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Compliance with Data Aggregation and Reporting Principles: The Impact of Monitoring it in a Bank

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Project Work

presented as partial requirement for obtaining the Master's Degree in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação

Universidade Nova de Lisboa

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MONITORING IT IN A BANK**

by

Inês Nobre da Veiga Galhote

Project Work presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Knowledge Management and Business Intelligence.

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June, 2024

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

[Lisbon, 9 June of 2024]

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ABSTRACT

The need to ensure accurate and timely aggregation and reporting of risk data has grown immensely in importance since the 2007 Financial Crisis. Consequently, information is now recognized as a critical asset in the financial sector and the regulatory pressure on financial institutions over data treatment, data quality, and data governance has been increasing. Therefore, to strengthen the banks' risk data aggregation capabilities and risk reporting practices, the Basel Committee on Banking Supervision introduced BCBS 239, a set of principles that the sector must meet. However, despite the efforts of this regulation a lot of banks have difficulties complying with the principles and the norm doesn't offer specific guidance on practices, techniques, or methods for its achievement. This task becomes even more difficult without properly monitoring the work that is being carried out towards alignment with the regulatory requirement. In this respect, the purpose of this study was to assess how a data visualization solution, which has been growing in use and importance over the last few years, could be deployed to help a financial institution track the progress of an activity conducted in the scope of an ongoing BCBS 239 project. To achieve that, a dashboard was developed for a particular organization in the banking industry, and its usefulness was evaluated based on the opinions of its users. Results indicate that the use of dashboards in the context of this regulatory project meets its intended purpose: providing an effective, useful, clear, and detailed visualization to monitor the work being carried out within the realm of this regulation.

KEYWORDS

BCBS 239; Data Visualization; Dashboards; Banking Industry

Sustainable Development Goals (SDG):



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LIST OF ABBREVIATIONS AND ACRONYMS

BCBS	Basel Committee on Banking Supervision
OSI	On-Sight Inspection
FSB	Financial Stability Board
BI	Business Intelligence
SMEs	Small and Medium-sized Enterprises
DSRM	Design Science Research Methodology
CDO	Chief Data Officer
CFO	Chief Financial Officer

1. INTRODUCTION

The Financial Crisis of 2007-2008 is one of the most significant financial shocks in modern history. The crisis began in the credit markets of developed countries, such as the United States, the United Kingdom, and Europe, but it rapidly affected the financial activity of many other countries worldwide (Edey, 2009).

This Global Financial Crisis showed that the Banks' IT and data architecture were inadequate to support the management of their financial risks and intensified the need to have more comprehensive information on the risks a financial institution faces, to enable better and timely business decisions (ECB, 2018). As a solution to these problems, in 2013, the Basel Committee on Banking Supervision introduced BCBS 239, a norm that presents a set of principles that banks should follow to strengthen their data aggregation capabilities and internal risk reporting practices on their risk-related data, as well as to improve the banks' decision making, reduce the likelihood of losses in a crisis, contribute to financial stability, improve information availability and improve strategic planning (BIS, 2013a).

However, despite the efforts of the BCBS 239 regulation, according to several studies (BIS, 2013b; ECB, 2018; Orgeldinger, 2018), a lot of banks struggle to achieve the principles of the norm. In addition, in his article, Orgeldinger (2018) states that BCBS focuses on providing principles, but it does not offer specific guidance techniques or methods for achieving them. This task becomes even more difficult without properly monitoring the work that is being carried out towards compliance. Furthermore, it's important to report both the efforts and the outcomes achieved to the individuals directly overseeing the BCBS 239 project.

Given this scenario, this study investigates the following research question: in what way can a BCBS 239 project be monitored, to assist a bank's conformity with the norm? To approach the research question, it will be assessed how data visualization, a concept that has been around for years and has had applications in the most various fields (Few, 2007), can be deployed in the context of a regulatory project, with the development of a solution that aims to facilitate monitoring of the project activities, provide insights, and consequently support on the path towards BCBS 239 compliance. Moreover, the importance and usefulness of the solution will be evaluated.

Hence, this Master's Final Work consists of the creation of a dashboard tailored for a specific financial institution with the aim of keeping track of the progress of a data management activity within the scope of the BCBS 239 project, to ensure effective oversight and fulfillment of the demands of the parent bank that required the application of the norm on the bank subsidiaries following an OSI (On-Sight Inspection).

In this regard, this project starts with an introduction where contextualization is given, and the relevance and importance of this topic is addressed. Additionally, in this Chapter, Chapter

1, the main objective and contribution of this project are covered, as well as the document's structure.

Then, Chapter 2, provides background on literature regarding three main topics: BCSB 239, Challenges in Achieving BCBS 239 Compliance, and Data Visualization. The first topic gives an overview regarding the objectives of the norm BCBS 239 and its importance. The second topic, Challenges in Achieving BCBS 239 Compliance, is important to address key issues and to build a bridge to the last topic of the literature review. Finally, the study on data visualization is important to understand how the use of these visualization techniques can help monitor information and share it with stakeholders. Therefore, these topics are able to provide a theoretical solid foundation for the development of the rest of the project and comprehension of the results obtained.

In Chapter 3, the methodology is presented with the steps that guide the execution of this project.

After that, in Chapter 4, the choice of the software to develop the artifact is justified and the dashboard developed for the company is presented with its respective meaning, objectives, and consequent relevance. Any treatments performed on the data used on the dashboard are also explained. Additionally, this section provides a more detailed description of the project being conducted at the bank and an explanation of the project activity on which the dashboard is focused.

Chapter 5 includes the results of this study which were gathered through individual interviews with the users of the dashboard.

Finally, conclusions regarding the developed project are presented in Chapter 6, and future work and limitations of this study are also discussed.

2. LITERATURE REVIEW

Before developing a project with the aim of providing a solution for monitoring activities geared toward compliance with a norm of the banking industry, it is essential to establish context and provide relevant background information. Through an analysis of existing literature, a theoretical foundation is given to support and justify the added value that the use of visualization tools can provide in the context of banking regulatory compliance.

Primarily, an introductory context is given through an assessment of the norm in cause, by addressing its key areas and overall importance, to explore the norm's potential benefits and impact on the financial institutions.

Secondly, to connect the first and the final topic of the literature review, as well as to provide a comprehensive understanding of the main issues encountered by the banks towards compliance with the norm, this section is dedicated to enumerating and highlighting the challenges that banks may encounter in that process, according to some authors.

Finally, the literature review focuses on the topic of data visualization with a focus on dashboarding and its advantages and key considerations, which will be helpful in Chapter 3 and Chapter 4. A comparison of data visualization tools is also addressed as there can be an overwhelming number of software options to choose from for dashboard development and it is important to address what was studied in order to consider the most appropriate solution.

2.1. BCBS 239

Before The Financial Crisis, a lot of financial institutions didn't have complete knowledge of the risks associated with their operations nor did they have adequate IT and data architecture to support their risk management processes (BIS, 2013a; ECB, 2018). Given the poor reporting processes of banks, it was extremely difficult to define risk data, aggregate it in a standardized manner, control its quality, and timely distribute the data to relevant stakeholders (Chakravorty, 2015). It was clear that banks needed to invest more in those areas in order to reduce the consequences that a similar crisis could bring in the future and improve risk assessment for better decision-making (BIS, 2013b; ECB, 2018).

To respond to these significant flaws identified during The Financial Crisis of 2007, ensure the advantages of having strong data aggregation capabilities and reporting practices on risk data, and to support financial stability, the Financial Stability Board (FSB) created a set of initiatives that motivated the appearance of BCBS 239 in January 2013: "Principles for effective risk data aggregation and risk reporting" (BIS, 2013a).

According to Martins, Mamede and Correia (2022) BCBS 239 is one of the most relevant banking regulations in force and according to Prorokowski and Prorokowski (2015, p. 74) "*the*

need for addressing challenges of aggregating risk data accurately and reporting it on a timely basis has become more important than ever". Therefore, Martins et al. (2022) state the need to have data management and data governance approaches when dealing with risk-related data to ensure informed decision-making and to comply with the regulation.

The BCBS 239 regulation is organized in a set of 14 principles distributed along 4 blocks. The first block of principles addresses the need for having strong governance and infrastructure to enable the flow of information between risk data aggregation and reporting, while the second block of principles highlights the need for having accurate risk data aggregation and validation methods. The Risk Reporting Practices block emphasizes the need to produce accurate and clear risk reports relevant to stakeholders. The last three principles regarding Regulatory Review, are the responsibility of the banking supervisors which have the role of reviewing and evaluating a bank's compliance with the principles (BIS, 2013a).

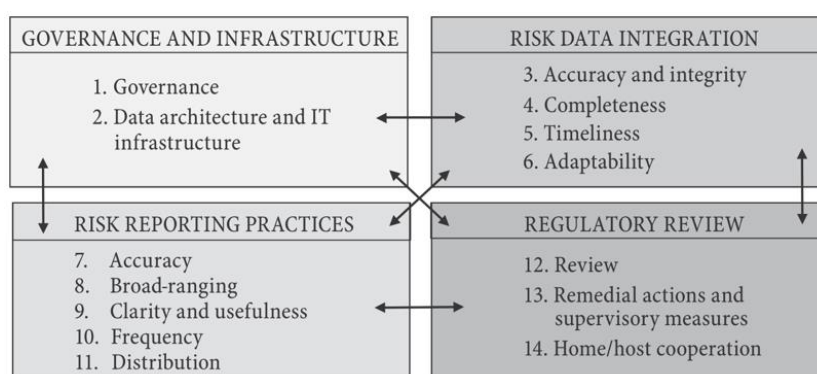


Figure 1 - The 14 principles of BCBS 239

Source: Orgeldinger (2018)

The principles are interrelated and interdependent as high-quality reports depend on strong risk data aggregation practices, effective governance, and proper infrastructure (BIS, 2013b). This means that each principle serves as an important foundation for the preceding principles. For instance, Principle 1 "Governance", emphasizes the need for governance to ensure compliance with the regulatory requirements and the need for imposing accountability on data quality in managing risk data. These aspects set the foundation of the entire BCBS 239 Framework for achieving the other principles.

A data framework based on a robust aggregation of data, according to the FSB, will help banks foresee problems in advance and improve risk management leading to efficiency and enhanced decision making whenever a crisis situation occurs (BIS, 2013a).

Without aggregating risk data, having a robust data framework, and strong reporting processes, financial institutions won't be able to avoid serious consequences to the credit institutions as they won't accurately assess the true extent of risks in the financial system (BIS, 2013a).

We can sum up the advantages of BCBS 239 as the following (BIS, 2013a; Chakravorty, 2015; Orgeldinger, 2018):

- Intensified and enhanced effectiveness of banking supervision;
- Increase in value and consequent competitive advantage for banks;
- Reduced costs in the long term;
- Lower losses;
- Lower capital needs;
- More accurate analysis of the risks the organization faces through enhancing the management of information;
- Ability to deal with stress and crisis situations;
- Improve the decision-making process;
- Improve the speed at which information is available.

However, these advantages are only possible if the organization is committed to taking accountability and improving its practices in order for that to happen.

2.2. CHALLENGES IN ACHIEVING BCBS 239 COMPLIANCE

The regulatory environment is changing, and the banking industry, which is a heavily regulated sector, is consistently being demanded to comply with new regulations, many of which come from outside the company (Martins et al., 2022).

Compliance with these regulations is measured through the corporate governance compliance level which indicates how well a company fulfills regulations aimed at avoiding financial losses and maintaining public confidence in banks (Zulfikar et al., 2020).

Despite the escalating regulatory pressure set by the BCBS for the bank's adoption of the BCBS 239 standard, many European banks haven't yet achieved adequate levels of compliance (Martins et al., 2022). This negatively impacts the industry and Orgeldinger (2018), in his article, lists two possible consequences of the lack of compliance with the norm. The first one is that the bank will face several problems such as a damaged reputation resulting from a lack of trust in the bank. The second consequence is that the bank might incur investments that don't provide an optimal return on investment, which may lead to extra costs for banks.

In December 2013, BCBS released the results of the banks' self-assessment regarding compliance with the norm in the BCBS268 report "Progress in adopting the principles for effective risk data aggregation and risk reporting", which showed how hard it is to comply with the principles (Chakravorty, 2015). By assessing the work undertaken by certain banks in alignment with the compliance of the principles, prior to the norm being released, the Basel Committee's Supervision and Implementation Group (SIG) observed that, regarding the Governance and Infrastructure principles, a lack of responsibility and accountability for data

quality posed a challenge for most banks, indicating the need for improvement (BIS, 2013b). Additionally, within the domain of Risk Data Aggregation practices, banks demonstrated significant gaps in the accuracy, completeness, timeliness, and adaptability of data (BIS, 2013b).

With this, it becomes evident that data is the main foundation of the norm, namely risk data, and given its crucial role to businesses, maintaining its highest quality should be a top priority, aligned with the need to have a centralized database for this data according to the Principle 2 of the norm (Martins et al., 2022). Therefore, organizations should ensure that their main asset, data, is organized, standardized, controlled, and managed effectively since the quality of data has a massive impact on businesses and companies as it serves as a support for decision-making, either at a department level or organization level (Jiang & Zhao, 2012; Laranjeiro, Soydemir & Bernardino, 2015).

Specifically in this norm, data is the foundation of everything, from conducting accurate risk assessments and management to meeting the regulatory requirement. However, as previously stated, banks' accountability over data quality is still a common problem even after the need that emerged after The Financial Crisis to have more rigorous control over corporation's risks and have data of better quality (Jiang & Zhao, 2012). If this doesn't happen, compliance with certain regulations imposed by the industry or by the company itself can be affected (Laranjeiro et al., 2015).

Additionally, BCBS 239 is an overarching regulation and banks should have their own understanding of the principles by establishing their minimum BCBS 239 standard (Chakravorty, 2015). However, this leads to an additional challenge that stems from the fact that the principles are vague, demonstrating a gap between theory and practice, while there isn't any specific guidance or methods on how to implement the principles (Orgeldinger, 2018).

Other times, a weak level of compliance is closely related to its lack of monitoring (Zulfikar et al., 2020). With respect to BCBS 239, insufficient monitoring processes across the banking group or across risk data pose an issue in meeting the principles (BIS, 2013b).

Moreover, according to Prorokowski and Prorokowski (2015), the success of BCBS 239 compliance also depends on the use of data visualization tools as these tools improve how information is presented and communicated between all departments involved in meeting the regulatory requirements.

Even though the authors mentioned recognize the importance of monitoring progress towards compliance with the norm, and some authors advocate for the use of visualization tools in this context, studies that specifically include such tools in addressing these matters were found to be very limited, if not inexistent. Therefore, it is crucial to find a solution that addresses these needs.

2.3. DATA VISUALIZATION

Data visualization transforms the way we perceive information and our daily lives (Aparicio & Costa, 2015). Few (2007), an author who had a substantial contribution in the field of visual communication of data, defines data visualization as the representation of information through images. Similarly, Bikakis (2018) defines data visualization as the presentation of data using visual or graphical elements, while a data visualization tool is the software used for creating these visual representations.

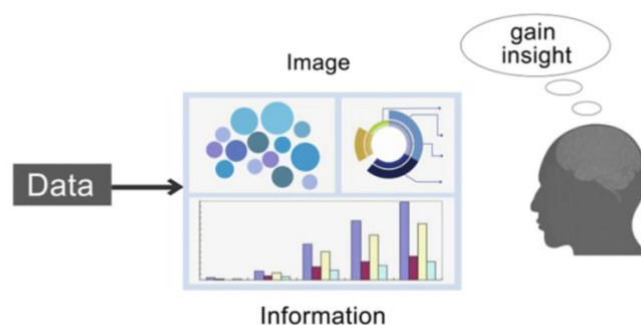


Figure 2 - The process of data visualization

Source: Li (2020)

Data visualization dates back to the 2nd century when the use of tables to represent data emerged (Few, 2007). However, it was not until the late 18th century, that the graphs we know today, such as bar and pie charts, were invented (Few, 2007).

This concept has been studied for a long time and, today, no other developments in the field of business intelligence have the capacity to move us towards fulfilling workplace intelligence as much as data visualization (Few, 2007). Particularly in the business world, data visualization is extremely helpful in monitoring activities and making informed decisions since it can enhance understanding and identification of problems (Aparicio & Costa, 2015; Li, 2020). Because of these reasons, data visualization is nowadays considered scientifically valuable and an excellent choice to share information with anyone who needs it despite their literacy in the domain (Tonidandel, King & Cortina, 2015).

Regardless of the size of the data to which is applied, visualization has an enormous advantage for companies in comparison to the use of text or tables as they facilitate viewing of information and are much more appealing and more likely to persuade an audience (Li, 2020; Tonidandel et al., 2015).

One of the most common applications of data visualization is dashboards since they are able to depict a picture of what is happening much more easily than traditional reports (Few, 2007; Sarikaya, Correll, Bartram, Tory & Fisher, 2018). Wexler, Shaffer and Cotgreave (2017) define

dashboards as a visual representation of data used to monitor situations and facilitate comprehension.

In sum, a dashboard serves as a visualization and reporting tool to monitor the information required to accomplish an objective and therefore access the progress towards its achievement, being a powerful tool to share information with stakeholders (Smith, 2013). Such information can be quantitative, expressed numerically, or it can also be qualitative as some insights can only be given with this type of data, such as tasks that weren't yet completed and deadline dates (Smith, 2013).

However, there are some key considerations that one should have while building a dashboard as the dashboard itself if not properly built does not guarantee satisfactory results. Such aspects to take into consideration are that visualizations should be defined according to (Tonidandel et al., 2015):

- The audience;
- The desired message to transmit;
- The information desired to be displayed.

These aspects are interconnected as different audiences may require different design choices. Some individuals may wish for a broader overview of the information while others require a more detailed and in-depth approach (Tonidandel et al., 2015).

Besides, according to Sarikaya et al. (2018), one should be careful not to create very complex visualizations as the more complex a visualization is the less comprehensible it is. For instance, the use of bar and line charts is simpler and requires a lower level of literacy to be understandable. Contrarily, the use of superficial features adds no real value to the dashboard and simpler graphics will continue to comply with best practices, as more detailed and complex graphs can make dashboards harder to decipher and do not contribute to an outstanding visualization (Few, 2007). Even simple interactive features, such as the use of filters, sometimes can be considered complex for casual and non-expert users and thus, reduced interactivity can reduce complexity (Sarikaya et al., 2018). Unwin (2020) suggests that adding explanatory text can increase the effectiveness and readability of graphics, thereby enhancing comprehension. However, he cautions that no one should create or analyze visual representations without knowing the context and having adequate background knowledge.

Additionally, overloading a single dashboard screen with too much content can be a bad practice as it can overwhelm the user, and, the color palette of the charts should be chosen not only for aesthetic purposes, such as to distinguish the charts from the background, but also to enhance functionality (Malik, 2005).

With this, it is possible to understand that by taking these considerations into account, information will be displayed correctly and thus, the audience will be able to retrieve

information in a much more understandable manner and take advantage of the benefits that data visualization can yield.

To put these considerations into practice and to transform a dataset into a presentation of everything that is known about the data, visualization tools are needed. There are various data visualization tools that don't require any coding, are ideal when working with data in smaller sizes, and allow data to be visualized within minutes (Divya Zion & Tripathy, 2020).

To help companies with the implementation of data visualization to support decision-making, there are free and open-source Business Intelligence (BI) solutions that can be used nowadays. These BI software solutions are called Self-Service Analytics Software and are designed to support anyone with the aim of obtaining information without the need to involve other people, such as IT specialists (Oliveira & Bernardino, 2020).

To build the dashboards there is the need to choose the software that is going to be used to build the solution most suitable to the user's needs (Divya Zion & Tripathy, 2020). Oliveira and Bernardino (2020) have compared Power BI, Tableau, Qlik, and other self-service BI tools for Small and Medium-sized Enterprises (SMEs). Qlik is a major competitor of Tableau but reloading can take a significant amount of time. Regarding Power BI the authors consider that this tool's main advantage is having a large number of custom visualizations and efficient connection with Excel, however, users of Power BI should have knowledge of DAX language, and Divya Zion and Tripathy (2020) state that the performance of this tool is slower than Tableau. Tableau, despite being one of the most widely known data visualization tools and being as powerful as Power BI, has limitations on data sources and the user interface may be less intuitive (Oliveira & Bernardino, 2020).

In Oliveira and Bernardino's (2020) study, Power BI checked more boxes of critical functionalities of a BI Platform according to the famous Gartner principles, enumerated in the table below as functionalities/criteria, and thus was considered the most complete free option.

Table 1 - Functionalities considered to be essential for a BI and Analytics solution

Functionalities/Criteria	Self-Service BI and Analytics Platforms				
	Pentaho	Power BI Free	Metabase	QlikView	Tableau Public
Access Control and Security	✓	✓	✓	✓	✓
Ad-hoc reporting		✓	✓	✓	✓
Ad-hoc query		✓	✓	✓	✓
Cloud Services		✓			✓

Data Visualization variety	✓	✓	✓	✓	✓
Data Integration	✓	✓		✓	✓
Dashboard Designer		✓	✓	✓	✓
Interactive Visualization		✓	✓	✓	✓
Mobile capabilities		✓		✓	✓
Natural Language Query		✓			
OLAP	✓	✓		✓	✓
Predictive Analytics	✓	✓		✓	✓
Real-time Analytics					✓
Real-time Collaboration			✓		
Report customization		✓	✓	✓	
Report Scheduling					

Source: (Oliveira & Bernardino, 2020)

However, choosing the most appropriate “Self-Service” platform will depend on the costs that the company is willing to spend and on the individuals who will use the software (Oliveira & Bernardino, 2020).

With all that was stated above, it is possible to understand the importance and impact that data visualization can provide when the aesthetic of the dashboards is aligned with the visualization’s intended functionality and the proper BI software tool is used (Few, 2007; Sarikaya et al., 2018; Unwin, 2020).

Despite its importance, data visualization is misinterpreted and most of the time ignored (Few, 2007). Therefore, companies need to place more emphasis on this topic as data visualization can offer a much easier, faster, and more understandable presentation of information.

3. METHODOLOGY

The previous chapter provided enough insights on how the use of dashboards can be a good solution to display information and provide relevant insights, in this case, it can be particularly useful in the BCBS 239 compliance journey of an organization. Therefore, to create the final intended artifact, the dashboard for the bank, and conduct this research, an organized approach is followed and detailed in this chapter.

3.1. DESIGN SCIENCE RESEARCH METHODOLOGY

As the objective of this research is to develop an artifact, the methodology chosen for this project is the Design Science Research Methodology (DSRM).

The DSRM is a research approach that believes that artifacts can be used to solve a problem (Helms, Giovacchini, Teigland & Kohler, 2010). Venable, Pries-Heje and Baskerville (2017) describe the process steps as follows:

The process starts with the problem identification. Then, the artifact objectives are defined. Following that, the design and development of the solution is performed, in this case, the dashboard, to which important considerations for its development should be given. The artifact is then evaluated regarding its efficiency and effectiveness by gathering feedback from potential users and stakeholders. Finally, the results are shared to contribute to the field of study.

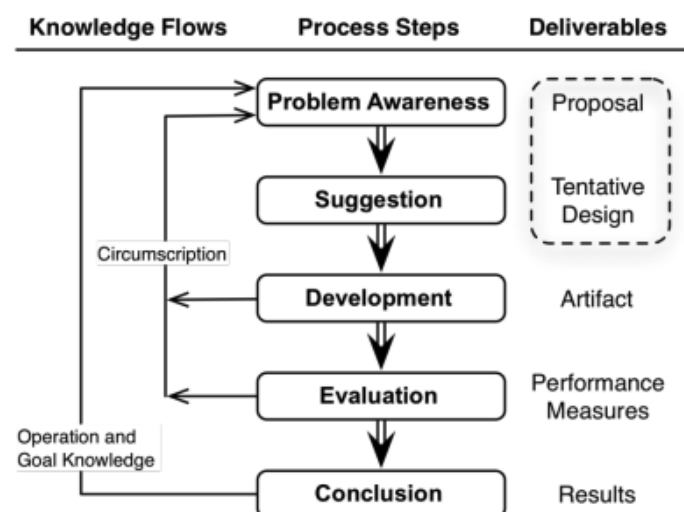


Figure 3 - Design Science Research general steps

Source: (Vaishnavi & Kuechler, 2004)

The methodology has different possible entry points. In this project, the entry point is the Problem Awareness step as this project starts with a problem and a motivation to solve it. The development and evaluation processes are iterative, which means it may be necessary to go back to those steps, as the development may not be correct the first time.

3.1.1. Problem Identification and Motivation

This research starts with a problem awareness that was initiated by the organization subject to this work: lack of monitoring of an activity inserted in the scope of BCBS 239. There was an existent need for the teams involved in the project to have a means of presenting a visual representation of their work and efforts towards the delivery of a project task to ensure that the stakeholders overseeing the initiative and the teams themselves had clear insights on the level of completeness achieved on the project occurring at the bank.

According to what was studied in **Chapter 2.2**, data visualization is important to support BCBS 239 success and is key in supporting communication among the involved departments. The development of a data visualization solution that provides insights for this organization regarding what is being executed, how far from the goals the department is, and how the activity is performing overall given the team's work, could contribute to an improved ability of the decision making of the board if the activity isn't going as planned. Moreover, it could enhance the team's work approach by shifting their focus towards what is lying behind goals.

Given my background in Information Systems and current knowledge of Information Management and Business Intelligence, I intend to help this company with a visual solution that can help the roles and responsibilities of the decision-making bodies and teams involved in BCBS 239 implementation, to monitor the project much easily and consequently fill this gap.

3.1.2. Objectives of the Solution

The problem identification described in the preceding section leads to the definition of the main research objective: to develop a dashboard solution that facilitates monitoring of a project activity conducted at the bank, to provide insights, and to assist on the BCBS 239 compliance path. This solution should be simple, straightforward, and user-friendly, allowing a clear understanding and interpretation of the information presented to the involved parties. To decision-makers the solution should enable instant evaluation of the teams' performance, by identifying any potential risk of missing the activity deadline and determining if any actions need to be taken to expedite the conclusion of the activity. To the teams, the solution should assist in identifying which parts of their work require bigger efforts.

3.1.3. Design and Development

After identifying the problem, defining the objectives of this work, and establishing enough knowledge in the literature review regarding key considerations to have when building a dashboard, the actual artifact can be developed for the bank. To establish a knowledge foundation for dashboard development, **Chapter 2.3** will be considered and taken into account.

Upon establishing the goal of the dashboard with the interested parties addressed in **Chapters 3.1.1 and 3.1.2**, a first tentative design suggestion was built. This design draft was the first dashboard created and presented to the end users which contained fewer pages and less information. This dashboard was then improved during the project to contain more insights, leading to the development of a final artifact, which is presented in **Chapter 4** with a detailed explanation of each dashboard page.

3.1.4. Evaluation

To evaluate the solution developed, an analysis of the opinions of the end users regarding the developed dashboard will be made through a qualitative method.

The chosen qualitative method is Semi-structured interviews. This type of interview follows a predefined set of questions while allowing more interactivity and flexibility than structured interviews since the interviewer has the opportunity to explore a topic in greater depth according to the participant's responses.

This approach is ideal for gathering data from a smaller sample size which happens in this case, due to the users of the dashboard being limited in the company.

In this research, the questions will be based on a set of criteria derived from the hierarchy of evaluation criteria for IS artifact evaluation (Prat, Comyn-Wattiau & Akoka, 2014). The criteria chosen to evaluate the artifact are the following:

- Efficacy: evaluates if the artifact achieved its desired goal;
- Utility to the organization: evaluates if the artifact is useful, taking into consideration its organizational context;
- Clarity: evaluates if the artifact is clear and understandable by the involved parties;
- Level of detail: evaluates if the artifact contains relevant information to the expectations of the users and stakeholders.

The approach of this evaluation and its results are presented in **Chapter 5**.

3.1.5. Communication of the Results

The last step of the methodology is the communication of the results (Helms et al., 2010). For that purpose, and because the results may be of interest to researchers of the banking industry and of the field of dashboard design, this project report will be published in the Universidade NOVA de Lisboa repository. By making this report public, organizations that are implementing BCBS 239, are struggling to assess their ongoing efforts or are requested by the stakeholders to update on the progress, can think of implementing a similar solution, having as a basis the results of this research. Internally, sharing the results with the bank can be useful to the bank's activity and to other projects in which the bank is involved.

4. EMPIRICAL STUDY

This chapter moves from theoretical concepts to their practical application. In this regard, it provides a detailed description of the project conducted within the bank subject to this work, to allow contextualization for the development of the dashboard and to offer insights into the real-world application of the current research. Then, the project activity associated with the developed dashboard is discussed followed by key considerations acknowledged during the dashboard development. Within this chapter, the data used on the dashboard and the applied data treatments are also shared. Finally, at the end of the chapter, the artifact created for the company is presented with a comprehensive explanation of its intended message.

4.1. THE PROJECT AT THE BANK

Over the last years, the regulatory pressure associated with the data treatment performed by financial institutions increased and it became imperative that organizations could adapt and prepare themselves to respond in a centralized, effective, and knowledgeable manner. Due to that, it emerged a need for organizations to have an area dedicated to Data Management.

For one year I was an intern in a newly created department, the Data Management Department, also known as CDO (Chief Data Officer) Office, in a Financial Institution that has an international business and is one of the most stable and profitable financial entities of its country of origin. For confidentiality reasons, the name and details of this Financial Institution will not be disclosed.

As a data manager, I am responsible for assuring data governance, data management, and data quality and for contributing to the increase of the economic value of data so that it can contribute to the bank's decision-making process. While having responsibility over the data of the entire bank, the department is also accountable for supporting the compliance with the regulatory requirements on data defined by the bank as critical for supervisory purposes and decision-making, which means it is accountable for the BCBS 239 project commissioned by the central institution overseeing the entire banking group following an OSI conducted at the parent bank.



Figure 4 - Data Management Department Main Objectives

Source: Author's Content

Therefore, a data manager's responsibilities are the following:

- Managing the bank's data: Conduct a data governance approach and define a common data language throughout the entire Bank by defining a taxonomy, data inventory and linking business terms to data sources and EUCs (End-User Computing);
- Ensuring data quality: Proactively ensure data quality, in particular through preventive monitoring and the analysis and correction of data quality problems;
- Information Architecture: Ensure that the information architecture is aligned with the requirements and needs of data aggregation and reporting, by using certified data sources;
- Reporting: Ensure that critical metrics come from certified sources and the documentation of the reporting process ensures auditability, traceability, and the generation of these metrics in crisis situations.

All these responsibilities are aligned with the norm BCBS 239, which demands these types of tasks. Therefore, for each of these responsibilities, there were activities that needed to be conducted by the Data Management department with the assistance of the Data Technology unit.

However, during the internship, and as addressed in **Chapter 3.1.1**, it became crucial to monitor the progress of the project and implement a method to access the ongoing work for showcasing updates to the board, the teams involved, and other stakeholders interested in the project's success.

4.2. THE DASHBOARD

In alignment with what was said before, Data Visualization was an emergent need while conducting the BCBS 239 project and a requirement for people overseeing the project, which led to the creation of several dashboard pages.

The dashboard developed is focused on a specific activity within the scope of the project being conducted by the CDO and Data Technology departments, which consists of populating the group's Corporate Database with data from Portugal that is not yet incorporated and was thus requested. This activity is crucial for the completeness of the project as having a golden source of information with quality to then generate reports is highly important in BCBS 239. Therefore, this task plays a vital role in ensuring alignment of concepts between the Portugal subsidiary and the headquarter, and in guaranteeing that the bank's data is stored in a central reliable repository. For this, the dashboard aims to illustrate the flow of data as it moves through various departments, ultimately reaching the final stage, where the data is integrated and validated in the Corporate Database.

This activity doesn't have a connection to only one BCBS 239 principle, yet it connects to several since the group needs to incorporate all risk data from the subsidiaries in a golden source and only after concluding this task it is possible to implement data quality controls on this data, as quality is needed to establish throughout the entire data management process from source to the reported information. Hence, the dashboard's purpose is to supervise the team's progress in sending this data and its incorporation into the headquarter. With such integration, it will also be possible for the headquarter to use this data for reporting purposes.

For the development of the dashboard, the knowledge base gathered from **Chapter 2.3** was taken into consideration. Since in this case, the audience is both the stakeholders and the teams involved in the project, there are different needs for each of them regarding the information desired to display. The teams wish to view information in a more detailed approach while the stakeholders and directors in a more general display. Therefore, multiple dashboard pages were created to fulfill the needs of both, some provide a general overview while others offer a deeper analysis.

With regards to the design of the dashboard, simpler design choices were made, such as the use of donut and bar charts. The purpose of this was to enable a clearer and faster visualization, ensuring that users could instantly view the information they needed. Besides, throughout the dashboard pages, simple filters are used, such as filters for date and data criticality (high, medium, or low).

It is important to note that the regulator considered the data fields with high and medium criticality as urgent, requiring rapid analysis and imposing a shorter deadline. Even though the data fields with low criticality were not as urgent, they were still necessary for the headquarter's control of information.

Finally, to create the dashboard the software chosen was Microsoft Power BI, not only because it is a solution with a lot of potential as seen in the literature review, but also because it is a leader in the market with outstanding features according to the 2023 Gartner Magic Quadrant for Analytics and Business Intelligence Platforms (Gartner, 2023).



Figure 5 - Magic Quadrant for Analytics and Business Intelligence Platforms

Source: (Gartner, 2023)

4.2.1. The Data

The data used for the creation of the dashboard for the financial institution was data in the scope of the regulatory project activity addressed above.

To keep track of the work executed the teams manually fill an excel. Each week a column that registers the status of work performed that week is added with the date of that week's Friday as the column name. Additionally, in a separate Excel file, teams add rows with the data fields that were already sent to populate the Corporate Database. Therefore, to produce a dashboard that guarantees a better picture of the work undertaken, data from Microsoft Excel was used.

The dashboard has six tables: three are fact tables, "Risk Data", "Data Sent" and "Thresholds", one is a dimension table, "Calendar", one is a calculated table, "Domain Completeness" and the other is a calculation table, "DAX Measures". The tables "Risk Data" and "Data Sent", despite having some attributes in common, are independent, as they depict different steps of the workflow. The "Thresholds" table is a fact since it stores quantitative metrics that instead of providing context for the analysis, are operationally used within the analysis itself. The data model is presented below:

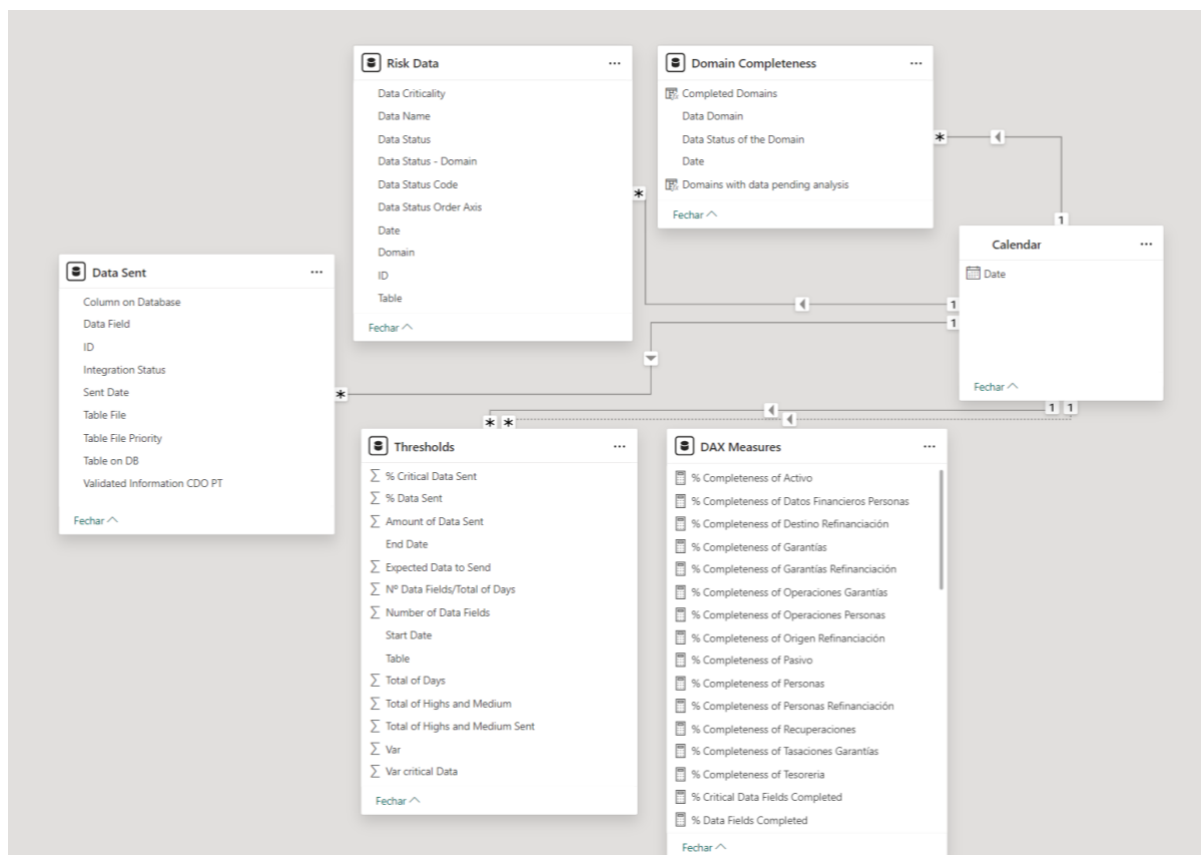


Figure 6 - Data Structure

Source: Power BI Author's Content

“Risk Data”: contains the aggregated information of financial risks used for supervisory purposes and for decision-making that the headquarter wishes to be sent and incorporated in the Corporate Database, as well as data statuses, which represent whether that data is being analyzed, was already analyzed, or was already sent. Each data field has an associated criticality, data domain, data table, and weekly status. This table was imported through an Excel file.

“Data Sent”: contains all data that was sent to the headquarter and its integration status on the Corporate Database. This table was also imported from an Excel file.

“Thresholds”: it is a table from an Excel file that contains the total of data fields to send from each data table and calculates, according to the start date and delivery date of the activity, how many fields should be completed until the current date for each data table file.

“Calendar”: this table was created using the DAX expression `CALENDARAUTO()` and it contains a data hierarchy with years, quarters, weeks, and days. It is useful to perform time analysis.

“Domain Completeness”: this table was created on the Table View of Power BI. It gathers all the data domains of the data requested to send and, using DAX expressions, columns were created to determine whether a data domain has all its data sent, or if any analysis of the domain’s data fields is pending, according to a specific date.

“DAX Measures”: it serves as a repository that aggregates all measures written in DAX language and that are used on the dashboards.

Regarding data treatment, any necessary cleansing of the data was done in the BI software chosen, Power BI.

For the “Calendar”, “Domain Completeness” and “DAX Measures” tables no data treatment was done, however, for the tables imported from an Excel file, some steps were required.

For the “Risk Data” table, the first step performed was the elimination of unnecessary columns such as columns containing the team’s comments, and names of data stewards, among others. Columns that recorded the status of each data field in the rows and were named with each week’s Friday date were unpivoted to allow two separate columns, one with the data code status and another with those dates. This step allows the dashboard to be filtered by each week’s date, along with the connection to the “Calendar” table. Then, a conditional column named “Data Status” was added to provide a meaningful interpretation of the status code associated with the data fields, since, for instance, several codes can mean that the data field is in development. Another conditional column was created to customize the sequence in which data statuses are presented on charts. Changes in data types and column names were also conducted.

For the “Data Sent”, similarly to what was done with the previous table, columns were removed, names and data types were changed and additionally, some values were replaced to provide a deeper understanding while displaying them in a visualization. Here, a conditional column was also added and ordered, to organize the data tables according to their priority of sending information. This allows the data tables displayed on a graph axis to be ordered according to their priority.

For the “Thresholds” table, the only data treatment performed was the elimination of unnecessary columns and changes in data types.

The “Domain Completeness” table was created through the use of DAX language and no data treatment was performed as this table catches all the data domains, dates, and data status from the “Risk Data” Table, which was already subject to data cleansing. Then, using DAX, two additional columns were created. One calculates whether a data domain is considered complete by having all its data sent to the headquarter, and the other column determines if there are any data fields pending analysis within the domains, indicating the existence of fields where analysis has not yet been initiated.

To update the dashboard on a weekly basis, Power BI allows to refresh data which means that every time a source file is updated with an added column or changed row, the software saves all data treatments applied before, saving a lot of work.

4.2.2. Developed Artifact

After performing the data treatment **6 dashboard pages** were created:

1 - Overall status of activity	2.1 - Overview	2.2 - Overview	3 - Status of data by data table	4 - Status of critical data by data table	5 - Integration of data in headquarter
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Figure 7 - Dashboard Pages

Source: Power BI Author’s Content

The first dashboard page is entitled “**Overall status of the activity**” and is presented below in Figure 8. It gives an overall status of the data to send and incorporate into the Corporate Database.

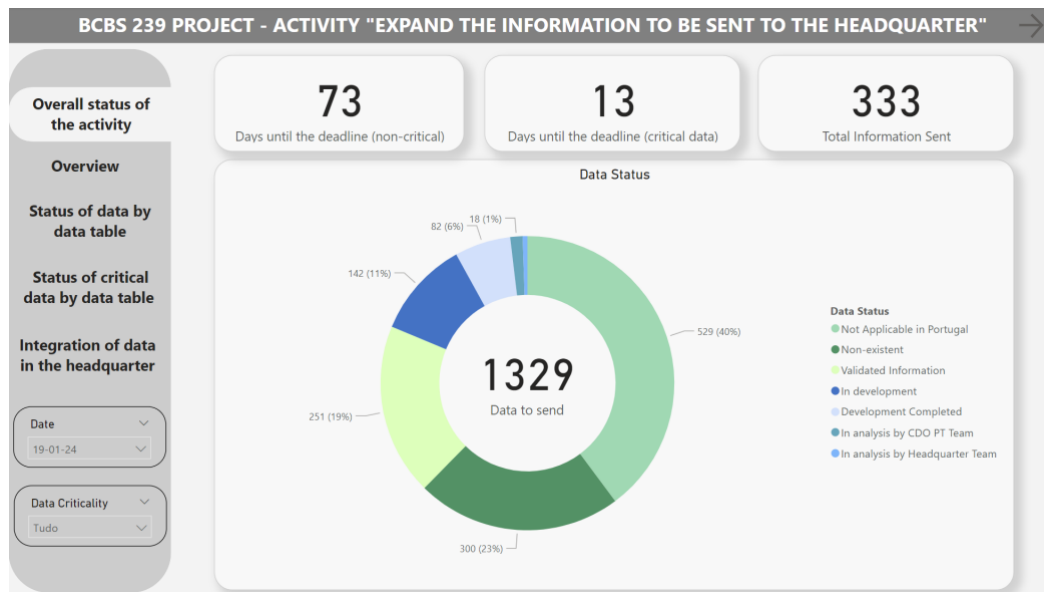


Figure 8 - Overall status of the activity

Source: Power BI Author's Content

It provides users with a countdown of days remaining until the deadline for sending non-critical and critical data to the headquarter, highlighting a stricter timeframe associated with critical data. This dashboard page is also important because it tells the user, out of the total of data to send, how much Portuguese data was actually sent and is being incorporated into the Corporate Database. Additionally, a donut chart was selected to portray the data status. Unlike a pie chart, it allows the display of a card in the center of the graphic with the total amount of data that the teams need to analyze and, if possible, send to the parent bank.

If the donut chart mainly displays green colors, it means that the majority of the information has already been analyzed up to the chosen date in the filter. It is however important to note that even though the data with the "Development Completed" status was already sent due to its finished development, the teams chose a light blue color to represent this status as this information still needs to be validated by the CDO of the bank in Portugal, which must ensure that the data was indeed correctly incorporated on the Corporate Database. When the data belongs to the "Not applicable in Portugal" or "Non-existent" categories, it means that only further on, this data will need to have action plans to be sent to the parent bank.

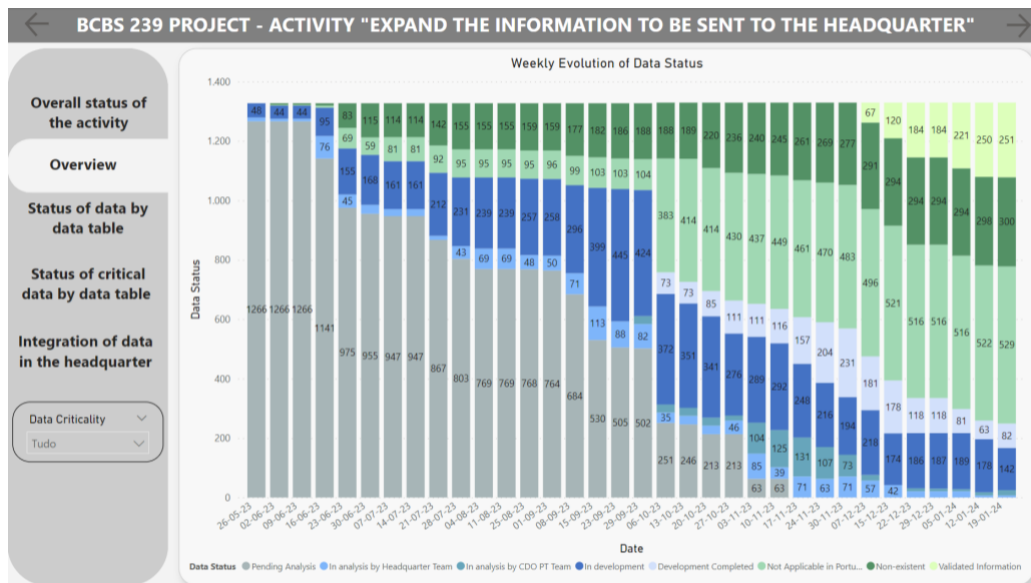


Figure 9 - Overview 1

Source: Power BI Author's Content

The next page is an **“Overview”** dashboard page, presented in Figure 9. It gives a general picture of the evolution of the work performed by the teams every week since the beginning of this project activity. The graphic categories are ordered in a way that when the user looks at it, immediately sees at the top of the graphic the most important information, which is the number of data sent increasing while observing a decrease in the number of data fields pending analysis, under development or being subject to analysis. The user can also choose to see this evolution according to data criticality, which can be done using the dropdown list filter.

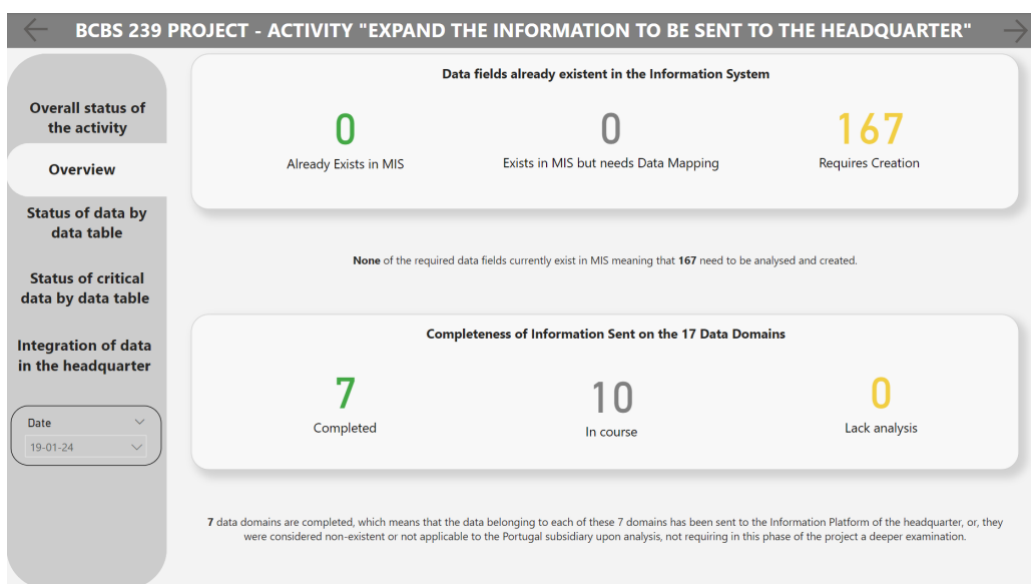


Figure 10 - Overview 2

Source: Power BI Author's Content

A second overview dashboard page was created “**Overview 2**”, with the objective of giving a general view of the work performed over the existent Data Domains and informing the user if any of the data fields that need to be sent exist in the Information System (MIS). This page is composed of six informative cards. The first three cards inform the user of the number of data fields that are present, or not, in the Information system, as well as the number of data fields that need to be developed on the system in order to be sent. The other three cards offer insights regarding the analysis of information for each of the 17 data domains. One highlights the number of domains whose information has been sent and the analysis is finished, the other card displays the number of domains under analysis and, the third card displays the number of domains whose analysis has not started yet. Information can be filtered by date.

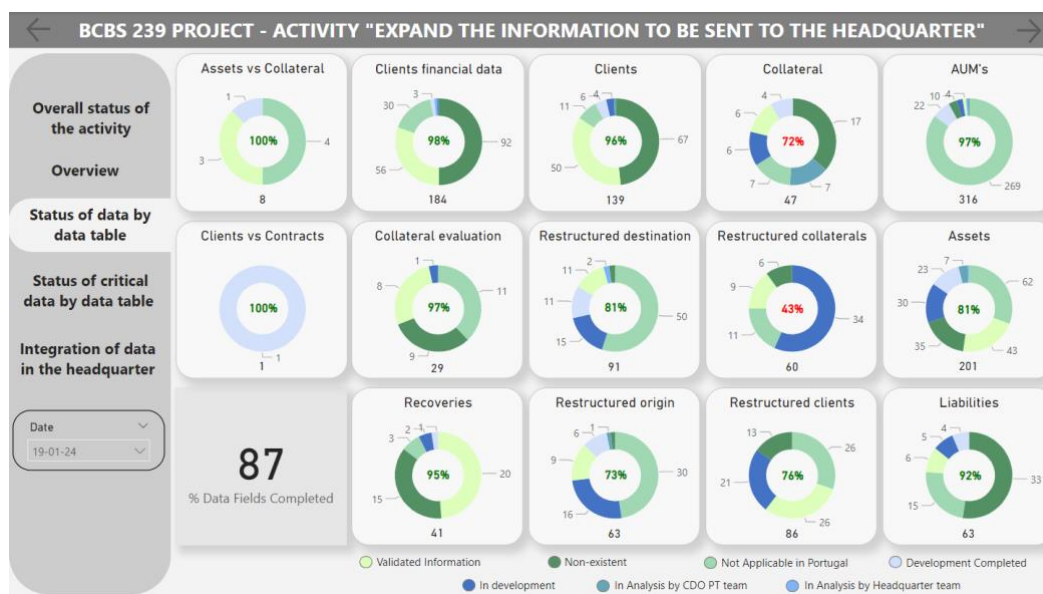


Figure 11 - Status of data by data table

Source: Power BI Author's Content

On the fourth dashboard page, a bigger level of detail is provided. The “**Status of data by data table**” shows the data status on each of the data tables, useful for understanding which data tables are falling behind the deadline and thus require more work to be conducted. Each data table is represented with a donut chart and in the middle of each chart the percentage of sent data for each table is displayed. The color of the percentage is controlled through conditional formatting using a DAX expression on which the actual number of finished data fields (fields that are developed, validated, not applicable, or non-existent) is compared with the number of target fields (number of data fields that should have been sent so far according to the days left until delivery). If the number of finished data fields is equal to or higher than the target, then it is shown in green, if it is lower it is shown in red.

A second dashboard page that addresses the status of data was created and is present in Figure 12. The **“Status of critical data by data table”** is similar to the previous dashboard page, however, it focuses only on data that is critical, which has a shorter timeframe for delivery.

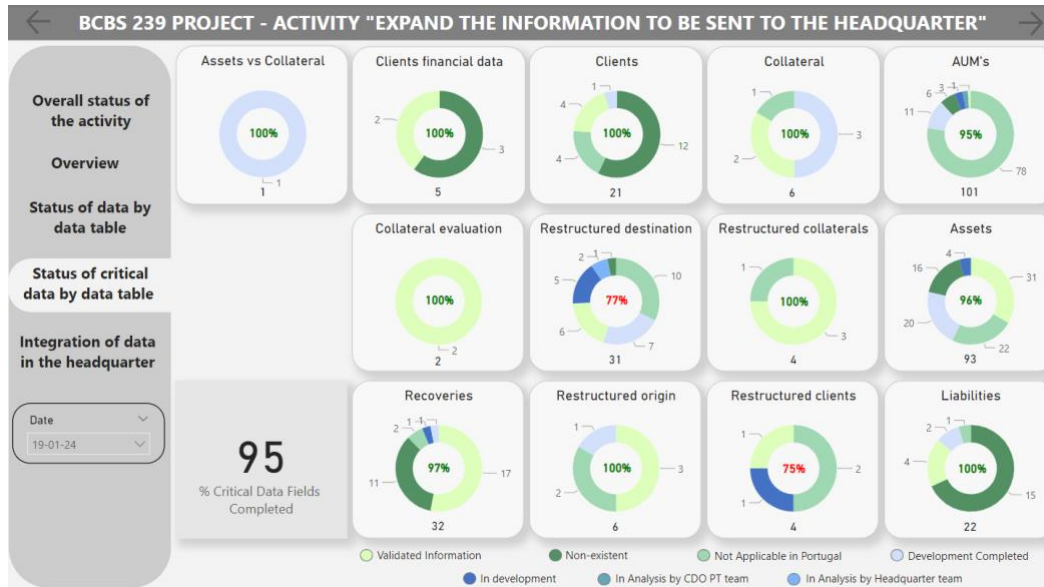


Figure 12 - Status of critical data by data table

Source: Power BI Author's Content

The need to create a specific dashboard page for critical data instead of just adding a data criticality filter to the previous one was due to this view being essential and an important part of the work activity, thus making sense to be separated in a new dashboard page. Besides, if a filter of data criticality were to be applied to the previous page, one graphic would be empty as one data table does not contain any medium or high criticality data.

Both the pages **“Status of data by data table”** and **“Status of critical data by data table”** facilitate the identification of the data tables that require more attention at the current week of analysis and help track the progress made so far. This helps the team focus their efforts on the tables that are falling behind the target.

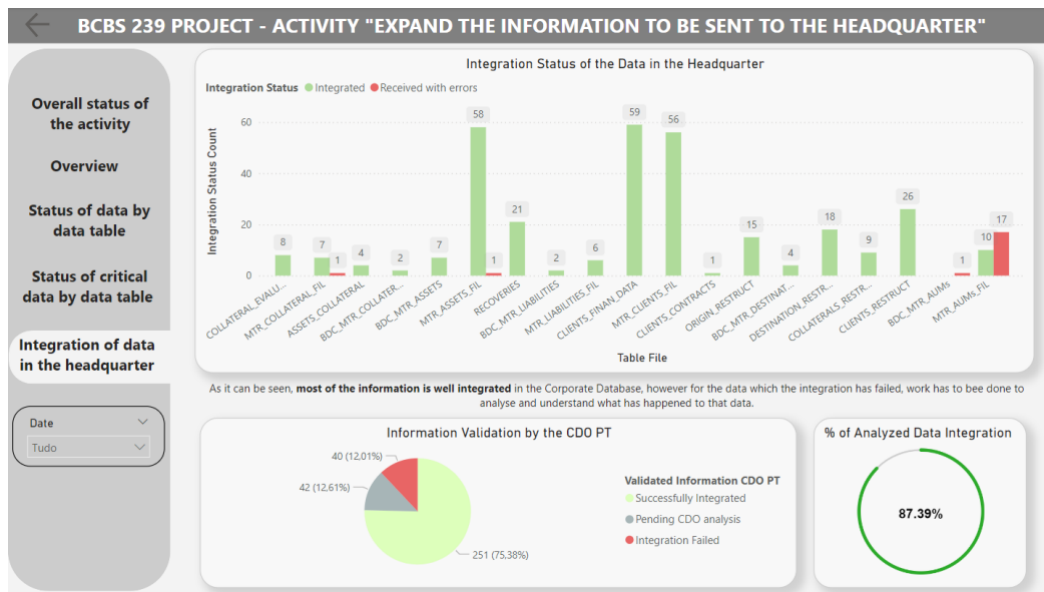


Figure 13 - Integration of data in the headquarter

Source: Power BI Author's Content

The last page is called **"Integration of data in the headquarter"** and has the objective of giving a visual understanding of the integration status of data that was already sent to the headquarter. This page provides information on successfully integrated data, data where its quality is maintained, and data for which integration in the Corporate Database failed. It includes a clustered column chart important to identify in which table file most integration errors occurred. When there are data fields classified as "Received with errors" is due to errors in the software of the corporate team that receives, processes, and stores the information received. This graph also contains the X axis ordered by table file priority of delivery, starting with the table file with the highest priority on the left of the Axis and the table with the lowest priority of delivery on the right. It also contains a pie chart that reflects the analysis of the CDO of the bank in Portugal on data integration, important since there is more data not properly integrated that is not being considered in the 'Received with errors' category. Finally, at the bottom right, it is displayed a KPI Donut Chart that indicates the proportion of analyzed data integration by the CDO. It is expected that the CDO will be able to keep track of the integration process as it unfolds to identify issues and have an action plan for addressing them. For that reason, the donut chart changes color according to thresholds that reflect this effort, green if above 85%, yellow if below 85% but above 50%, and red if below 50%. All the visualizations can be sliced by the date of when the information was sent to the headquarter.

All the above-described dashboard pages have arrow buttons on the top that allow the user to go back and forth in the dashboard.

5. RESULTS AND DISCUSSION

After the dashboard's development, it is crucial to evaluate if the solution contributes to a better oversight of the work conducted in the organization, assess if it has reached its goal, and if time should be invested in updating the dashboards. Besides, it is important to identify areas of improvement.

Therefore, in this Chapter, the evaluation of the artifact is described, and results are presented to assess if this data visualization solution assists in monitoring a BCBS 239 project activity.

5.1. EVALUATION APPROACH

After sharing the dashboard with its users, a qualitative approach was used by conducting a total of eight individual interviews. The participants of the interviews are users of the dashboard, and all are involved in this project. Three participants are executives, and in specific, the Chief Financial Officer (CFO) and the Director of the Technology Department, have an important role in making decisions to guide the team's action based on the status of the activity. Five are technical workers also eager to keep track of the ongoing status of the project. Additionally, two of the eight participants are from the headquarter and their main job is to assist with any doubts regarding the information that the team of Portugal needs to send. The name of the participants is anonymous therefore, to distinguish the participants, each participant will be given a letter: A, B, C, D, E, F, G, or H. More information regarding the participant's profile is presented in Appendix A.

For this evaluative approach, a set of questions was defined according to a set of Evaluation Criteria selected in **Chapter 3.1.4**.

Additionally, the participants were asked to rank each of the 10 questions on a five-point Likert scale, which ranges from 1 (strongly disagree) to 5 (strongly agree), enabling the measurement of the participant's attitudes about an issue addressed with the questions. Therefore, the user has five possible answer choices: strongly disagree, disagree, undecided, agree, and strongly agree (Batterton & Hale, 2017).

After the participants score each question, they are asked what the rationale behind their scores is. This will allow them to expose any flaws or weaknesses within the artifact, while also providing any suggestions for the dashboard improvement. Participants can also highlight the artifact's strengths, allowing a balanced evaluation. Consequently, a deeper comprehension of the users' opinions and enriched results are achieved by adopting this approach.

Table 2 - Interview Questions

Evaluation Criteria	#	Questions
Efficacy	Q1	Does the dashboard provide important insights that are relevant to an activity inserted in the scope of BCBS 239?
	Q2	Does the dashboard help to monitor this part of the ongoing BCBS 239 project at the bank?
	Q3	Does the solution help to identify any risks of falling behind the activity deadline?
Utility to the organization	Q4	Is the dashboard valuable in the current project?
	Q5	Should the dashboard be maintained and updated weekly, and shared with the teams?
	Q6	Does the dashboard provide a good approach to showcase the progress of the team's work on the activity?
Clarity	Q7	Does the dashboard improve visibility over the status of the activity and consequently of the BCBS 239 compliance?
	Q8	Does the dashboard provide a clear and simple-to-understand visualization, even for simple users?
Level of detail	Q9	Does the dashboard provide enough detail to support the board's decision and the team's work?
	Q10	Does the dashboard contain all the necessary and important information?

Source: Author's Content (Adapted from Prat et al. (2014))

5.2. RESULTS

This section presents the results of the interviews. Therefore, Table 3 displays the results of the interviews with the scores given by each participant to each question as well as the average score of each.

Table 3 - Result of the Interview Questions

Evaluation Criteria	#	Questions	1	2	3	4	5	Avg.
Efficacy	Q1	Does the dashboard provide important insights that are relevant to an activity inserted in the scope of BCBS 239?				G	A, B, C, D, E, F, H	4,9
	Q2	Does the dashboard help to monitor this part of the ongoing BCBS 239 project at the bank?			G		A, B, C, D, E, F, H	4,8
	Q3	Does the solution help to identify any risks of falling behind the activity deadline?				B, G, H	A, C, D, E, F	4,6
Utility to the organization	Q4	Is the dashboard valuable in the current project?			A	G	B, C, D, E, F, H	4,6
	Q5	Should the dashboard be maintained and updated weekly, and shared with the teams?				G, H	A, B, C, D, E, F	4,8
	Q6	Does the dashboard provide a good approach to showcase the progress of the team's work on the activity?			G	B, D, F, H	A, C, E	4,3
Clarity	Q7	Does the dashboard improve visibility over the status of the activity and consequently of the BCBS 239 compliance?				D, G	A, B, C, E, F, H	4,8
	Q8	Does the dashboard provide a clear and simple-to-understand visualization, even for simple users?			A	B, C, G	D, E, F, H	4,4
Level of detail	Q9	Does the dashboard provide enough detail to support the board's decision and the team's work?				A, F, G, H	B, C, D, E	4,5
	Q10	Does the dashboard contain all the necessary and important information?				B, C, G, H	A, D, E, F	4,5

Source: Author's Content

While answering the questions the participants justified the scores they gave and mentioned positive and negative aspects as well as opportunities for improvement. The reasoning behind the participants' answers is presented in Table 4.

Table 4 - Reasoning behind the participants' responses

Evaluation criteria				
Participant	Efficacy	Utility to the organization	Clarity	Level of detail
A	- The dashboard allows the user to see the evolution and progress of the work conducted towards the project conclusion, helpful in understanding what to improve and consequently, speeding up the process of sending data. - The dashboard also allows to compare the work done so far with the work to be done, and in this sense, it allows to check whether delivering what was stipulated until the deadline is at risk.	- The dashboard is valuable for monitoring the project, but it is not a deliverable for project conclusion. - The dashboard should be maintained and updated weekly since it allows to verify what went well or not so well on a certain week and adopt strategies in order to improve the results obtained. Therefore, it is also useful to follow the team's work.	- The dashboard allows to see if the work undertaken is on track to meet deadlines. - The dashboard can be hard to decipher for people outside the project, for instance, to understand the acronyms used.	- The dashboard is very useful for directors by allowing a high-level view of the project, as it allows them to retrieve general conclusions, however, to influence technical decisions is harder since there are parts of the work harder than others, for instance, a data table that is falling behind the deadline, it may be because the development of its data fields is harder than others. - All relevant information is present in the dashboard as the user gets an overview of what was done to achieve certain goals and what can still be done.
B	- Granular task monitoring is well reflected. - There is no risk indicator that answers the question "What are the risks that can occur during the activity?". For instance, a risk occurring from the team being reduced. However, this wasn't required on the dashboard and is a qualitative answer.	- The dashboard is useful and needs to be maintained as long as the project activity is in progress. - The dashboard needs to be shared weekly with the teams and providing a summary of its findings each week would be a great approach.	- The dashboard provides a clear view for its users, however, for a person with less knowledge regarding the project, an explanation may be needed.	- The dashboard can enhance results achievement, for instance by directing the work towards a data table below expected results. - For the teams that are directly involved in the activity, the dashboard gives all the necessary information. It could include the level of completeness of the activity overall on the first page, but it was also never a requirement.

Participant	Efficacy	Utility to the organization	Clarity	Level of detail
C	- The dashboard provides meaningful insights because it addresses from different perspectives the status and evolution of the activity of sending new information to the headquarter. It allows to analyze the data from the point of view of who is technically responsible for sending it, who is responsible for its integration into the parent company, and who is responsible for the final validation of its quality. - The dashboard provides periodically the relevant information for monitoring the activity. - The dashboard allows to evaluate whether the activity is within what was planned or not, with enough time to have some kind of action/mitigation of risk by including pages that contain measures that compare the percentage of work achieved with the estimated compliance against estimated completion dates.	- In addition to allowing the monitoring of the activity by those who perform it, the dashboard also gives relevant information on the evolution of the project to senior management. - Given the short deadlines of this initiative it is important that its follow-up is done with weekly periodicity at least. - The solution assists in showcasing the progress of the team's work because it uses a simple and graphically appealing approach to show the progress of the various sub-activities of the teams involved in the initiative/activity while drawing attention to possible delays.	- The dashboard improves visibility over the status of the project in a simplified way as it allows users to gather a lot of information and metrics that otherwise would be difficult to read and follow. - The dashboard is simple to understand, but the second overview dashboard page is not as clear and useful as the other pages. Besides, for those who are not aware of the information provided in the dashboards, it may not be as clear as it is for a simple user who has knowledge regarding the topics displayed in the dashboard.	- The dashboard provides enough detail as it addresses from complementary perspectives the various sub-activities to be carried out by the various teams and the evolution of each one of them. - The dashboard could have been complemented with a new dashboard page on the evolution of another activity related to the sending of new information to the headquarter, which is the documentation of the lineage of the fields sent.
D	- As a director, I asked to have a way to monitor this activity of the project and the dashboard was able to fulfill the need as it is through the use of metrics that progress can be evaluated. - The solution is effective in identifying potential risks of delay and it was through the dashboard that we could identify that at a certain point, we were falling behind in the delivery of the critical data fields.	- The dashboard should be maintained, updated, and shared weekly with the involved parties. Even when the activity is over, the dashboard will be important for a historical record as it will be necessary for other contexts and may be adapted to new scopes of the project. - The dashboard itself is useful but a rationale behind it and its numbers needs to be taken into consideration. The dashboard should be used and accompanied by a critical analysis of its users.	- The dashboard improves visibility over the status of the activity and its compliance, but qualitative information would also be important to support and justify the numbers, such as the number of employees working in each team, etc. - All the dashboard pages are easy to understand, it is not needed to be an advanced user to understand what is represented there.	- The dashboard gives the KPIs needed to follow this part of the project and it is not necessary to create any other way to follow it, as it provides the necessary level of detail. - There isn't any information missing in the dashboard.

Participant	Efficacy	Utility to the organization	Clarity	Level of detail
E	- All the relevant information to the project is included in the dashboard. Therefore, monitoring the project is possible using only the dashboard. - With the solution we can gauge whether we are within or outside the stipulated deadline.	- The dashboard is extremely valuable for the executive committee to monitor the project. - A weekly update of the dashboard is important to monitor the project's progress since the dashboard is essential for this purpose.	- Without a doubt, it is possible to assess the project's status by consulting the dashboard. - The dashboard graphics are intuitive and easy to read.	- The dashboard contains all the information needed for decision-making. - The progress of developments in each part of the project can be consulted in detail from the table/ data field.
F	- The dashboard is effective in monitoring the activity of the project, by providing important insights. It also helps to identify risks of the activity falling behind the deadline.	- The dashboard is very valuable to the current project, and thus, should be maintained and updated weekly. - The solution gives a more general view of the activity and its progress rather than the team's work itself.	- The dashboard is extremely clear and simple to understand, improving visibility over the status of the project activity, even for simple users.	- The dashboard gives an amazing overview, but to show the work of each team for instance would have to be worked on a bit more. - All information needed to take action, make decisions and follow the activity, is present in the dashboard.
G	- The solution is effective in performing a follow-up over this task of the project. - The dashboard gives a partial view of the activity. But as it is a dashboard, it doesn't reflect the effort put behind the results. - The dashboard helps indeed to identify the risk of delay but for instance, in the status of data by data table page, it could be added the number of data fields necessary to send until the current date in addition to the already existing percentage, since a table that has red percentage can be more at risk than another table in red as it may be more delayed.	- The dashboard reflects the status of the data sent and the progress of the task, showing to be a valuable solution. - The dashboard should be updated weekly but, in the case where the deadline of the activity is approaching, then, the dashboard could be updated more often. - The dashboard provides a quantitative overview to showcase the progress of the activity but doesn't reflect for instance the effort put into this task, such as the doubts that arise from the team regarding the data fields to send and the time that took by the headquarter to respond to those doubts.	- The solution ensures visibility over the status of the activity and consequently of the BCBS 239 compliance but there is a need to be critical to analyze those numbers, having the dates in consideration. - The dashboard provides a simple visualization, but if needed, more textboxes could be added to make everything clearer.	- The dashboard does its job by providing relevant information. It could add as referred previously, a vision over the doubts of the teams, the specific incidents of the data fields integration errors, and the deadline dates to be more complete and add even more detail to support the team's work.

Participant	Efficacy	Utility to the organization	Clarity	Level of detail
H	- The information that the dashboard displays is important and all the parties involved have a vision of their work which helps to follow the activity. - The dashboard is a tool that helps to identify possible risks and dangers. However, a lot of data fields are constantly changing their status during the project due to being more difficult to understand and identify by the team of Portugal. These cases could be identified to allow to monitor the risk of not being able to send them to the Corporate Database.	- The dashboard is useful and has been helpful in committees and follow-up sessions. - The artifact could be updated either weekly or every two weeks as sometimes there isn't a lot of time to do it regularly. - The dashboard helps to follow the progress of the team's work. As said before, the only thing that is less positive is the fact that for some data fields more time was devoted and in order for that work to be demonstrated, this data could have been identified.	- The entire dashboard has enough clarification to be understandable. Every graphic has data labels perfectly identified with colors, titles to correctly identify what is being represented and sometimes there is even auxiliary text displayed on the dashboard pages. All these aspects improve the visibility of the activity status.	- The dashboard provides enough details but when it displays alarming numbers, a qualitative explanation should be given to enhance decision-making. - The dashboard provides important information but for instance, when X data fields are analyzed by the headquarter and Y of those data fields return with more doubts to the headquarter, there isn't on the dashboard information that tells the headquarter how much of those data fields got back to the status "In Analysis by Headquarter team" after their doubts were clarified.

Source: Author's Content

5.3. DISCUSSION OF THE RESULTS

After collecting the participant's responses, the following graphic demonstrates that overall, the scores indicate a positive evaluation of the dashboard across each criterion. The criterion with the highest average score is "Efficacy".

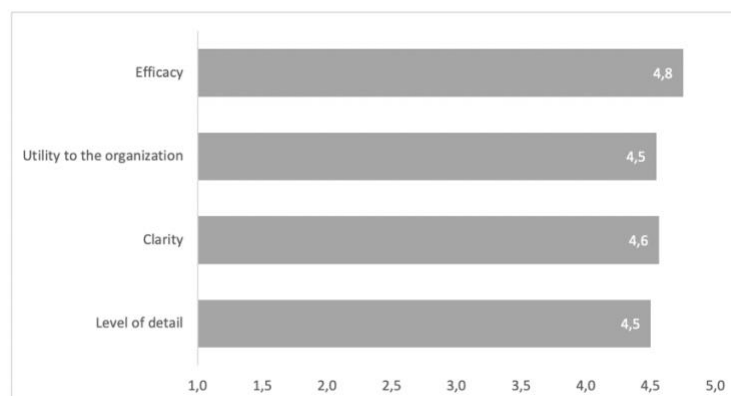


Figure 14 – Criteria average scores

Source: Author's Content

To make sense of these results the remainder of this chapter will focus on discussing them.

5.3.1. Efficacy

For the criterion “**Efficacy**” the great majority of the participants have given all questions a score of 5, which supports the idea that the artifact is highly effective and meets its desired goal: to provide important insights to monitor the status of an activity inserted within the scope of the BCBS 239 project.

The users are very positive that the dashboard provides important insights and information helpful to monitor one activity of the BCBS 239 project (Q1 and Q2) since it allows them to see the evolution and progress of the work conducted by showing different perspectives over the status of the activity.

They also consider the dashboard helpful and effective in identifying potential risks of falling behind the activity deadline (Q3), contributing to a fast definition of an action/mitigation plan in case the dashboard information shows any delays considering what was planned. Despite agreeing that the solution helps to identify risks, one of the participants considers that there are aspects that can pose a risk and impact the conclusion of the activity on time that cannot be identified in a dashboard, such as a reduction in resource availability. Another participant suggests that the number of data fields necessary to send until the current date could be added in addition to the already existing percentage on the dashboard page that shows the data status on each of the data tables, to make the perception of risk more meaningful.

5.3.2. Utility to the organization

Regarding “**Utility to the organization**”, participants agree that the artifact is useful to the project they are currently participating in.

The participants are confident regarding the value of the solution to the ongoing BCBS 239 project at the bank (Q4), especially to senior management, but also to the teams. One participant highlights that the dashboard is useful to be used in committees and follow-up project sessions. There is, however, one participant “undecided” as the solution is valuable however, it is not one of the deliverables to conclude the project.

Furthermore, most of the participants consider that the dashboard should be updated every week and shared with the teams (Q5), as it is useful to get a picture of what has been done in a certain week and to adopt strategies in case they are necessary. One participant even suggests that the dashboard could be updated more often as a deadline approaches.

It was also found that the dashboard is useful and valuable for showcasing the progress of the team’s work on the activity (Q6) since the participants consider that is possible, through looking at the graphics, to evaluate the progress of the teams in the various sub-activities, and consequently track their advancements. However, one participant indicates that this depends on whether the users perform a critical analysis of the results and think about the rationale

behind the numbers being displayed. Another two participants, despite considering the artifact useful to evaluate the progress, state that the solution gives a more general and quantitative view of the activity than properly on the work of the teams themselves. Finally, another participant agrees the dashboard helps to follow the progress of the team's work since all parties involved have a vision of their work but highlights that some data fields require more time for analysis than others and this should be taken into consideration. As the headquarter is responsible for explaining and clarifying doubts regarding some data fields, this data may be constantly changing status and going back to a more initial phase of analysis, the headquarter analysis, and in the dashboard, according to this participant, it doesn't reflect that there was already work done in those data fields.

5.3.3. Clarity

"Clarity" was the second-best classified criterion indicating that the participants found the dashboard clear.

Participants consider that the solution improves visibility and clarity over the status of the activity and consequently of the BCBS 239 compliance (Q7), as according to them, it shows the status of the project in a simplified way that would be hard to follow if the dashboard didn't exist. However, two participants believe it's important that for that to happen, users need to perform a critical analysis by considering what qualitative information can justify the numbers in the dashboard, since for instance team's vacations or doubts regarding certain data fields can influence the status of the work.

Participants also indicate that the artifact is simple, easy to understand, and intuitive even for simple users (Q8) but some participants state that these users would need to know about the topics of this project activity, which is in line with what was studied during the literature review. Four of the eight participants strongly agree that the dashboard is very easy for anyone to understand, and one participant justifies this by stating that the graphics have data labels perfectly identified with colors, titles that identify what is being represented, and sometimes even auxiliary text is displayed on the dashboard pages.

5.3.4. Level of detail

Finally, the participants of the interviews expressed satisfaction with the **"Level of detail"** of the dashboard.

Overall, they consider that the dashboard provides enough detail to support the board's decision and team's work (Q9) since they state it supports the board's decision-making with all the necessary metrics to retrieve conclusions and to support the team's work by directing

their efforts to certain aspects that are not going so well and consequently enhancing results. Participants also agree that the solution is excellent for directors by providing a high-level view of the project activity. However, three participants rated Question 9 with a score of 4 acknowledging that making technical decisions by the teams may be challenging just by looking at the dashboard. They pointed out the existence of constraints that may influence the results and that are not visible through just numbers. Additionally, one participant gave a score of 4 to the same question since to enhance decision making it is important to provide a qualitative explanation when the dashboard displays alarming numbers. Contrarily, four participants strongly consider that the dashboard has enough detail to support the team's work and one participant even states that the dashboard addresses from complementary perspectives the various sub-activities to be carried out by the various teams and the evolution of each one of them.

Lastly, participants consider that overall, the dashboard contains all the relevant and important information to monitor and follow the activity (Q10), since the users get an overview of what was done and can still be done, which means the users get all the information needed to drive action and make decisions. Some participants left some suggestions regarding other information that could enrich the dashboard, namely, including the level of completeness of the activity immediately on the first page of the dashboard, creating a new page documenting the lineage of the data fields sent and its status, adding information regarding doubts on the concepts of the data fields to send that emerge in the course of the activity and to which the headquarter team needs to answer, incorporating the status of the doubts (if they were clarified or not), documenting the specific incidents of the data fields integration errors, including the specific dates of the deadline in the dashboard and, finally, identifying data fields that require more work of analysis and thus are constantly changing status.

In general, based on the responses from the participants, the artifact was considered to be effective and useful to the company, providing a clear visualization and enough level of detail to help monitor the work being carried out towards alignment with an activity inserted in the scope of a regulatory project, as we can see from the criteria average scores. Therefore, and based on the results, it can be concluded that all eight participants are overall happy with the artifact, and the dashboard was adopted by the company being weekly updated and shared with the teams and stakeholders involved in the project.

6. CONCLUSIONS AND FUTURE WORKS

By assessing the work conducted in the previous chapter, conclusions can be drawn based on the outcomes obtained. Therefore, for this final chapter, conclusions of this project are presented as well as the contributions of this research to academic literature and its practical implications. Recommendations for future work will also be given based on the opportunities for improvement identified on the limitations of this study and the interviews conducted.

6.1. WORK PROJECT CONCLUSION

This research aimed to understand in what way could a BCBS 239 project be monitored, to support a financial institution's conformity with the norm BCBS 239.

Since the literature review it was possible to understand that financial institutions may face difficulties in achieving compliance with the norm, and sometimes, this can be due to an insufficient monitoring process. It was also acknowledged that data visualization can be a powerful tool to improve the way information is presented, helping to identify possible problems, risks, and issues and thus, influencing the way decisions are made.

For this project, the objective was to test if a data visualization solution could be useful to monitor an activity geared toward compliance with a specific norm of the banking industry, in a financial institution. For that purpose, a dashboard was created, and interviews were conducted with several users of the dashboard to understand how the people involved in the regulatory project perceive the utility of the artifact. Based on the drawn interview results, it is evident that the users of the dashboard experience enhanced visibility over the status of the activity, with an intuitive, easy-to-understand, and detailed solution that effectively provides important insights to monitor the status of an activity inserted within the scope of the BCBS 239 project.

Therefore, this work provides contributions to both research and practice.

Regarding contributions to literature, this study has multiple contributions. Firstly, it enhances understanding of the utility and effectiveness of using dashboards for monitoring a regulatory project within the banking industry, thereby enriching research on the fields of dashboard design, data visualization, and the banking industry. Additionally, given the absence of specific guidance or methods to follow to achieve the principles of the standard, and recognizing the challenge to monitor the work carried out towards compliance, this work project provides an effective approach to address these concerns. Furthermore, it also investigates user satisfaction by collecting feedback from industry professionals which generates insights into the usability and efficacy of the solution and can guide future work within this domain. Lastly, this research approaches a topic not extensively covered in the literature and can be useful to other organizations seeking a way to assess and present their efforts toward compliance.

In addition to contributing to science, this study also has practical implications:

- The use of the dashboard allows the identification of possible risks and helps mitigate them more effectively helping to meet deadlines which are extremely important in regulatory projects. Therefore, the dashboard helps to follow a more proactive project compliance management.
- The artifact supports the decision-making process by providing insights relevant to the executives, enabling informed actions based on the project's status displayed in the dashboard.
- The dashboard can serve as a central point of information, facilitating communication among all the departments involved in coordinating efforts to meet regulatory requirements.

With these contributions and based on the output of this research, it can be concluded that this study achieved its goal. This implies that employing data visualization to monitor and track progress in projects of this nature can be an effective approach.

6.2. LIMITATIONS AND FUTURE WORK

As in every study, limitations and future work recommendations can be identified:

- This study was conducted in only one Financial Institution, and the evaluation of the artifact is based on the opinions of a limited number of participants who are involved in the regulatory project that aims to comply with a set of principles within the scope of the BCBS 239 standard. Therefore, it would be interesting and crucial to study the effectiveness of the use of dashboards, with the same research objective, across multiple Financial Institutions currently implementing an identical project. This would contribute to reaching more supported conclusions.
- The questions of the interviews are formulated based on a set of criteria derived from the literature (Prat et al., 2014) and are selected based on what the researcher finds important to evaluate the research and to provide an answer to the research question. However, several other criteria could've been selected to evaluate the artifact. This leads to another suggestion for future work that can be followed for another work project of this type which is to use other criteria to evaluate the solution in order to deduce more findings, or, to just complement the set of evaluation criteria used in this work to provide a more comprehensive understanding.
- This study is focused on a specific activity of a project in progress at a bank, which aims to comply with the BCBS 239 norm. Therefore, it would be important to continue this study by encompassing all the activities needed to perform to comply with the principles of the norm, by studying the impact of data visualization over these other

project activities. Despite the solution being helpful for monitoring and gaining insights into the work conducted in a specific project activity, it cannot be concluded that this solution has the same outcome and desirable result for the other project activities. Hence, future research should focus on expanding the study to understand if the solution is valuable in a broader context.

- This work is focused on a specific norm of the banking industry, but as the banking industry has a significant amount of norms and is subject to a lot of regulatory pressure to promote stability and trust in the financial system, it would be interesting to conduct a future study over the use and implementation of dashboards or different tools or approaches of data visualization, to monitor projects related to other norms of this sector.

To continue this work in specific, improvements could also be made. The development and evaluation processes of the DSRM methodology are iterative and therefore, additional changes to the artifact could be made based on the interview results:

- In this work, dashboard pages to monitor a regulatory project activity were developed and evaluated to understand how users perceive its utility and efficacy. Despite the users considering that, overall, the already constructed dashboard has the necessary information to achieve its objective, some users, while providing their reasoning behind their answer to Question 10 of the interview, suggest that new dashboard pages and information could be added, and have detailed their suggestions. Additionally, some participants claimed to be “undecided” on certain questions, which provides an opportunity to make improvements.

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APPENDIX A

More information regarding the participants of the interviews can be consulted in Table A.1 below.

Table A.1 - The participants

Participant	Role	Professional experience	From headquarter?
A	Data Engineer	1 year	No
B	Chief Data Officer (CDO)	24 years	No
C	Responsible for the Data Technology Department	30 years	No
D	Director of the Data Technology Department	28 years	No
E	Team Lead of the Data Technology Department	27 years	No
F	Chief Financial Officer (CFO)	30 years	No
G	Responsible for the Data Management Department	8 years	Yes
H	Director of the Data Governance Department	26 years	Yes

Source: Author's Content

APPENDIX B

The Ethics Committee Report can be consulted below.

Thank you for filling in the Research Ethics Checklist. After reviewing your request, you can proceed with the study we do not foresee any major ethical concerns with the project.

Project No.: **OTHER2024-4-278487**

Project Title: **Compliance with Data Aggregation and Reporting Principles: The Impact of Monitoring it in a Bank**

Principal Researcher: **Inês Nobre da Veiga Galhote**

according to the regulations of the Ethics Committee of NOVA IMS and MagIC Research Center this project was considered to meet the requirements of the NOVA IMS Internal Review Board, being considered **APPROVED** on 10/05/2024.

