Developing a BI Solution for Public Process Monitoring.

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Abstract. The development of Business Intelligence (BI) tools is essential for improving the efficiency and quality of services in public and private organizations. However, public institutions, especially at the subnational level, often face challenges due to legacy systems that complicate effective data utilization. This study focuses on a subnational public institution, the Court of Auditors of the State of Pernambuco (TCE-PE), which previously relied on a dashboard with several limitations, including usability issues, data inconsistencies, and maintenance complexities due to its dependence on multiple SQL Server database views. This study presents the development of a new dashboard, designed using an agile methodology, to centralize data transformations within the BI tool. The proposed solution focuses on the Accountability process, aiming to enhance data consistency and improve performance monitoring. The development process was structured into four key phases: Problem Identification, Planning and Requirements Collection, Design and Development, and Validation and Testing, ensuring a systematic and iterative approach to address the institution's needs. The new system utilizes Qlik Sense, eliminating dependency on SQL Server views and allowing real-time analysis through interactive dashboards. The solution overcomes prior limitations, providing faster, more accurate, and reliable analyses aligned with the institution's strategic objectives. By improving flexibility, usability, and data reliability, this initiative not only serves as a reference for other subnational institutions in Brazil but can also be adapted as a model for organizations operating in diverse contexts worldwide.

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1. Introduction

Over time, the volume of information has grown exponentially, particularly in the public sector, which deals with data essential for decision-making and activity monitoring. This growth has made the public sector increasingly aware of the potential value that can be derived from the data it generates (Munné, 2016). In this context, there is a rising demand for Business Intelligence (BI) tools, which stand out as fundamental strategies for organizing and structuring data, facilitating information management, and supporting data-driven decision-making (Negash, 2004).

The use of dashboards in the public sector has proven to be an effective strategy in the context of governmental digital transformation (Andrade et al., 2023), especially in the face of growing challenges in managing large volumes of data and the pursuit of greater transparency and operational efficiency. For instance, serves a

variety of purposes, from performance monitoring to policy formulation and public engagement (Matheus et al., 2020). These dashboards provide flexibility by offering both broad overviews and specific insights, promoting transparency and detailed analysis of critical events. However, for these dashboards to reach their full potential, it is essential to ensure the quality of the data used, considering aspects such as granularity, timeliness, and accuracy. Inadequate use or lack of optimization of dashboards can compromise the efficiency of monitoring critical processes and hinder strategic decision-making based on reliable data (Matheus et al., 2020).

Within this context, the Court of Auditors of the State of Pernambuco (TCE-PE) has adopted BI tools to monitor and analyze data related to its activities, with a particular focus on the Process Monitoring Dashboard. However, the dashboard faced limitations that compromised both its usability and the consistency of the information presented. These challenges were primarily associated with the integration of multiple views used to extract and transform data, which reduced the dashboard's efficiency and made its maintenance more difficult. Additionally, the sharing of these views across departments, which applied different data treatments, led to the emergence of conflicting information. As a result, there were obstacles to the accurate visualization of key indicators essential for tracking and improving organizational processes.

The limitations of the previous system resulted in significant impacts, such as delays in indicator analysis and difficulties in implementing essential improvements for monitoring critical processes. These issues were primarily caused by information fragmentation, challenges in adopting new technologies, and difficulties related to data integration and quality. To ensure the effectiveness of BI dashboards, it is essential to overcome these limitations, focusing on proper design and data quality, which are critical factors for promoting transparency and accountability (Matheus et al., 2020). Furthermore, the implementation of BI systems requires a transformation in technological infrastructures, overcoming the barriers of legacy systems and meeting the demand for dynamic and timely information (Mix, 2016).

This study aims to present the development process of a new dashboard for process monitoring, focusing on the "Accountability" modality at TCE-PE. The study highlights the benefits and limitations of the proposed solution, which was developed in Qlik Sense to address issues in the previous system, such as usability problems, data inconsistencies, and reliance on SQL Server views. By enhancing the consistency, efficiency, and reliability of analyses through interactive and real-time visualizations, the solution contributes to optimizing the institution's internal processes and aligning with its strategic goals. Additionally, this study serves as a reference for subnational public organizations, promoting best practices in the use of BI tools to improve efficiency, transparency, and decision-making support within the broader context of digital government and the specific challenges of digital transformation in the public sector.

This article is structured as follows. Section 2 presents related works. Section 3 discusses the theoretical foundation on process management and monitoring in the public sector, as well as the tools and technologies employed. Section 4 details the methodology adopted in the development of the new dashboard. Section 5 describes the main implementations of the dashboard. Section 6 presents the analysis and interpretation of the results obtained. Finally, Section 7 discusses the conclusions and future perspectives of this study.

2. Literature Review

In both public and private organizations, numerous studies explore the use of BI tools for data monitoring and analysis to support decision-making. In the private sector, Widjaja and Mauritsius (2019) addressed the implementation of a BI system at *Indomobil*, one of the leading automotive companies in Indonesia. The study aimed to develop a performance dashboard using the Power BI tool to facilitate the analysis of operational data at the strategic management level. The implementation followed four stages: analysis, design, planning, implementation, and control. The results indicated that the dashboard implementation provided a better understanding of the company's operations, enabling efficient monitoring and identification of areas requiring improvement.

The study by Sanabia-Lizarraga et al. (2024) was conducted at the Agro-logistics Observatory of the Sonora Institute of Technology (ITSON), aiming to support the analysis of Mexico's agricultural foreign trade. The objective was to develop an interactive Power BI dashboard for analyzing Mexican agricultural exports, enabling the visualization and comparison of export and import data to support decision-making for commercial and academic purposes. To achieve this, the Cross-Industry Standard Process for Data Mining (CRISP-DM)

methodology was adopted, involving the collection and cleaning of data from various sources and a modeling process that integrates geospatial data and economic classifications. The developed dashboard provided a detailed visualization of the Mexican agricultural trade scenario and was well-received by its stakeholders for its usefulness in strategic decision-making for the agricultural sector.

In the public sector, Samad and Setyabudhi (2023) identified the need for software to improve and facilitate police services at the Integrated Police Service Center (SPKT). The data used were still processed, according to information needs, using Microsoft Office applications (Word and Excel), which had limitations. Thus, the authors designed a public service administration application to assist in managing this data. The application includes a dashboard that presents important information, combined and organized on a single screen, allowing for quick visualization. The results of developing the public service administration dashboard using the waterfall model involved nine tables to support the application and enabled easier data retrieval. Among the limitations of the work, the authors highlight that the solution is restricted to administration and employee pages and does not support online services for email. Additionally, they emphasize the need to increase human resources to support the new system.

Given the recent increase in the number of refugees due to the war in Ukraine, Sprenkamp et al. (2023) proposed a tool for the Swiss government to manage refugee needs. The authors aimed to demonstrate how modern Natural Language Processing (NLP) techniques can be applied to identify refugee needs from large volumes of textual data. To achieve this, they used the Design Science Research approach, which involved semi-structured interviews with stakeholders to define design requirements and develop the "Refugees to Government" (R2G) application, based on topic modeling applied to Telegram data. This application analyzes public Telegram messages, making them available on a dashboard where users can navigate the data and view the main refugee needs in an organized manner. The results show that the system is effective in identifying refugee needs and can be used to complement public policies. However, the study raises ethical challenges related to refugee privacy and risks of misuse of the tool.

Also in the public sector, Vila et al. (2018) highlight the use of information visualization tools to enhance governmental decision-making. The authors proposed the design of a dashboard that integrates visualizations built from open data provided by the Municipality of Bahía Blanca, Argentina. This dashboard was divided into six areas and aims to provide an overview of the most relevant information about the city, facilitating high-level data analysis for the mayor and other authorities. The proposed dashboard is capable of providing a broad overview of the city, presenting information on the most important areas related to policy. However, the authors argue that dashboards are unable to portray cities as they are in real life due to their reliance on open data, which must be made available by government agencies.

The development of the BI dashboard for the TCE-PE differs from previous studies due to its focus on oversight and transparency in public administration. While works such as (Sanabia-Lizarraga et al., 2024; Widjaja & Mauritsius, 2019) address performance optimization in the private sector, and others like (Samad & Setyabudhi, 2023) deal with specific public services, this study aims to enhance the control of administrative processes and accountability, ensuring greater reliability and efficiency in data management. Despite advancements in BI tools, several challenges persist, including data fragmentation due to reliance on multiple sources (Samad & Setyabudhi, 2023; Sanabia-Lizarraga et al., 2024), limited applicability of solutions without a broader governance approach (Samad & Setyabudhi, 2023; Vila et al., 2018), and concerns regarding transparency and data reliability in decision-making (Sprenkamp et al., 2023; Vila et al., 2018). To address these issues, the proposed dashboard uses Qlik Sense technology, contrasting with the predominant use of Power BI, to integrate and centralize information, reducing fragmentation caused by multiple SQL Server views. This approach strengthens public governance by providing a unified and accessible view of data, serving as a reference for other institutions seeking to improve their management through BI solutions focused on transparency and efficient oversight.

3. Background

3.1. Process Management and Monitoring in the Public Sector

All organizations, whether public, private, or non-profit, need to manage a series of processes (Dumas et al., 2018). Thus, it is necessary to adopt an effective strategy for managing their business processes. A business

process can be defined as a set of interrelated events, activities, and decisions involving various actors and objects, aimed at delivering a valuable outcome to at least one customer (Dumas et al., 2018). In the context of the public sector, business processes are adapted to address the complexity of government regulations and the diversity of stakeholders involved. Effective management of these processes is crucial for improving organizational effectiveness and efficiency, especially when based on cross-functional processes (Gulledge Jr & Sommer, 2002).

However, the degree of implementation and maturity of business process management in public institutions remains relatively low, and the willingness to share knowledge on the topic is limited (Ahrend, 2014). The effective adoption of BPM is often hindered by the lack of integration of its principles into the organizational culture, resulting from both the absence of competitive pressure for rapid changes and the inherent bureaucracy in decision-making processes (Dumas et al., 2018). Additionally, public organizations also face challenges related to multiple stakeholders and cross-cutting portfolio objectives, as they deal with a broader and more complex variety of clients compared to private organizations (Tregear & Jenkins, 2007).

To improve the quality of services offered, proper monitoring of business processes is necessary (Fioretto & Masciari, 2024). Process monitoring reflects the actual performance of planned activities and is essential for good governance, facilitating accountability and transparency (Mohamed & Kulmie, 2023). Through the data collected, it is possible to identify bottlenecks, recurring errors, or deviations from the expected behavior of processes, enabling the adoption of corrective actions (Dumas et al., 2018).

Like other public institutions, the TCE-PE also requires constant monitoring of its business processes. Playing a key role in overseeing public administration, the TCE-PE is responsible for analyzing documentation provided by public institutions, conducting audits, evaluating the legality of managers' actions, and verifying the cost-effectiveness of expenditures and their compliance with government guidelines and programs (TCE-PE, 2025a). In this context, the use of monitoring tools to assess the efficiency of TCE-PE's business processes is crucial for transparency in the analysis of public accounts. In this regard, the prototype of the process dashboard was developed focusing solely on the "Accountability" procedural modality. This modality was chosen due to its importance to the institution and the large volume of available data on it.

3.2. Monitoring Technologies and Tools

Monitoring technologies and tools are used to track, analyze, and evaluate the performance of data related to processes or activities within an institution. In the public sector, monitoring plays a significant role in enhancing activities, contributing to increased effectiveness and efficiency of services provided to society. These tools enable the identification of deficiencies, the evaluation of trends, and the implementation of best practices. Additionally, they allow for the extension and improvement of processes and services, using appropriate instruments to accelerate continuous performance improvement (Dascalu et al., 2016). This provides public managers with more accurate information for decision-making, directly contributing to greater administrative efficiency and better accountability to society.

One of the standout tools in the field of data monitoring and analysis is Qlik Sense (Qlik, 2025), a modern BI platform widely recognized for its advanced capabilities and versatility (Ceccato, 2023). Its functionalities range from data collection and integration to the creation of interactive visualizations and predictive analytics, making it a powerful solution for both public and private institutions. Among its key features are:

- **Customizable and Interactive Dashboards:** Allows the creation of dynamic dashboards with visualizations tailored to the needs of different audiences and purposes, promoting detailed analysis and informed decision-making.
- **Integration with Multiple Data Sources:** Supports data from various sources, such as spreadsheets, SQL databases, XML files, and cloud systems, centralizing information for efficient analysis.
- **Scalability and Flexibility:** Serves small teams to large organizations, allowing adaptations for specific scenarios and ensuring relevance in different organizational contexts.
- **Advanced and Predictive Analytics:** Provides tools for scenario simulations and pattern identification, aiding in anticipating trends and defining more assertive strategies.

Figure 1 illustrates these characteristics in a simplified manner. Data can be extracted from various sources, transformed, and loaded to be presented in dashboard format, in a process known as Extraction-Transformation-Loading (ETL). ETL plays an essential role in data integration and transformation, ensuring

the quality, consistency, and reliability of the analyzed information (Venkateswarlu & Vasista, 2023). Furthermore, the implementation of robust internal controls during each phase of ETL is crucial to prevent errors and ensure data integrity, allowing analyses and decisions to be based on reliable and up-to-date information (Dingre, 2023).

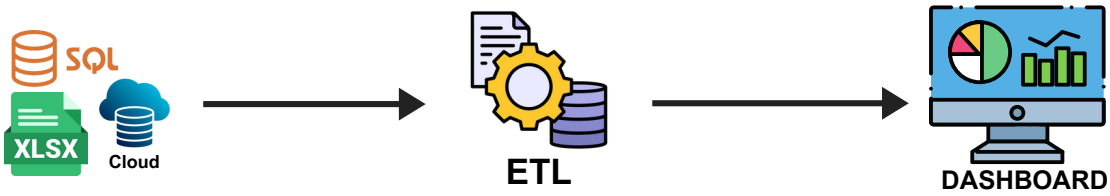

Fig. 1 – Representation of the ETL Process in the context of data integration.

4. Research Method

The development of the new dashboard was carried out collaboratively, using concepts derived from agile methodologies, as described by (Al-Saqqa et al., 2020). These concepts aim to ensure the delivery of a high-quality product within reduced timelines and with optimized resources, aligning with the dynamic needs of the project and promoting continuous adaptability. In this context, the development cycle was adjusted to implement an incremental process with continuous deliveries and feedback. Each increment was subjected to testing and validation, fostering efficient communication among stakeholders and ensuring continuous validation of the product as new functionalities were added. The activities followed a pre-established schedule, structured into four main stages, as shown in Figure 2: Problem Identification, Planning and Requirements Gathering, Design and Development, and Validation and Testing. These stages are detailed below.

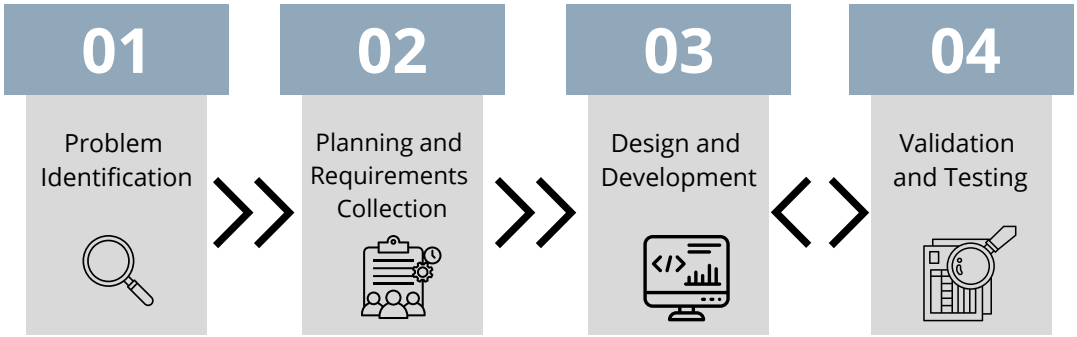

Fig. 2 – Adopted methodology.

4.1. Problem Identification

In this phase, an analysis was conducted to identify the problem to be addressed and the organization's needs. This process involved identifying causes and effects, understanding the nature of the problem, and considering potential constraints. The analysis was primarily based on the previous dashboard and existing requirement documents to understand its deficiencies and limitations. The goal of this stage was to ensure that the proposed solutions not only meet the identified needs but are also effective, feasible, and aligned with the organization's strategic objectives.

Although functional, the process dashboard previously used by the Process Office of TCE-PE had issues that compromised its usability and the consistency of the information presented. Additionally, the dashboard included indicators that were no longer relevant to the sector, while essential indicators were not addressed. The data feeding this dashboard were processed and filtered externally, through the extraction, treatment, and filtering of multiple views from various SQL Server databases.

As a consequence of this chain of views, the dashboard's efficiency was reduced, and data consistency was compromised. Furthermore, these views were shared across various departments, which applied different

types of data treatments, making maintenance difficult and facilitating the emergence of conflicting information. These issues hindered the accurate visualization of the indicators necessary for monitoring and improving the organization's processes. Thus, it became necessary to develop a tool to mitigate these problems.

4.2. Planning and Requirements Collection

After identifying the problems, the next step involved planning and requirements collection, including the establishment of a schedule to be followed and the definition of activities for each phase of the development process. This schedule considered the potential constraints identified in the previous stage and the limitations of resources and time that could impact the feasibility of the proposed solutions. The planning was structured based on the schedule, which was divided into three main stages: Requirements Gathering, Process Dashboard Development, and Testing and Validation.

In the Requirements Gathering stage, activities such as identifying indicators for the Overview, Time, and Inventory tabs, defining filters and views, and reviewing and finalizing the requirements document were carried out. Next, in the Process Dashboard Development phase, data treatment, implementation of the Overview, Time, and Inventory tabs, as well as the implementation of filters and views, took place. Finally, in the Testing and Validation stage, specific tests were conducted for each tab, along with performance and usability tests to ensure the system's effectiveness.

The development of the dashboard was estimated to take 371 calendar days, considering the overlap of some stages, which occur simultaneously. This timeline was distributed among the project activities according to their complexity. The Requirements Gathering stage was planned for a total of 225 days, with 60 days allocated to identifying indicators for the dashboard tabs, 30 days for defining filters and views, and 15 days for finalizing the requirements document. The Process Dashboard Development began immediately after the completion of the general tab's requirements gathering, with an estimated duration of 270 days. Data treatment and the implementation of filters and views also occurred during this period, while the implementation of the tabs was divided into 90-day cycles for each one. Testing was conducted immediately after the implementation of each tab, totaling 65 days, with 15 days for individual tests and 20 days for performance and usability evaluation. With the schedule defined and approved by management, the project execution began.

As defined in the schedule, the project started with requirements gathering, which were recorded in a document containing all the necessary information for the dashboard's development, including technical and functional aspects aligned with organizational objectives. The document was developed through weekly meetings between the TCE-PE team, which defined the indicators to be implemented, as well as the filters and dynamic columns needed to improve information visualization.

The document began with a brief introduction, followed by descriptions of the elements that make up the dashboard: dimensions, measure groups (tabs), related views, and filters. Each tab has its own set of measures; however, the filters and the dynamic table are common to all tabs. Thus, the measures for the Overview tab were defined first, followed by the general and complementary filters and the dynamic table. Finally, the requirements for the Time and Inventory tabs were defined, respectively. After defining the requirements for each tab, the document was submitted to management for approval before being forwarded for development.

4.3. Design and Development

The team involved in the development process included internal public servants and outsourced professionals, working collaboratively throughout the process. This stage consisted of two main phases: design, which involves the processes of data extraction, transformation, and structuring, and development, which refers to the creation of the dashboard, ensuring that the requirements established in the documents are met. During the design phase, the preparation and organization of the data required for the system take place, while the development phase involves the construction of functionalities, charts, columns, and visual structures of the dashboard.

The development of the dashboard included a detailed analysis of the previous dashboard, applying reverse engineering to map the origin and sequence of the *views*, identifying the essential source tables. With this information, it was possible to create a code that extracts data directly from the source, eliminating the dependency on *views* in the new system and ensuring greater control over data consistency and quality. After

mapping the data sources, the direct extraction of information from the databases began, eliminating the need for *views*.

With the data properly structured, the development of the dashboard commenced, following an incremental model using the BI tool Qlik Sense *QLIK Sense* (Qlik, 2025). The dashboard was organized into three main tabs: Overview, Time, and Inventory, each designed to meet specific analysis and monitoring needs. The Overview tab provides a general view of the processes, including information on the number of processes that have completed certain procedural stages. The Time tab displays data related to the duration of process stages (current position), while the Inventory tab presents all formalized processes that have not yet completed the execution phase. The implementation of new tabs was planned for future updates, allowing for the continuous growth of the dashboard.

4.4. Validation and Testing

The validation and testing phase was conducted as each tab was implemented, with the goal of verifying whether the developed solution meets organizational needs. For this purpose, a dashboard validation spreadsheet was used, with access shared between the development team and the testing team, which was composed of the same members responsible for the requirements gathering. The spreadsheet facilitates communication between the two teams and speeds up the resolution of potential inconsistencies during the dashboard implementation phase.

When an inconsistency is identified in the dashboard under development, it is recorded in the validation spreadsheet, which contains specific fields to document a detailed description of the issue, include illustrative images, and provide the step-by-step process that led to the error. With this information, the development team can reproduce the issue and implement the necessary correction. Simultaneously, the testing team monitors the resolution status through a field in the spreadsheet that presents the options: Not Implemented, In Progress, Implemented, Discarded, and In Backlog. The spreadsheet also includes a field for observations, used to record important information about the progress of corrections or to justify the discarding of certain issues.

5. Dashboard Development

The system architecture was developed using Qlik Sense, which integrated both the front-end and back-end of the application. This tool was adopted because it is already used institutionally by TCE-PE. Data were extracted from the Electronic Process System (TCE-PE, 2025b), an electronic process platform of TCE-PE, which facilitates the handling of processes, communication of acts, and transmission of procedural documents virtually. The processes are available for public consultation (TCE-PE, 2025c). It is worth noting that the developed dashboard is exclusively for internal use by TCE-PE, as it contains sensitive and restricted information. According to Article 46 of Resolution No. 22/2015 of TCE-PE, only procedural documents of a public nature will be made available for public consultation, except in cases involving confidentiality to protect privacy or public interest (TCE-PE, 2015). Thus, the Electronic Process System seeks to balance public transparency with the security and confidentiality of its internal data.

The data used in the dashboard were extracted from two main databases, which play complementary roles in the system. The first is the **Reading Database**, which contains essential information about the cases, such as nature, session, judgment, deliberation, and redistribution. The second is the **Complementary Database**, which stores additional data such as information about reporters, municipalities, types of modalities, jurisdictional units (UJ), and staff members. Based on these data, the new dashboard was developed with an initial focus on the "Processes" dimension, aligned with organizational goals, in contrast to the previous dashboard, which included the dimensions: Processes, Activities, and Communications. This dimension encompasses data related to electronic processes, which make up the accounting process modality of TCE-PE providing information such as case quantities, duration, deadlines, and more. The dimension was divided into three tabs: Panorama Geral, Tempo, and Estoque.

The Panorama Geral tab aims to provide an overview of the accounting process and allow monitoring of its phases, showing the quantity of cases that have completed a certain procedural phase. The Tempo tab presents data related to the duration of specific steps in the process, and by default, when accessed, it shows data for the

current date. Finally, the Estoque tab consists of all formalized cases that have not yet completed the execution phase, i.e., all ongoing cases on the selected date. Additionally, the developed dashboard offers several key functionalities for process analysis and monitoring at TCE-PE, enabling interactive visualization and real-time data tracking. Some of the implemented features include views, general filters, complementary filters, and a table with dynamic columns.

Each tab of the dashboard presents a unique set of related views. Views are graphical representations of the measures related to a specific perspective, such as the number of cases by year or month. Thus, views refer to how the data will be graphically displayed to the user. Unlike the previous dashboard, the new Process Dashboard presents views more aligned with organizational goals. Specifically, in the Panorama Geral tab, as illustrated in Figure 3, the user can choose from various options to view the data in different ways. It is important to note that some information in the dashboard has been hidden in the figures due to the sensitive nature of the data.

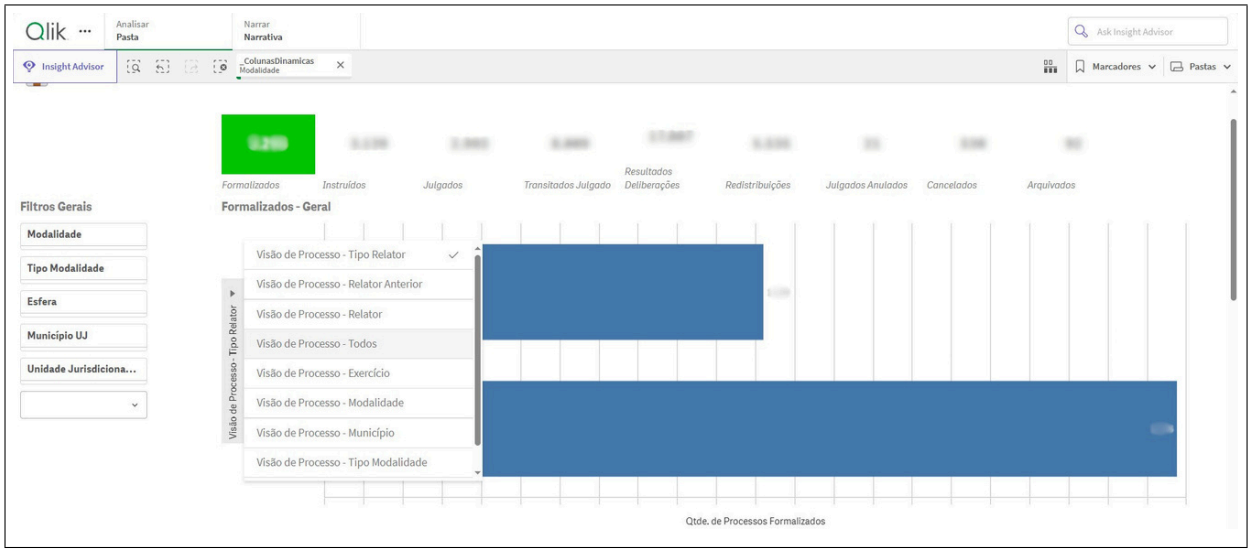

Fig. 3 – Views of the Panorama Geral tab.

The three tabs of the dashboard share a set of interactive filters. These filters apply the criteria selected by the user, adjusting the information displayed in the views. Two types of filters were defined: general and complementary. The general filters include common criteria such as modality, type of modality, sphere, municipality, jurisdictional unit (UJ), exercise, reporter, and process status. The complementary filters offer additional options to further refine the analysis. Figure 4 presents some of these filters.

In addition to the filters, all tabs include a dynamic table. This table presents a representation of the process data that make up the views presented. The table allows the user to add or remove columns dynamically based on their analysis needs. By default, the table displays the following columns: Process Number, Process Link, and Modality, with additional columns that can be added as needed. Figure 5 shows an example of the dynamic table. It is worth noting that the process numbers have been hidden to maintain their confidentiality.

The dashboard was developed to optimize process analysis, offering an intuitive interface and advanced filtering and visualization features. The customization of the dynamic table provides greater flexibility in data visualization, meeting the diverse needs of users. Moreover, the organization of the tabs and filters enhances navigation and allows users to quickly access the most relevant information. With flexibility for future adjustments and expansions, the tool enables continuous monitoring of organizational processes, allowing for greater control and efficiency in operations.

6. Results

The implementation of the new dashboard brought significant improvements to the analysis and monitoring of processes at TCE-PE. To evaluate its effectiveness, tests were conducted with simulated scenarios, demonstrating its ability to provide information more quickly and intuitively. The dashboard allowed managers to

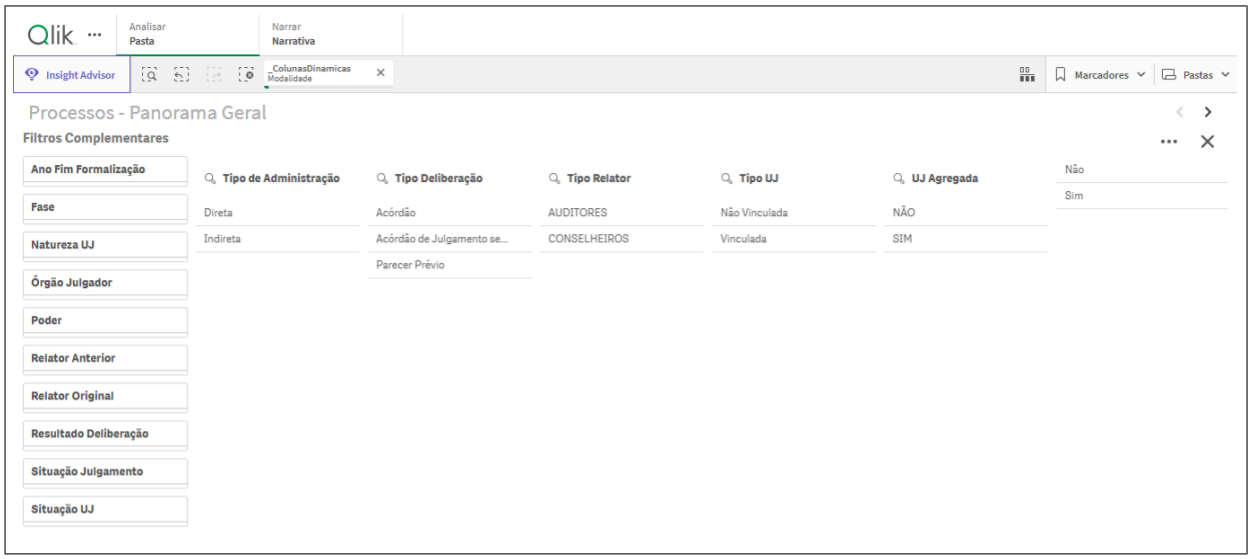

Fig. 4 – List of complementary filters.

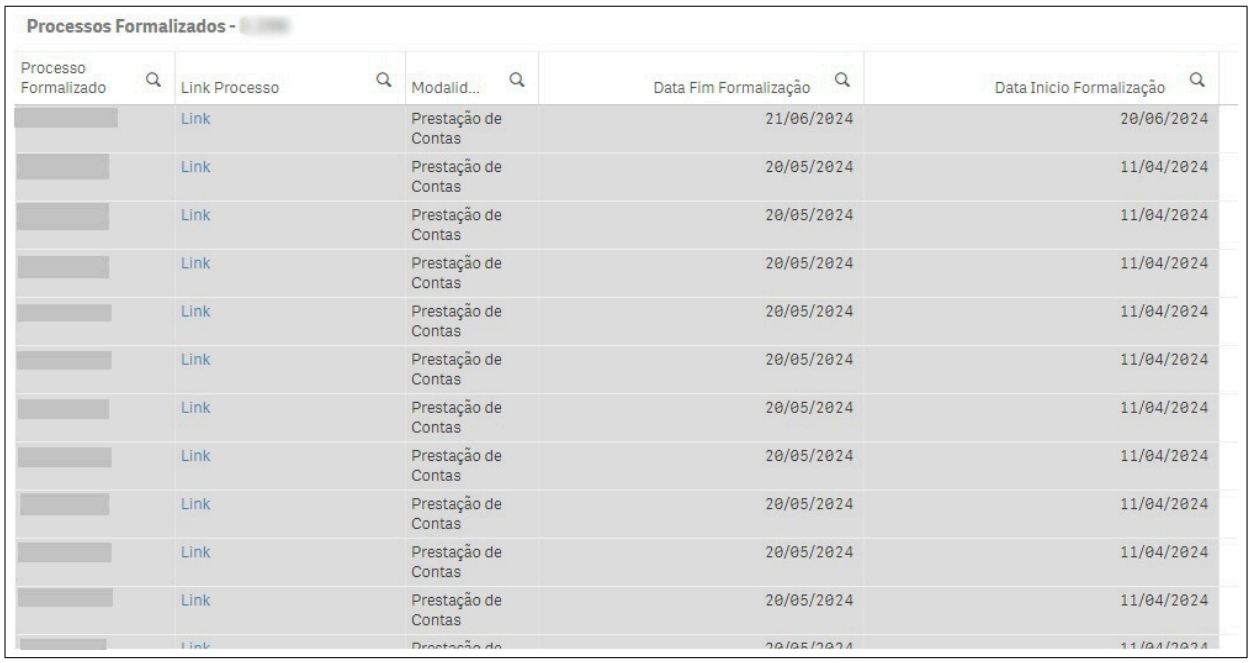

Fig. 5 – Example of a dynamic table.

quickly access essential data, such as the evolution of processes, average processing times, and identified bottlenecks, facilitating strategic decision-making.

Figure 6 presents an example of the Time tab, highlighting the number of processes adjudicated in 2018. In this tab, it is possible to clearly visualize how many processes were completed within and outside the deadline, as well as the timeliness index and the average time, in days, from formalization to adjudication. Additionally, the visualization allows for the identification of the distribution of adjudicated processes over the months of the selected year, providing a more detailed analysis of the processing over time.

Figures 7 and 8 present an example of the Overview tab, filtering the number of formalized processes in the Municipal Sphere with the nature of City Council. In Figure 7, the processes are classified into two modality types: Management and Government. In Figure 8, it is possible to visualize the distribution of processes by year and month of formalization. Figure 9 presents another form of analysis, filtering the Deliberations stage within the Municipal Sphere, considering only processes with the nature of Municipal Prefecture for the year

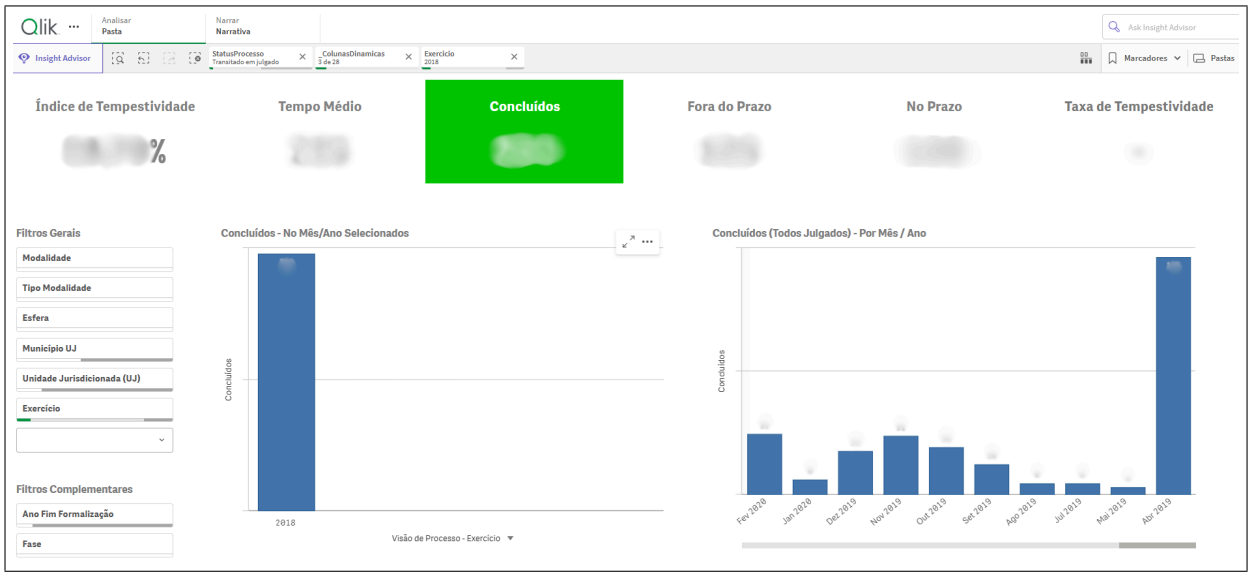

Fig. 6 – Simulation of Adjudicated Processes in the Time Tab.

2024. This visualization allows for the observation of both the total deliberations conducted throughout the year and their monthly distribution.

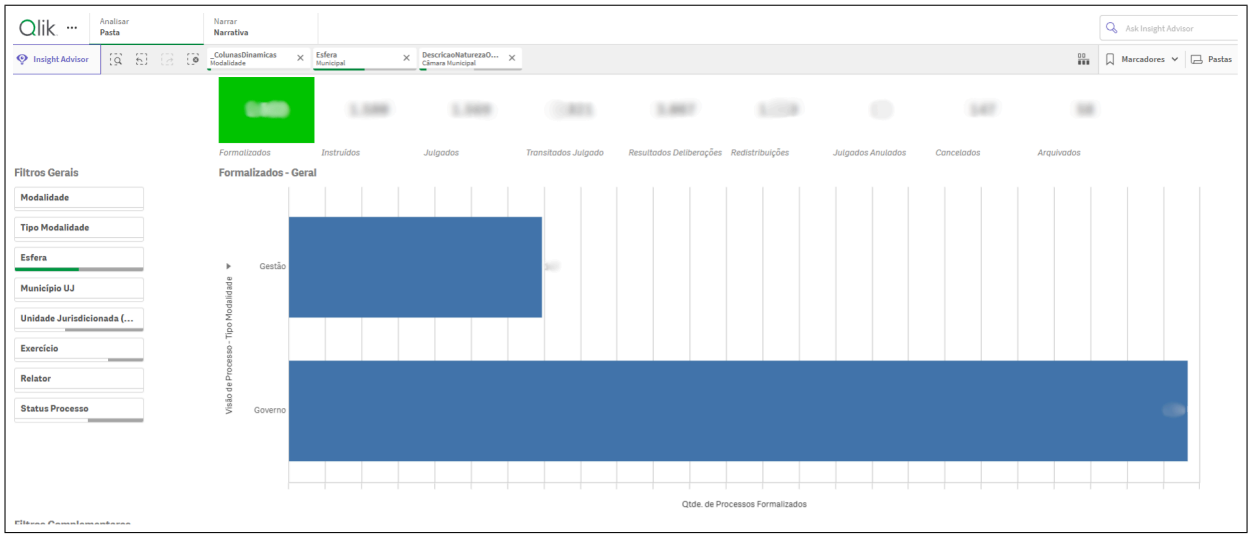

Fig. 7 – Simulation of Formalizations in the Overview Tab, Categorized by Modality.

The implementation of a new, more efficient dashboard aligned with organizational objectives brought significant benefits to the TCE-PE. Among the main benefits achieved are:

- **Greater Efficiency:** The direct extraction of source tables and the optimization of the data flow ensured greater reliability and system performance. The elimination of the use of *views* provided more control over the data, increasing the accuracy of the information presented. Additionally, the centralization of transformations in the Qlik Sense tool reduced processing complexity, making analyses faster and more reliable.
- **Simplified Maintenance:** The entire development and data transformation process was centralized in the Qlik Sense tool, facilitating the identification and correction of errors, the application of improvements, and the understanding of implemented rules.
- **Improved Visualization and Analysis:** The new dashboard presents data interactively and visually clearly, facilitating decision-making and enabling more detailed and intuitive analyses. Additionally, the new filter and view options allow information to be displayed in a customized manner according to user needs.

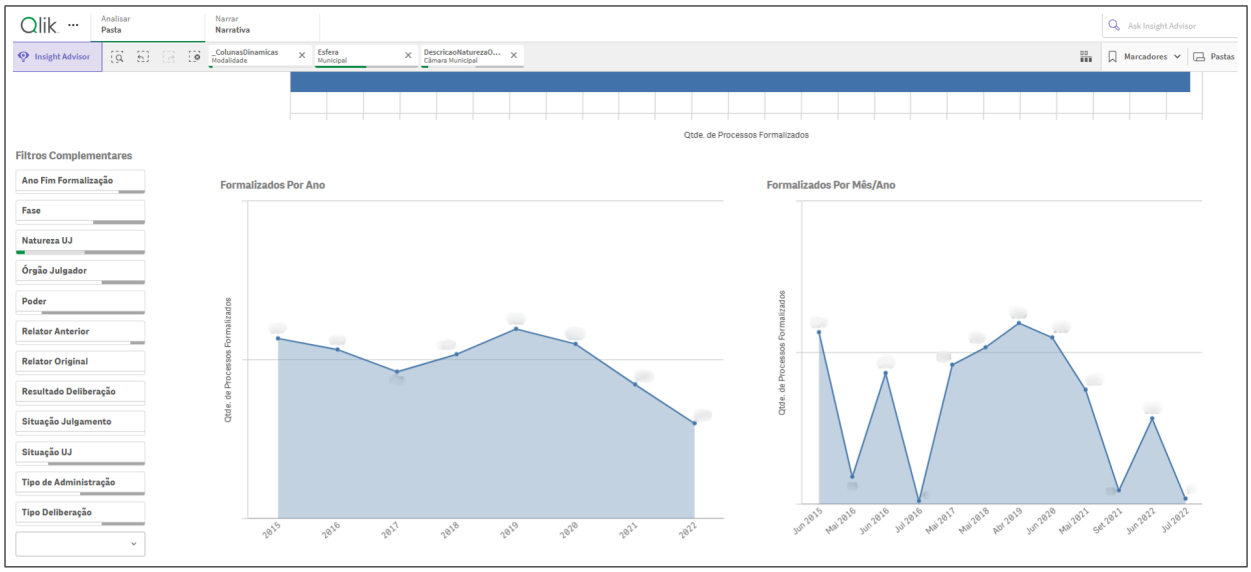

Fig. 8 – Simulation of Formalizations in the Overview Tab, Distributed by Year and Month of Formalization.

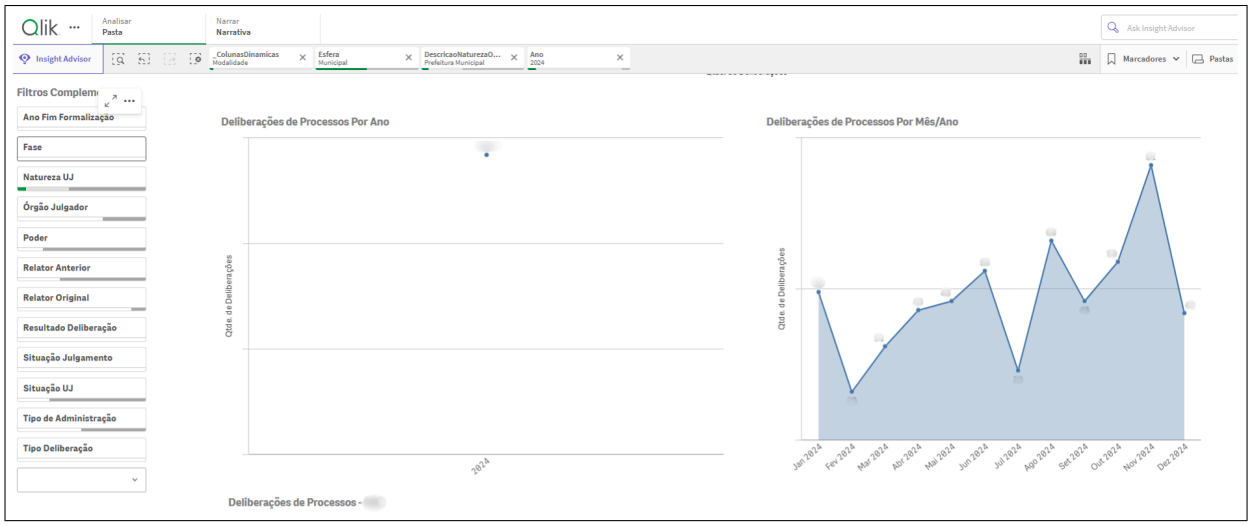

Fig. 9 – Simulation of Deliberations in the Overview Tab, Filtered by Modality and Distributed Throughout 2024.

- **Governance and Accountability:** The dashboard increases transparency in internal processes and strengthens accountability, facilitating the analysis and monitoring of processes by the institution's employees, while ensuring more efficient governance.
- **Scalability and Flexibility:** The developed dashboard has a scalable architecture, allowing flexibility for future adjustments and updates, with the possibility of system expansions as new requirements arise.

Despite the advancements achieved, the new process dashboard at TCE-PE presented some limitations:

- **Limited Implementation Scope:** The dashboard exclusively covers the Accountability modality, one of the main business processes of TCE-PE. However, other procedural modalities could benefit from the dashboard to enhance the analysis and monitoring of their flows. This limitation is due to the prototype having a reduced scope, aiming to ensure agile development and effective implementation.
- **Access and Transparency Restrictions:** The dashboard was designed for internal use at TCE-PE, meeting the needs of the sectors responsible for monitoring and oversight. However, due to the sensitive nature of procedural information, access is restricted to authorized employees, limiting its potential to promote greater public transparency.

- **Absence of Advanced Analytical Features:** The dashboard did not incorporate techniques such as machine learning or predictive models, which could add value to monitoring by estimating deadlines or identifying risks of delays. Artificial intelligence approaches could also detect anomalies and generate automatic alerts for situations requiring managerial attention.

Despite these limitations, the benefits of the developed solution outweighed the challenges, consolidating the dashboard as an essential tool for improving the management and monitoring of processes at TCE-PE. The centralization of data transformations in Qlik Sense mitigated the identified issues, simplifying maintenance and increasing system reliability, ensuring more accurate and trustworthy information. Thus, the developed dashboard was approved by its stakeholders, contributing to greater governance, accountability, and efficiency of the institution.

7. Conclusion and Future Steps

For the public sector, monitoring business processes is essential to ensure good governance, accountability, and transparency. However, maintaining the consistency of the data used is of utmost importance. In this context, this study presented the development of a new BI dashboard for monitoring the Accountability modality processes at TCE-PE, aiming to address the limitations of the previous dashboard, which had usability issues, data inconsistencies, and maintenance difficulties, primarily due to the chaining of multiple views in SQL Server.

The proposed solution centralizes data transformation in the Qlik Sense tool, eliminating the dependency on multiple views and providing greater reliability and efficiency in information analysis. The new dashboard was designed to optimize the analysis and monitoring of processes at TCE-PE, offering an intuitive interface and advanced visualization and filtering functionalities. The segmentation into tabs, the flexibility of dynamic tables, and the diversity of views allow for more precise and efficient tracking of information. With a modular and interactive structure, the tool facilitates data exploration and enables adjustments according to institutional needs. Additionally, its scalable architecture ensures flexibility for future expansions, consolidating the dashboard as an essential resource for strategic management and data-driven decision-making. Furthermore, the new dashboard has also strengthened management by providing more reliable and up-to-date data to support faster and safer strategic decision-making.

In addition to enhancing process management at TCE-PE, the methodology adopted in this work provides a solid foundation for other subnational institutions, including state-level entities in Brazil, to implement similar solutions with minimal adaptation. With appropriate adjustments, the system architecture and approach can be extended to public institutions at various levels, both nationally and internationally, driving the modernization of data monitoring and analysis strategies across diverse governmental contexts.

To ensure the continuous evolution of the new process dashboard, future work is proposed, including the inclusion of new indicators as monitoring analyses are refined. Furthermore, other procedural modalities will be implemented to expand the system's scope and meet additional monitoring and analysis demands. The implementation of more advanced analytical functionalities, such as Machine Learning techniques and predictive analytics, is also envisioned.

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  - **George Valença**: Validation, Writing – Review & Editing.
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