Designing and Implementing a Dashboard with Key Performance Indicators for a Higher Education Institution

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Abstract: In a context where public and private institutions continuously seek excellence in management and improvement in service delivery, governance is one of the contemporary practices that has been adopted not only as a model for evaluation and monitoring, but also for transparency. To this end, the institutionalization of a governance model represents not only a challenge for public managers, but also the opportunity to make use of information technology, especially Business Intelligence, as a way to ensure agility in accessing and processing information. Through this work, we propose the construction of a prototype of a dashboard for the BI system to be adopted as a practice of governance by results in a Brazilian public institution, focusing on education, not only to support the decision making of managers, but also to allow efficiency and public transparency, and to minimize the difficulties in access, in the management of various BI systems and the informational asymmetries existing in the Public Administration.

1 INTRODUCTION

Access to information and the ability to put knowledge to productive use have always been the hallmark of successful people, companies and even nations (Fraga, Erpen, & Varvakis, 2017). The dynamics and competitiveness of the modern world require that organizations, public or private, make decisions quickly and based on knowledge obtained from Business Intelligence (BI) systems. BI represents an important tool in conducting business effectiveness and innovation, because it allows transforming the large volume of operational data into complex and competitive information, capable of assisting in decision making with the use of analytical and interactive tools. In this context, BI is also an important tool for the practice of Corporate Governance (GC), because it allows the strategic alignment of the organization, the measurement of results and transparency of information, due to the continuous use of indicators, built based on a set of information. It is this set of information that allows the manager to make a safe decision and minimize the risks of failure in a project or in a strategic action. From this point of view, it was found that the Federal Institute of Education, Science and Technology of Mato Grosso (IFMT) has great difficulty in accessing data and building management indicators, and that there is still a need to implement tools that help managers in decision-making, promoting governance and transparency of information.

The objective of this work is to propose and carry out a proof of concept of a BI system for governance by results, through performance indicators within the IFMT, aiming to support the decision making process.

The motivation for this research is due to the fact that during the professional exercise at the IFTM, one of the authors experienced moments of difficulty in the rapid access to information for decision making, due to the absence of a model focused on the governance of results and performance indicators. In this sense, besides the personal and professional interest in the subject, it is observed that the relevance of the research is related to the use of performance indicators and governance. These are contemporary

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themes that are beginning to be demanded by Public Institutions, in addition to society itself.

The rest of the paper is organized in the following way: Related topics will be approached, namely Business Intelligence (BI), the components of a BI system, and interfaces and ways of representing KPIs. Following are the design, development, description, and evaluation of the dashboard. The article ends with a conclusion.

2 RELATED TOPICS

In this section, the main concepts related to this work are introduced

2.1 Business Intelligence

Business Intelligence (BI) can be presented as an architecture, a tool, a technology, or a system that holds and stores data, analyses it using analytical tools, and provides information and/or knowledge, facilitating the production of reports, queries, and fundamentally, allowing organizations to improve their decision-making. In short, Business Intelligence can be defined as a process that transforms data into information and then into knowledge (Azevedo & Santos, 2009). Turban & Volonino (2013) conceptualize BI as a combination of software architecture, databases, analytical tools, graphical displays and decision-making methodologies, whose objective is "to enable interactive access (sometimes in real time) to data, to enable manipulation of data, and to give business managers and analysts the ability to conduct appropriate analyses." (Sharda, Delen & Turban, 2018, p. 16) or improve the organization's performance (Piedade, 2012). For this author, at the strategic level, BI systems provide information on several performance indicators that allow to verify whether the strategic objectives of the organization have or have not been achieved, supporting the planning or redefinition of new methods of operation and business. At the tactical level, BI demonstrates how business processes are evolving, if there are problems and what are the new business trends. Lastly, at the operational level, BI can provide information related to the activity of the organization, its business or its customers. In short, for Reginato & Nascimento (2007, p. 73), the tools of BI can "provide a systemic view of the business and help with uniform distribution of the data between users. Its main objective is to transform large quantities of data into quality information for decision making".

2.2 Components of a BI System

The four main components of a BI system, according to Sharda, Delen, & Turban (2018), are the Data Warehouse (DW), Business Analytics (BA), Business Performance Management (BPM) and a user interface for viewing the information (Figure 1).

DW is the place where all the data extracted from the information systems are stored, which are organized and oriented from the main subjects of the organization, vary over time in the availability of historical and current data, are integrated and have the characteristic of being non-volatile; that is, it is not allowed to change or delete the data after inclusion in the DW (Loshin, 2012; Reginato & Nascimento, 2007; Sharda, Delen, and Turban, 2018).

It is important to highlight that before the data are deposited in the DW, it is necessary to go through the ETL (Extract, Transform and Load) process, that is, it is the process that collects the relevant data from transactional databases, spreadsheets, and text files, transforms them into a pattern (through cleaning, treatment and classification processes) and loads them into the DW (Turban & Volonino, 2013).

Business Analyics are tools that help transform data into knowledge, which can help stakeholders make business decisions, promote revenue growth, risk reduction, cost management and others (Sharda, Delen, and Turban, 2018; Loshin 2012).

BPM uses analysis, reporting and BI queries to optimize the overall performance of the organization. This tool can be based on the Balanced Scorecard (BSC) methodology, allowing for comparison, and sharing of performance goals and results, so that managers can quickly understand how the company's activities are going. These systems use various types of indicators to measure organizational performance. The most commonly used indicators are KPIs or key performance indicators.

Finally, there is the user interface that corresponds to the way information is visualized, made available as reports or web interfaces (dashboards, reports, scorecards, spreadsheets and other information transmission and visualization tools, such as corporate portals and virtual reality presentations (Côrte-Real, 2010; Sharda, Delen, and Turban, 2018).

2.3 Interfaces and Ways of Representing KPIs

For Costa (2012, p. 167), as a fundamental requirement, a BI system must offer interfaces that make it easier for the manager to interact and

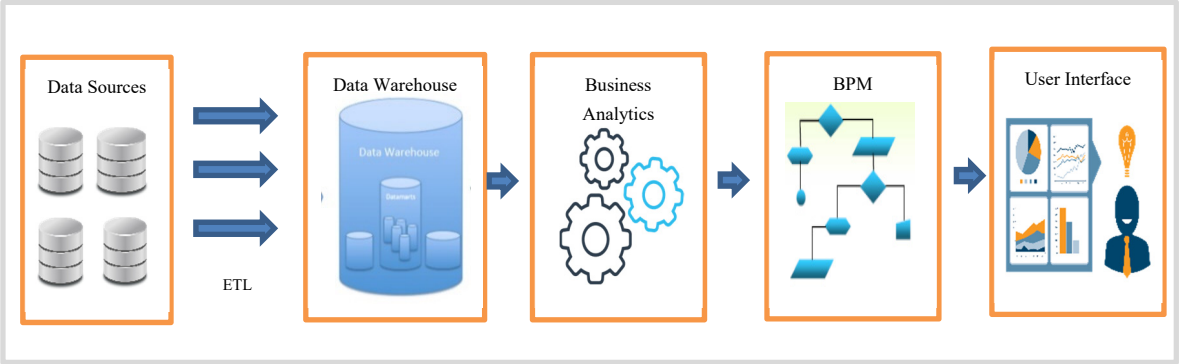

Figure 1: Components of a BI system.

understand data in order, for example, to provide adequate information for decision-making. This human-machine interaction (user-friendly interface) allows the individual to generate reports and analyze autonomously, thereby improving user satisfaction and experience. These interfaces can facilitate access to KPIs, but for the decision-making and success of governance by results, it is important that business managers have knowledge about performance indicators, have a critical vision, and know the objectives and strategic goals of the organization.

KPIs are usually represented by visual elements, capable of demonstrating the performance, state or status of an indicator and can often be related to productivity, quality, capacity, time, profitability and others. These types of KPIs are more dynamic, interactive and easy for the user to understand, as they allow them to quickly understand whether the situation is correct or not.

KPIs are released on dashboards or printed reports. In dashboards, KPIs are presented in a more interactive and visual manner. Few (2007) conceptualizes the dashboard as a visual representation of the most important information to achieve one or more goals, consolidated and organized in a single view screen so that the information can be monitored quickly and with user participation.

3 DESIGN, DEVELOPMENT, DESCRIPTION, AND EVALUATION OF THE DASHBOARD

This section presents the design, development, description, and evaluation of the dashboard.

3.1 Design

To carry out this stage it is important to carry out the planning, selection and definition of the constructive aspects. For this purpose, a documental report (included in the appendix) was prepared, containing the planning, roadmap, and requirements for the development of the BI system, in which the internal characteristics of the researched institution, the expected benefits for the solution of the problem and the context in which the BI system will operate were taken into consideration (user type and technology).

Thus, it is possible to design a BI system that consists of two main elements: a) dashboards containing the indicators created for the areas of teaching, research, extension and management; and b) a web page for hosting the performance indicators and user access. The details of the development and evaluation process are presented in the following sections.

3.2 Development

Among the various types of BI tools available in the market for the development of the dashboard to display performance indicators, the starting point was the classification carried out by Gartner, called "Magic Quadrant" (Howson, Sallam et al, 2018), to guide the process of choosing the software used to develop the dashboard. The experimental phase of this research included the installation and use of a demonstration copy of the selected software. All software has great potential for use and can be used as BI tools in the institution, but some of these are easier to use. The analysis of each of the selected software tools is presented in Table 1.

Table 1: Evaluation of software characteristics and requirements.

Characteristics and requirements		Power Bi	QlikView	Tableau	Tableau Public	Pentaho
Licence	Free	*	*	*	X	X
	Commercial	X	X	X	X	
Operating system	Windows	X	X	X	X	X
	Linux		X	X	X	X
	Mac OS X		X	X	X	X
Platform	Desktop	X	X	X	X	X
	Web	X	X	X	X	
Usability **	Ease of use	Good	Excellent	Excellent	Excellent	Difícil
	Data manipulation	Good	Good	Excellent	Excellent	Difícil
	Attractive	Regular	Excellent	Excellent	Excellent	Regular
Product	Cost	Moderate	High	Moderate	Não possui	Do not have
	Market	Small, medium and large companies	Small, medium and large companies	Small, medium and large companies	Small, medium and large companies	Medium and large companies

* These softwares are free for a limited time.
** Scale used: difficult, regular, good, and excellent.

Initially, the main requirement for the construction of the BI system was the use of an open-source tool; however, throughout the elaboration of this research, it was verified that we could opt for one that was not open source as long as its cost ratio benefit would justify it. Thus, after evaluating all these constraints, Tableau Public was chosen.

DW was locally stored and built based on the selection of data extracted from the Institution's information systems, documents published on the institutional website and open data from the Federal Government. However, for the construction of some indicators, a database with fictitious content was also used, because some available information was incomplete and others depended on specific or exclusive access authorization; thus, for security reasons and to avoid the information being not corrupted, stolen or misused, a database with fictitious content was chosen. This does not damage the development of the research, since the intention is to propose a model that can be used by the institution. Before loading the data into the DW through the ETL process, some information from the databases was processed, transformed, and standardized. To perform this action, it is possible to use Tableau Prep or the Tableau Creator that includes, in addition to the Tableau Desktop the Tableau Prep. With this, it is possible to perform the cleaning and preparation of the data and join and combine data between different tables or databases.

However, in some databases, it was not necessary to apply the ETL techniques because the data obtained were fully capable of being applied in the BI tool for building dashboards. However, depending on the system or from the database, some data needed to be transformed or standardized, such as by example the names of the IFTM's Campi, as for these data there were identified various forms of nomenclature: codes, acronyms, full or abbreviated names, etc. The information obtained in some of the institution's databases required the cleaning, association, and preparation of data, but as the volume was not so large, this process was performed with the tools made available in Excel (filters, formulas, and supplements such as Power Query and Power Pivot), as shown in the set of images in Figure .

To ensure the security of this process and to facilitate association and data sizing, the Star Schema (multidimensional modeling) was adopted for the design of the DW. Kimbal and Ross (2013) state that the multidimensional model consists of fact tables linked to dimension tables by means of primary and foreign keys. According to Fortulan & Gonçalves Filho (2005, p. 58), the Fact Table is the main one, where the occurrences are stored, and the Dimension Tables provide a description of the data and have only one primary key. The Star Schema for the execution of the budget expenditure is presented in Figure . It is important to highlight that this type of relationship is automatically performed by Tableau, when the user performs the selection of the dimensions, as demonstrated for example in Figure.

After loading the data into Tableau Public, other dimensional modeling was also performed through

groupings, intersections, or associations, as shown in Figure and Figure. However, it is important to note that for the dimensional modeling process, Tableau Public itself carries out the steps in a satisfactory manner, without the need for additional and parallel tools. In any case, the actions performed were important for the enrichment and improvement of knowledge, as it helped in the work developed by Tableau.

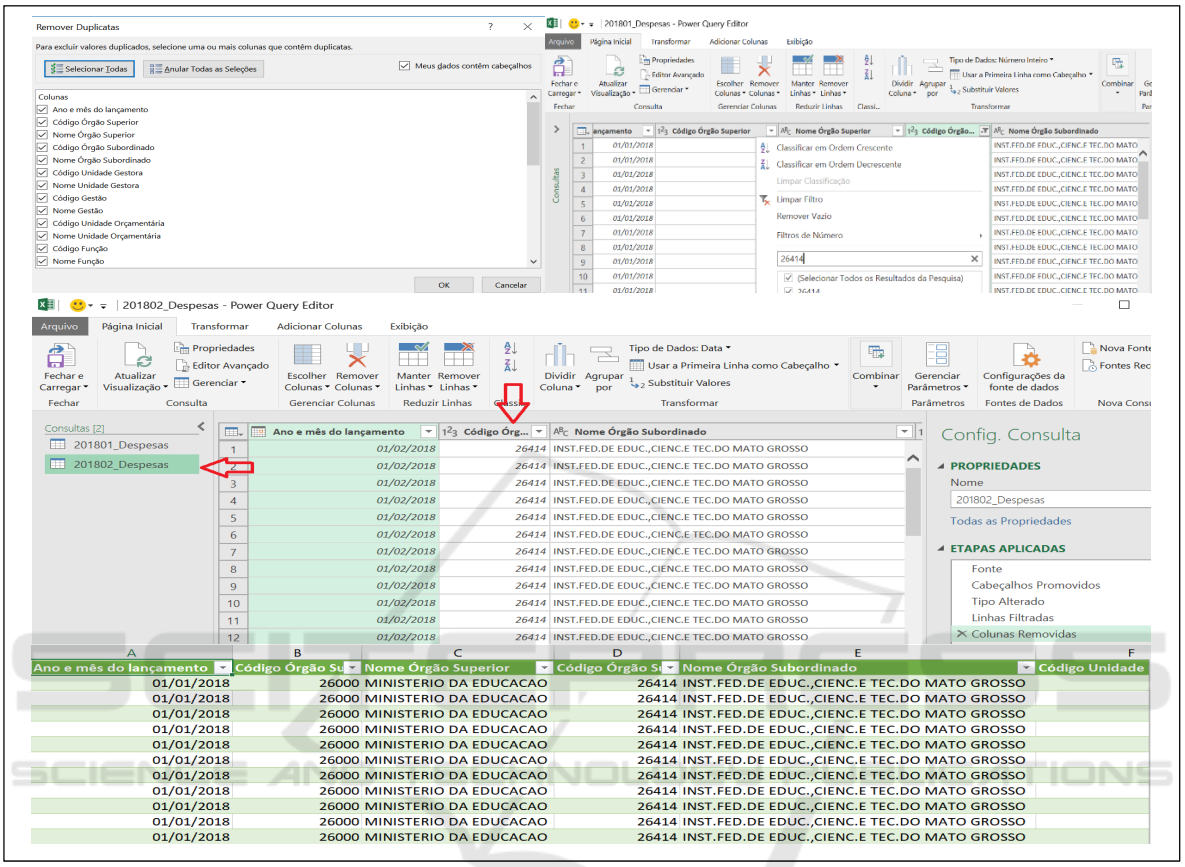

Figure 2: Star scheme for the execution of the budget expenditure.

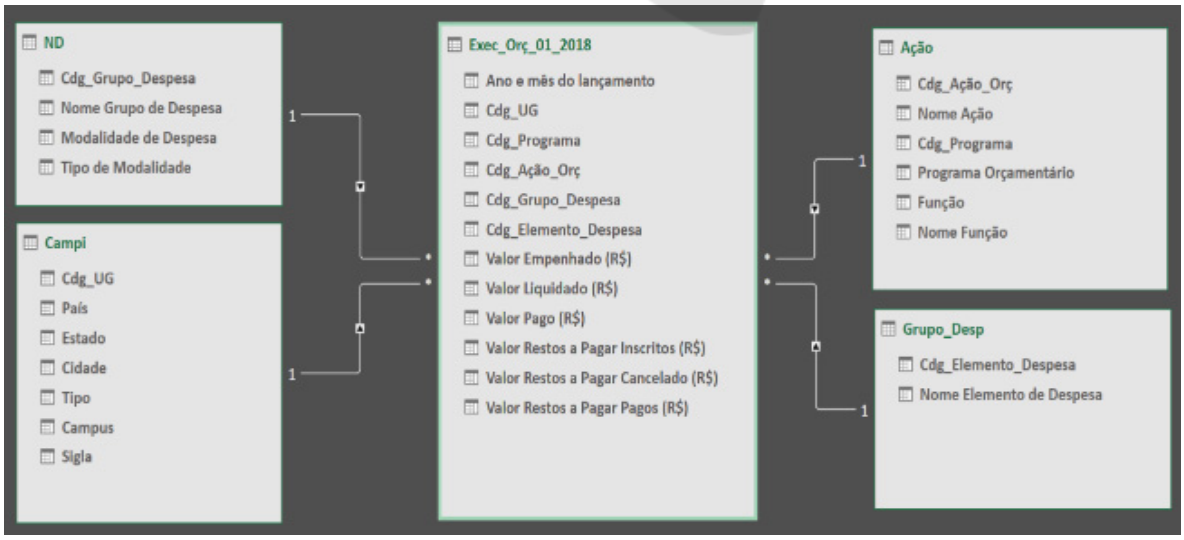

Figure 3: Use of MSExcel™ tools for data processing.

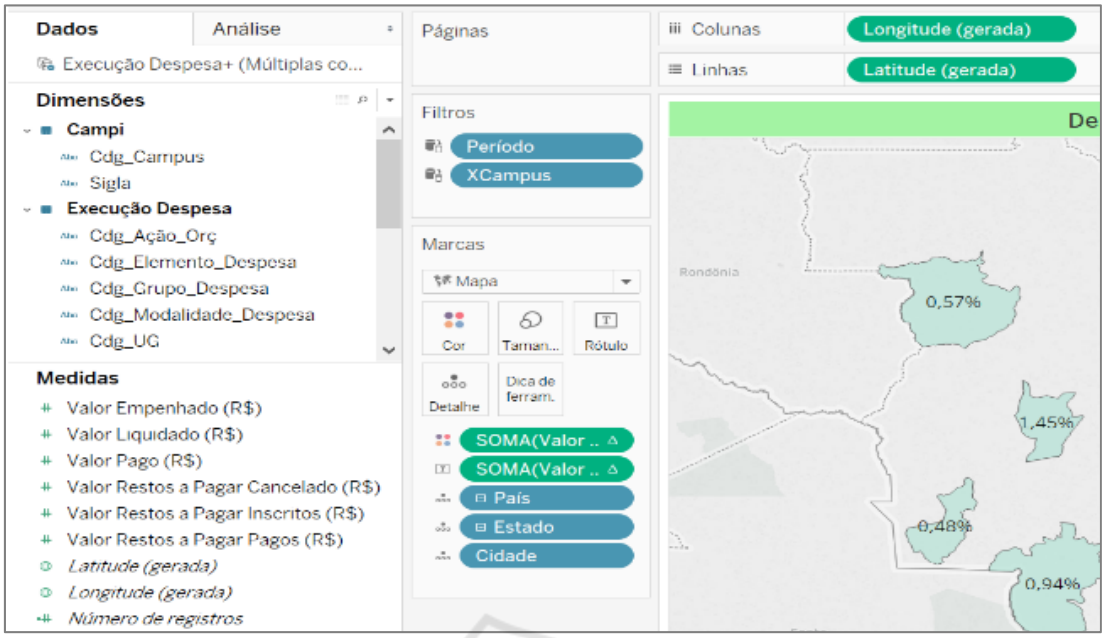

Figure 4: Screen with dimensions and measurements.

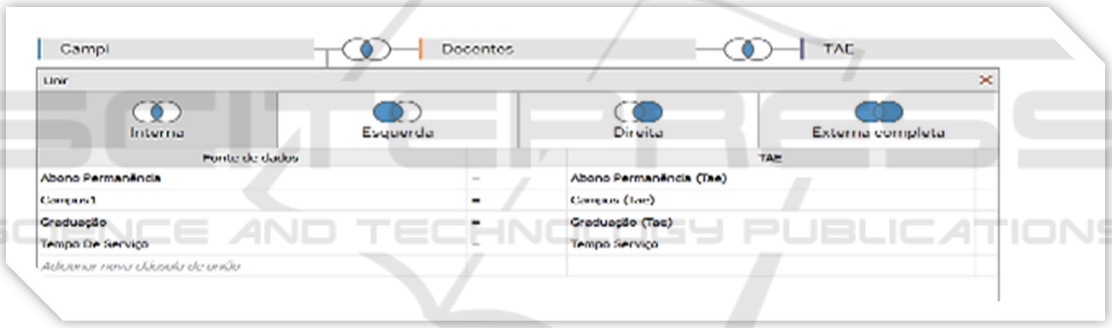

Figure 5: Relationship of databases.

Figure 6: Connections and interconnections with the various DM.

After the construction of all dashboards, they were made available on a web page, which was conceived with the intention of being aggregated on the institutional page of the IFMT. However, since this proposal is academic and not institutional in nature, this platform for dissemination and visualization of the performance indicators of the institution was built and hosted in a different location. There was no damage to the development of the proposed project and the test application has potential

for future use by the Institution, if so desired, because the tools and technologies chosen are compatible.

3.3 Short Description

The dashboard of the web platform was divided into four areas: a) teaching, b) research, c) extension, and d) management. Figure presents an example of a dashboard containing the performance indicators for these four areas. Each graph that makes up the dashboard is individually built into a Tableau spreadsheet. These spreadsheets allow the insertion of metrics, filters, dimensions, details, masks, measurements, and calculated fields. Each sheet is then sized and visually organized on the panel, thus composing the thematic part of each area of the BI system.

Several types of visual elements were used, such as geographic maps, word clouds, buses, pizza, lines, and areas, with the intention of making the navigation pleasant and varied for the user, which is more attractive and dynamic. It is important to note that not all pages of the dashboard presented in this paper for reasons of confidentiality.

3.4 Evaluation

Once the artifact was built, several tests and experiments were conducted to verify its performance. The prototype was made available for experimentation and evaluation, and to make the proof of concept. One of the authors, accompanied the users selected for the experiments, and the problems pointed out by those users were approached to update the dashboard. The feedback obtained from initial users was very positive.

4 CONCLUSION

The use of the BI tool Tableau Public to implement the proposed indicators proved to be an efficient solution, as it allows the use of Data Marts composed of several and varied types of data, as well as flexible, intuitive, and fast analyses.

The results obtained in the proof of concept demonstrate that the proposed model has the potential to assist managers in the decision-making process,

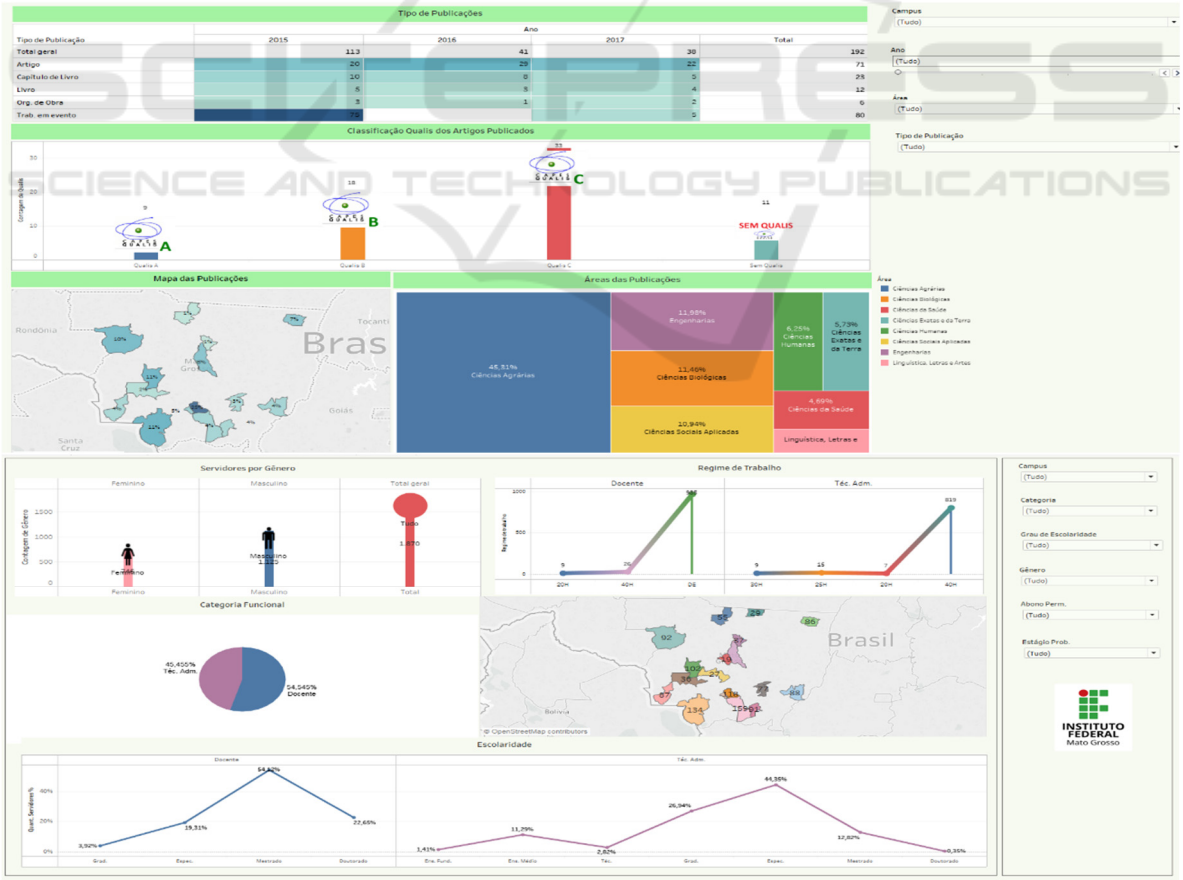

Figure 7: Dashboard with the governance indicators.

monitoring performance and results, promoting transparency of actions and stimulating the search for improvement in service delivery. Similarly, it was demonstrated that BI systems and tools are important instruments in the construction of this model because they ensure reliability, minimize errors, and provide dynamics and agility in the processing and presentation of information, in addition to optimizing time and manpower.

During the research, some difficulties and limitations were encountered. There were difficulties in accessing the data in the databases because of the wide variety and types of data available, as well as the security procedures and access restrictions. Likewise, the process of choosing the best software to build the performance indicators requires a considerable amount of time and study of each system.

This research has potential for future work, namely the evolution of the artifact, since it requires improvements and new implementations, not only to overcome the limitations currently existing, but also in the construction of new performance indicators.

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