architecture Implementation

The implementation of Enterprise Architecture (EA) in the public sector underscores the significance of appropriate frameworks and human factors. Sallehudin et al. (2019) emphasizes the necessity of aligning technology, organisation, and people to achieve success. They argue that integrating these elements is crucial for overcoming the challenges inherent in the complexity of governmental structures and ensuring the effectiveness of information systems. Afarini and Hindarto (2023) proposed the implementation of EA in e-Government development and services, highlighting the importance of robust

strategic planning and the selection of suitable frameworks. These authors suggest that adopting EA can enhance the efficiency and transparency of public services, facilitating interoperability between different departments and systems.

Furthermore, Bakar and Hussien (2018) and Sharma and Mehra (2021) highlight the influence of human factors on the success of EA implementation. Bakar and Hussien (2018) associate the success of EA with employee training and engagement, while Sharma and Mehra (2021) identify critical factors such as leadership, organisational culture, and technical competencies. These studies suggest that, in addition to a solid technical structure, it is essential to consider human and cultural aspects to ensure the adoption and sustainability of EA in the public sector. Mokone et al. (2019) complement this view by developing a decision support process for selecting an optimal EA framework for e-Government implementation, emphasising the need for well-defined criteria in choosing the most suitable framework.

Ivas (2023) notes that in many organisations, EA still struggles to be recognised and valued by business leaders. In practice, the legitimate role of EA in strategic decision-making is often limited to providing advice on the opportunities and limitations of new technologies. Since this aligns only with traditional EA, the discipline is seen as IT-specific support, something that can be easily dispensed with. Consequently, EA rarely participates in strategy formulation and is generally involved only in implementation.

2.2 Enterprise Architecture Framework

Enterprise architecture (EA) is a set of fundamental descriptive representations to define an organization (Zachman, 1987). These representations highlight the aspects necessary for the management and maintenance of the enterprise. EA is a discipline aimed at mapping and documenting the structure, processes, information, and technologies of an organization, allowing the alignment of strategic objectives with practical implementation and offering a holistic and integrated view of the enterprise.

To develop EA, it is necessary to define a framework that consolidates one or more structures serving as a basis to create a wide range of distinct architectures (Zachman, 1987). An enterprise architecture framework also aims to enhance the strategic alignment of a complex organization, facilitating both the creation and execution of strategy through the adoption of an integrated architecture (Ivas, 2023).

2.3 Enterprise Architecture Platform

An Enterprise Architecture (EA) platform is an integrated solution that helps organizations visualize, plan, and manage their structures and business processes. It is designed to support the deployment and execution of intelligent services in a specific context (Windolph et al., 2023). Windolph et al. (2023) developed their platform based on five functional layers: edge layer, integration layer, data layer, analysis layer, and intelligent service layer. This platform aims to acquire and integrate data, process and analyze it to derive meaningful insights, which form the basis for intelligent business process management system (BPMS) services.

In their study, Mdima et al. (2017) proposed a conceptual framework for the pre-implementation assessment of ERP systems within the context of EA in Tanzanian organisations. Their research highlights the importance of evaluating technological readiness and aligning ERP systems with organisational goals to enhance productivity and efficiency.

There are also off-the-shelf systems for EA modeling, such as Archi and the market leaders SAP LeanIX, Orbus Software, Ardoq, Mega, Capsifi, Bizzdesign, BOC Group, Software AG, Avolution and QualiWare (Frangou et al, 2024).

To enhance this research, a framework and an EA platform were developed. This development and implementation tailored to the specific needs of an IT organisation can significantly enhance decision-making processes.

3 METHOD

This research spanned thirteen months, from September 2023 to October 2024. It was conducted within an IT organisation, of the Brazilian government, whose mission is to provide IT services and resources to twelve other agencies. This ecosystem operates as a federated service delivery model, aiming to offer organised and standardised administrative and IT support services to reduce costs and ensure consistent standards and quality across these agencies (Amaral, 2024). Initially, this IT organisation provided services solely to its parent agency, but following the creation of federated agencies, demand rapidly increased. This necessitated the management of IT asset inventory and integrations, as well as the implementation of a tool for capacity and IT infrastructure management.

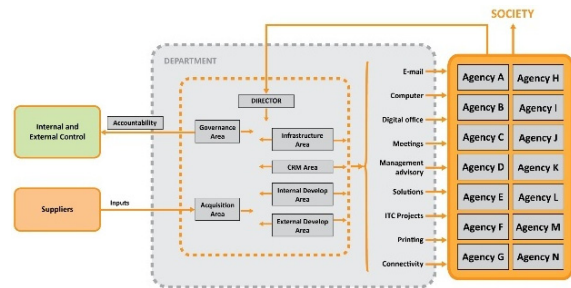


Figure 1: Brazilian public sector IT organisation and federated agencies.

To achieve the research objective, the Action Research (AR) methodology was selected, as it aligns well with this article and can be utilised to manage workflow and processes for various organisational activities (Ali, Edghiem and Alkhalifah, 2023). Consequently, five AR stages were employed: 1) diagnosing the problem through identification and definition; 2) planning the action by proposing methods and processes to solve the problem; 3) taking action by implementing practical measures; 4) evaluating performance; and 5) learning lessons to define new methods and improvement steps (Evered and Susman, 1978).

For diagnosis, context studies were conducted using semi-structured Voice of the Client (VoC) interviews with eleven IT executives from federated agencies. The interview protocol was developed with a header and questions aligned with a qualitative research plan, following the guidelines of Sweetman et al. (2010). The questions included:

- What services are utilised by the IT organisation? How do you request them?
- What IT services does your agency plan to acquire from the IT organisation?
- Whom do you contact in case of doubts/problems with these services? How do you request support?
- What is the IT organisation not doing well?
- What is the IT organisation doing well?
- What is the IT organisation not doing but should be doing?
- What is the IT organisation doing but should not be doing?
- On a scale of 1 to 5, how satisfied are you with the services provided by the IT organisation?

The analysis was conducted identifying "core meanings" in the responses, grouping themes that allow the definition of categories (Bardin, 2011).

For planning, the components of the EA framework and its integrations were defined, serving

as a roadmap for the development phase. During the action phase, the ITEA platform was developed based on upstream and downstream development, featuring five application programming interfaces (APIs): IT strategic management, unified projects, portfolio of digital solutions, process management, and the ITEA framework. This paper emphasises the portfolio of digital solutions as it forms the core of the ITEA.

For evaluation, weekly sprints were defined for the upstream and downstream phases. Additionally, quality tests and validation meetings were conducted for all APIs. For lessons learned, weekly meetings were held where the project's client monitored the project's progress and removed impediments.

4 EXPERIMENTAL RESULTS OF IT ENTERPRISE ARCHITECTURE

This section presents the research results, including the implementation strategies, ITEA framework, the ITEA platform and a portfolio of digital solutions.

4.1 Implementation Strategies

Before the implementation of technologies supporting ITEA, a survey was conducted with stakeholders of Federated agencies to identify issues in the delivery of IT organization services. This qualitative research followed the Voice of Client (VoC) structure and was applied in twelve agencies. The results indicated that the IT organization should be proactive regarding the performance of developed solutions, IT infrastructure, and the continuity of ITEA. In addition to providing insights for the construction of ITEA, this survey contributed to the development of the IT strategy by guiding the provision of better services.

One of the concerns from both the Federated agencies and the IT organization's board was the continuity of ITEA. To address this, the operation and monitoring process was defined. The process begins with demand management, where the need for technological development must be modeled using Techmap pattern. This serves as a pre-specification for analysis by the IT governance instance. Following the IT governance deliberation, the demand is directed to development, initiating the roadmap construction, which already considers integration between areas (layers) and organizational impacts. It is noteworthy that during the development period,

TechMap is not counted in the Portfolio, only when it is in production.

To monitor ITEA, two dashboards were implemented: one to verify the architecture data registered in the Portfolio and another for real-time performance of digital solutions.

4.2 The ITEA Framework

The proposed ITEA framework is the reference model (rules, layers, artefacts, and buses) for the development of the platform and its digital portfolio. This information was shared in a collaborative, traceable, and versionable manner. When fully implemented, this practice eliminates dependencies on external software for data display and task performance, maintaining coherent and centralized information.

Preliminary studies involved defining the Metamodel IT Enterprise Architecture, which serves as a reference to guide the development of TechMap and the preparation of the IT Enterprise Architecture Platform. This vision is structured as follows:

- Definition of the IT Enterprise Architecture Framework;
- Detailed Metamodel Enterprise IT Architecture Reference.

The fundamental principles of this IT Corporate Architecture Framework can be summarized as follows (Figure 2):

- **Layers:** This structure provides a common foundation for the enterprise architecture information, encompassing the business perspective of federated agencies. The layers framework enables transparent information sharing across the entire federated agencies. Each layer contains specific artifacts and can be further decomposed into sublayers.
- **Buses:** They introduce two cross-cutting perspectives to the twelve-layer architecture, ensuring integration and alignment. These perspectives are: i) Information/Indicators based on indicators that measure the performance of the architecture layers, resulting in a performance system; ii) Best Practices, Standards, and References: Provides methodological guides that direct all layers.

These two aspects ensure that the enterprise architecture is coherent and efficient, promoting methodological alignment across all layers and providing an integrated view of the ecosystem.



Figure 2: Preliminary Framework for IT Enterprise Architecture.

The layers of the IT Enterprise Architecture Framework guided the structuring of TechMap and the Library (details on TechMap in subsection 4.3.2):

- TechMap: Provides a modeling standard that uses visual artifacts to support the EA of a digital solution. These artifacts, referred to as data architecture, are assets or building blocks of EA layers.
- Library: Acts as a repository of artifacts, deliverables and building blocks from the architecture layers, allowing for maintenance close to the respective sources of information. The goal is to mitigate redundancies and duplication of data entry.

Together, TechMap and Library constitute the foundation of the Portfolio of Digital Solution, the main module of the ITEA platform.

It's important to highlight that these layers promote the alignment of IT with Business. Specifically, where the "relationships" are revealed, it shows the information flow between the IT organization and the offices. Additionally, domains were defined for grouping the layers. These domains outline the types of architecture: governance architecture; business architecture, divided into process and project architecture, service architecture and digital solution architecture; and technological architecture, divided into data architecture and IT infrastructure architecture.

Based on it, a data model for the development of the IT enterprise architecture platform is defined.

4.3 The ITEA Platform

Federated agencies comprise approximately 222 digital solutions, including application programming interface (APIs), apps (applications), portals, data

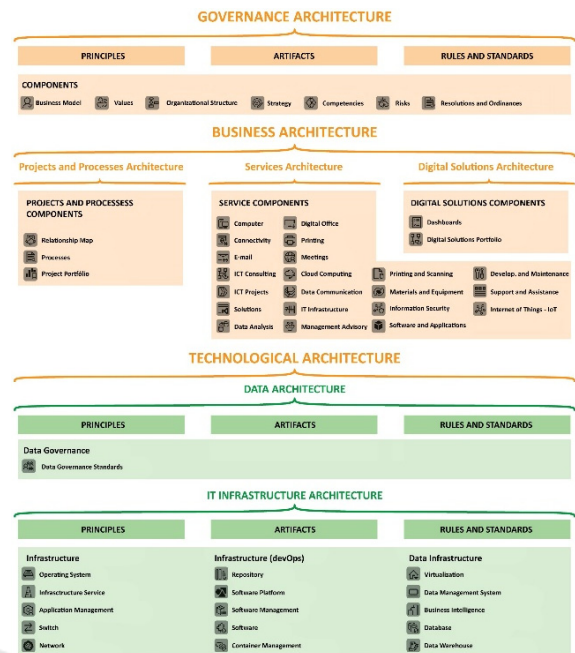


Figure 3: Framework for IT Enterprise Architecture.

warehouses, dashboards, and systems. These solutions are the responsibility of their respective offices, but they are supported by the IT organization. To ensure effective management, the creation of the ITEA platform was necessary. This environment was developed using the SharePoint platform, in conjunction with Power Apps and Power BI, empower each employee to directly input their data, goals, and progress. Furthermore, these tools support version control of changes and results, offering a clear and organised view of data evolution over time, thereby ensuring transparency and accountability.

The key aspect is that the platform integrates and manages the architecture data from the corporate architecture framework. The following modules were developed:

- ITEA Framework: Records architecture standards and rules;
- Integrated IT Strategy: Defines objectives, goals, key performance indicators, and initiatives for the Federated agencies and IT organization management;
- Unified Projects: Gathers all performance projects. Beyond strategy in the Brazilian public sector, this includes various project sources. It incorporates TechMap for new projects, a step for EA operations;
- Process Management: Shows the added value chain and processes;

- Digital Solutions Portfolio: Organizes the entire IT assets and includes the TechMap of digital solutions.

For this research, the digital solutions portfolio, which proved to be the core of integration for the other modules, will be presented.

4.3.1 Portfolio of Digital Solutions

The Portfolio of Digital Solutions is a system developed using Power Apps for registering architecture data related to the ITEA framework.

The homepage of the Digital Solutions Portfolio starts with a library (repository) view, showing all the registered architecture data for each layer. On the homepage, users can choose between two ways to view the library: by office or by categories. In the office view, users can see the architecture data library for a specific office. In the categories view, users can select the business segment.

The category view was an evolution of the digital solutions layer. It was found that the effort to maintain architecture data within the business architecture (strategy, projects, and processes) of the offices was high and would not bring significant benefits to IT management improvement, given the unstable business environment of these offices. To address this issue, digital solutions were categorized according to their descriptions, resulting in business categories independent of the configuration of the Brazilian government offices.



Figure 4: Shapes of data architecture.

For example, the rectangles for digital solutions are green and contain the following information (Figure 5):

- Purpose of the solution regarding the type of user (internal or external user);
- Solution name;
- Development team;
- Type of solution;
- Number of integrated systems;
- Evolution and maintenance operations;
- Office client.

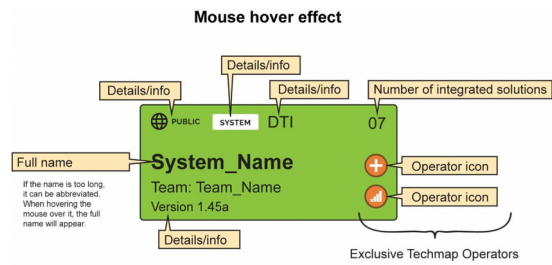


Figure 5: Shape of digital solutions.

This simplified notation, unlike ArchiMate, is a strategy to facilitate the dissemination of this knowledge, as, over the years, the Brazilian government has discontinued EA initiatives due to their complexity (Vilela-Cury, 2023).

4.3.2 TechMap

For this research, a simplified language for EA modelling was chosen to facilitate the rapid dissemination of knowledge on EA. Additionally, this language must be integrated into the EA platform, which is called TechMap.

TechMap originated in the insurance sector as a request from the board to understand, from a business perspective and in a simplified manner, the justification for IT investments in a less technical way. These investments mainly concern the development of new digital products and the acquisition and maintenance of IT infrastructure.

Therefore, TechMap provides an overview of corporate architecture from the viewpoint of a digital solution or technological initiative, showcasing the architecture data integrated into the digital solution (Figure 6).

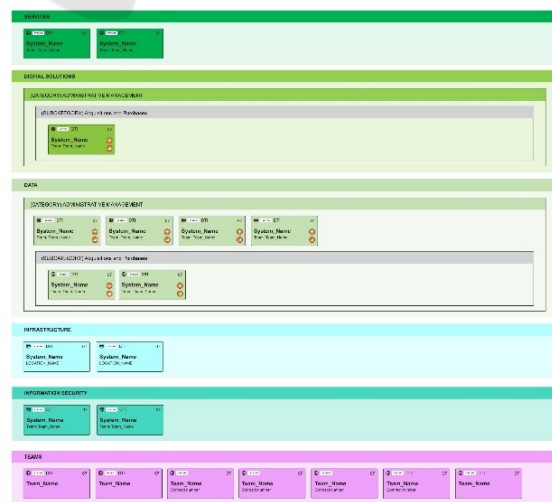


Figure 6: A TechMap view.

The modeling environment of TechMap reuses the same structure and format as the Digital Solutions Portfolio library, thereby simplifying the understanding for both business and IT stakeholders.

Thus, both the business and IT departments can anticipate the acquisition of new resources, reuse existing IT assets, and manage all their assets effectively.

5 EVALUATION

This section demonstrates how we evaluated the implementation of ITEA in a public sector office in Brazil. Freire and Vasconcelos (2024) emphasize that a reference architecture should be free of architectural flaws. However, considering the efficiency and effectiveness of applying enterprise architecture, other aspects must be considered, particularly the role EA plays in the managerial and organizational context, the problems it solves, the benefits it brings, and the effort required to maintain this system in operation.

Thus, this study presented an EA framework where the architectural components serve not just one organization, but an IT ecosystem formed by federated agencies in the Brazilian public sector. Despite a robust architecture that emphasizes business-IT alignment, some boundaries could not be overcome, such as the inability to track strategies, projects, and initiatives of other agencies. In this case, it is possible to monitor the architecture at the IT architecture level, as the hosting contracts are with the IT organization providing resources to other agencies.

Specifically, in the case of developing the Digital Solutions Portfolio, the following quantities of architectural data were registered: Service Layer (12 IT services), Digital Solution Layer (173 digital solutions), Data Layer (0 metadata was registered by the end of this research), Infrastructure Layer (55 IT infrastructure data) and Team Layer (27 teams).

Such a volume of data slowed down the loading process in Power Apps, making it recommended to use Power Apps Premium, as the data is stored in a database.

Another important aspect for the implementation of ITEA is the profile of the architecture managers. This is a complex topic that should be managed by specialists from both business and IT areas to avoid discontinuity and inefficiency in EA operations. In Brazil, securing a job in public administration requires passing a competitive examination. However, for positions in the IT sector, candidates are

not required to have prior education or experience in IT. In the IT organisation was identified a significant skills gap, revealing that most professionals fall short of the desired competencies. Specifically, in the realm of enterprise architecture, the individuals responsible for its management possess qualifications and experience that markedly differ from those required, particularly in terms of technological knowledge (Sharma and Mehra, 2021; Sallehudin et al, 2014, Bakar and Hussein, 2018, Mdimba et al, 2017).

6 CONCLUSIONS

This research demonstrates the feasibility of implementing Enterprise Architecture (EA) for an IT organisation that works with shared services, highlighting its potential for the systematic integration and optimisation of organisational processes, as noted by Sallehudin et al. (2019). The approach facilitates a comprehensive understanding of strategic planning, organisational processes, and information systems, suggesting significant potential for improving collaboration and information flow between different agencies.

The Action Research methodology highlights a collaborative approach, particularly in constructing the ITEA platform, contributing to transparency and accountability in the EA implementation process. However, challenges such as the traceability of business and IT alignment between agencies remain.

A critical success factor was evidenced; the implementation of EA in the public sector IT organisation in Brazil revealed a significant skills gap, indicating that most professionals do not possess the desired competencies, as pointed out by Sharma and Mehra (2021) and Bakar and Hussein (2018). These findings underscore the urgent need for competency development programmes and a review of recruitment and training policies in the IT sector. Future research could explore strategies to mitigate these skills gaps and evaluate the effectiveness of the implemented interventions.

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