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# The Adoption of Big Data Analytics in Portuguese SMEs: Drivers, Barriers and Organisational Implications

Luís Miguel da Silva Fernandes

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November 2025







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# The Adoption of Big Data Analytics in Portuguese SMEs: Drivers, Barriers and Organisational Implications

Master's Final Assignment – Written Assignment  
presented to *Universidade Católica Portuguesa*  
to obtain a Master's Degree in Business Analytics

by

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To all of you, I express my most sincere recognition and gratitude.



# Declaration of honour

I hereby declare on my honour that I have prepared my written thesis, “The Adoption of Big Data Analytics in Portuguese SMEs: Drivers, Barriers and Organisational Implications”, with complete honesty and free from any fraudulent practices, namely copying or plagiarism.

I also declare that I am aware that committing fraud during written assessments constitutes a serious violation of the rules of ethics and academic conduct in force at the Universidade Católica Portuguesa, resulting in disciplinary action, as outlined in the Code of Ethics and Conduct of this University – paragraph b, nr. 3 of article 8 and nr. 3 of article 12.

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A handwritten signature in black ink, appearing to read 'Luís Miguel da Silva Fernandes', written over a horizontal line.



# Abstract

This dissertation examines the adoption and use of Big Data Analytics (BDA) by Portuguese Small and Medium-sized Enterprises (SMEs), seeking to understand the factors that facilitate or limit this process. The study was motivated by the limited integration of data-driven technologies within smaller firms in Portugal, despite their recognised potential to enhance competitiveness, efficiency and innovation. The research question guiding this work was: *How are Portuguese SMEs adopting and using Big Data Analytics, and what factors influence this process?*

A qualitative methodological approach was employed, combining multiple case studies with semi-structured interviews conducted in three companies from different sectors. This design made it possible to capture diverse experiences and to explore how organisational, technological and cultural dimensions interact during the adoption of analytical practices.

The findings reveal that adoption remains at an early stage, with most companies relying mainly on descriptive analysis supported by basic tools such as Excel, while only a few have begun integrating more advanced systems. The main barriers identified include financial constraints, limited internal expertise, and resistance to change, whereas leadership support and a culture open to innovation were found to be decisive enablers.

The research highlights that, even at modest levels of analytical maturity, the use of data contributes to improved efficiency, faster decision-making and enhanced strategic awareness. These results provide valuable insight into the digital transformation of Portuguese SMEs and suggest practical and policy measures to foster broader and more effective adoption of analytical technologies.

**Keywords:** Big Data Analytics; Small and Medium-sized Enterprises; Digital Transformation; Organisational Culture

# Resumo

Esta dissertação analisa a adoção e utilização de BDA pelas Pequenas e Médias Empresas (PME) portuguesas, procurando compreender os fatores que facilitam ou limitam este processo. O estudo foi motivado pela reduzida integração de tecnologias orientadas por dados nas empresas de menor dimensão em Portugal, apesar do seu reconhecido potencial para reforçar a competitividade, a eficiência e a inovação. A questão de investigação que orienta este trabalho foi: *Como estão as PME portuguesas a adotar e a utilizar Big Data Analytics e que fatores influenciam este processo?*

Foi adotada uma abordagem metodológica de natureza qualitativa, combinando estudos de caso múltiplos com entrevistas semiestruturadas realizadas em três empresas de diferentes setores de atividade. Este desenho permitiu captar experiências diversas e explorar de que forma as dimensões organizacionais, tecnológicas e culturais interagem durante a adoção de práticas analíticas.

Os resultados revelam que a adoção permanece numa fase inicial, sendo que a maioria das empresas recorre essencialmente a análises descritivas suportadas por ferramentas básicas, como o Excel, enquanto apenas algumas começaram a integrar sistemas mais avançados. As principais barreiras identificadas incluem restrições financeiras, falta de competências internas especializadas e resistência à mudança, ao passo que o apoio da liderança e uma cultura organizacional aberta à inovação surgem como fatores determinantes de sucesso.

O estudo evidencia que, mesmo em níveis modestos de maturidade analítica, a utilização de dados contribui para uma maior eficiência, decisões mais rápidas e melhor perceção estratégica. Estes resultados oferecem um contributo relevante para a compreensão da transformação digital das PME portuguesas e sugerem

medidas práticas e políticas para promover uma adoção mais ampla e eficaz das tecnologias analíticas.

**Palavras-chave:** Big Data Analytics; Pequenas e Médias Empresas; Transformação Digital; Cultura Organizacional

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# List of Abbreviations

AI – Artificial Intelligence

BDA – Big Data Analytics

IoT – Internet of Things

SME – Small and Medium-sized Enterprises



# 1. Introduction

The rapid digitalisation of the economy, supported by advances in technologies such as the Internet of Things (IoT), cloud computing and Artificial Intelligence (AI), has fundamentally changed how organisations operate and make strategic decisions. As industries become increasingly data-driven, companies are beginning to recognise information as one of their most valuable assets (McAfee & Brynjolfsson, 2012). Yet, the ability to turn growing volumes of information into meaningful insights requires sophisticated analytical approaches collectively known as BDA. Through the use of advanced technologies and methods, BDA enables organisations to transform both structured and unstructured data into practical knowledge that can enhance decision-making and stimulate innovation (Gandomi & Haider, 2015).

Although the potential of BDA is widely acknowledged, many firms continue to struggle with its effective implementation. Successful adoption often demands more than technical resources, it involves organisational change, new leadership perspectives and a willingness among employees to embrace data-driven ways of thinking (Fosso Wamba et al., 2015). These challenges tend to be even greater for SMEs, which generally face financial limitations, shortages of qualified professionals and less developed technological infrastructures (Coleman et al., 2016; Horváth & Szabó, 2019). In Portugal, these constraints are particularly visible: the country continues to show a relatively low level of digital maturity and a slow rate of analytics adoption (Santos, 2023; Durão et al., 2019).

Studies on the Portuguese context highlight that many organisations still lack clear strategies for integrating analytical tools, and SMEs remain especially limited by financial and human resource constraints (Santos, 2023; Cintrão, 2022). While international research has examined the advantages and barriers of using BDA, few studies have focused on how these issues affect smaller firms within

the Portuguese business landscape. Understanding how SMEs approach analytics is therefore crucial for identifying both the obstacles they face and the opportunities they can seize through data-driven strategies.

As the volume, speed and diversity of information continue to expand, developing analytical capabilities has become essential for maintaining competitiveness (Gandomi & Haider, 2015; Tiwari, Wee & Daryanto, 2018). However, for many SMEs, the challenge lies not only in acquiring the right technologies but also in building a culture that values data-based decision-making (Gupta & George, 2016). Organisational culture and leadership therefore play a decisive role in determining whether analytical initiatives succeed or fail. Companies with supportive leaders and an openness to change are more likely to integrate analytics effectively into their operations (Cintrão, 2022).

This study seeks to explore how Portuguese SMEs are adopting and using Big Data Analytics in practice. Its main goal is to understand how these organisations are integrating BDA into their daily operations, what challenges they face, and what factors help or hinder the process. The research is guided by the following question:

*How are Portuguese SMEs adopting and using Big Data Analytics, and what factors influence this process?*

To address this question, the study aims to:

1. examine how Portuguese SMEs currently apply BDA tools and practices.
2. identify the organisational and technological barriers that limit effective implementation.
3. analyse the perceived benefits and outcomes of adoption, with a particular focus on the role of organisational culture.

By concentrating on SMEs, this dissertation contributes to filling a recognised gap in the existing literature and provides insights into the wider process of

digital transformation in Portugal. Academically, it connects empirical evidence from small firms with theoretical models of BDA adoption and organisational culture. From a practical perspective, it offers guidance for managers seeking to make better use of data, outlining the key enablers, constraints and strategies for developing analytical maturity. Additionally, by examining the Portuguese context, the study may help policymakers design initiatives that promote innovation and strengthen the digital capacity of SMEs.

The research follows a qualitative approach based on multiple case studies and semi-structured interviews. This design allows for a deeper understanding of how analytics is implemented in real business contexts and captures the diversity of experiences among firms. The analysis focuses on identifying relationships between challenges, responses and outcomes, building a coherent picture of how BDA adoption evolves in SMEs (Eisenhardt & Graebner, 2007; Miles, Huberman & Saldaña, 2014).

SMEs represent more than 99% of businesses in Europe (European Commission, n.d.), making their digital development essential for sustainable economic growth. Strengthening their ability to use analytics effectively is key to enhancing competitiveness and encouraging innovation. The insights derived from this study may therefore support both organisational leaders and public institutions in fostering data-driven decision-making across the Portuguese SME sector.

The remainder of this dissertation is organised as follows. Chapter 2 provides a detailed review of the literature on Big Data and Big Data Analytics, addressing their origins, concepts and main dimensions, as well as the opportunities and challenges associated with adoption. Chapter 3 describes the methodological framework, including the research design, data collection and analysis procedures. Chapter 4 presents the empirical findings from the case studies, outlining how the participating SMEs use data, the tools they employ and the

difficulties they encounter. Chapter 5 discusses these findings in light of existing theoretical perspectives. Finally, Chapter 6 concludes the dissertation by summarising the key insights, highlighting theoretical and practical implications, and suggesting directions for future research.

## 2. Literature Review

The purpose of this chapter is to examine the theoretical foundations and empirical developments surrounding BDA and its relevance to organisational competitiveness, particularly within the context of SMEs. The rapid digitalisation of the economy, combined with the widespread adoption of connected devices, has led to the generation of data at unprecedented volumes, speeds and levels of diversity. This has rendered traditional methods of analysis insufficient (Jamarani et al., 2024). Within this context, BDA has emerged as a set of technologies and methodologies capable of transforming vast quantities of structured and unstructured data into strategic insights, providing organisations with a significant competitive advantage (Gandomi & Haider, 2015).

By reviewing the origins and growth of Big Data, the conceptual frameworks of BDA and its practical implications for business performance, this chapter aims to establish a comprehensive understanding of how data-driven technologies are reshaping management practices. It concludes by addressing the challenges that limit BDA adoption, especially among SMEs, and by examining the current state of implementation in Portugal.

### 2.1 Origins and Evolution of Big Data

The concept of Big Data has evolved considerably over time, though its exact origin remains somewhat ambiguous. Cox and Ellsworth (1997) are often credited with one of the earliest academic references to Big Data, having identified the challenges associated with processing and visualising large volumes of data using conventional computing technologies. As datasets expanded, they began to exceed the capacity of main memory, local disks and

even remote storage, making traditional data management increasingly inefficient. Initially, this issue was addressed simply by acquiring additional computational resources (Press, 2013). However, as data generation accelerated, this approach proved unsustainable, prompting a fundamental shift in how data were stored, processed and analysed.

By 2011, the term Big Data had gained widespread recognition, largely due to IBM and other major technology firms promoting advanced data analytics solutions (Gandomi & Haider, 2015). This marked a turning point, moving the focus from merely managing large datasets to deriving actionable insights from them.

Big Data is typically characterised by its high volume, velocity and variety, which make it too voluminous or too unstructured to be managed and analysed through traditional means (Davenport, Barth & Bean, 2012, p. 22). The emergence of Big Data can be attributed to several interrelated factors, including the digitalisation of business processes, the expansion of social media and the proliferation of connected devices. Together, these factors have created an unprecedented surge in data generation that has rendered manual analysis impractical.

Technological advances such as cloud computing and machine learning have enabled organisations to store and process vast amounts of information more efficiently, overcoming the computational limitations that previously constrained data analytics (McAfee & Brynjolfsson, 2012). Initially, analytics focused mainly on structured databases, where information was organised in clearly defined tables. With the rise of unstructured data sources, such as sensor logs, social media content and video, new analytical approaches became essential. Pioneering companies began using advanced platforms such as Hadoop, which allowed them to manage data diversity and complexity, paving the way for modern Big Data Analytics (Davenport et al., 2012).

## 2.2 Conceptualisation and Definition of Big Data Analytics

Given the challenges posed by the scale and complexity of Big Data, organisations have increasingly turned to BDA to extract actionable insights and support evidence-based decision-making.

BDA has been widely examined in academic literature for its transformative impact on how organisations process information and make strategic choices. It is defined as a set of techniques and technologies that enable the collection, storage and analysis of large volumes of structured and unstructured data to generate strategic knowledge (Popovič et al., 2018). Unlike traditional approaches to data analysis, BDA is distinguished by its capacity for real-time processing, which allows organisations to detect patterns and trends as they emerge (Davenport et al., 2012).

Over time, data analysis has evolved significantly. Early Business Intelligence and Analytics systems primarily focused on structuring and processing data for retrospective evaluation. The advent of Big Data expanded this scope to include advanced techniques such as machine learning and AI, capable of handling complex, large-scale datasets (Chen, Chiang & Storey, 2012). Rapid developments in computing technology and the exponential growth of digitalisation have further fuelled this shift, making predictive and prescriptive analytics increasingly attainable for businesses (Fosso Wamba et al., 2015).

BDA is often described through five fundamental dimensions: Volume, Velocity, Variety, Veracity and Value. These dimensions distinguish Big Data from traditional information management systems and highlight both the challenges and opportunities of implementation.

- **Volume** refers to the enormous quantities of data generated daily from diverse sources such as sensors, social media and financial transactions. Effective management of this volume requires scalable infrastructures

such as cloud computing and distributed storage systems (Gandomi & Haider, 2015).

- **Velocity** concerns the speed at which data are produced and processed. Within the BDA framework, analyses must be carried out in real or near-real time to enable timely and informed decisions (Davenport et al., 2012).
- **Variety** encompasses the diversity of data types available, including text, images, video and sensor signals. This multiplicity challenges traditional analytical techniques, necessitating sophisticated data integration and processing methods (McAfee & Brynjolfsson, 2012).
- **Veracity** refers to the quality and reliability of data. Inaccurate or inconsistent data can result in poor decision-making, which underlines the importance of validation processes and robust data governance (Fosso Wamba et al., 2015).
- **Value** represents the strategic advantage gained by transforming raw data into insights that drive innovation and operational efficiency (Tiwari, Wee & Daryanto, 2018).

## 2.3 The Strategic Importance of BDA for Organisations

The significance of BDA for organisations lies in its ability to transform data into a competitive asset. Companies that utilise advanced analytics can make more precise and agile decisions, minimise risk and seize emerging opportunities (Kache & Seuring, 2017). Integrating BDA into operational processes often enhances efficiency, reduces costs and improves customer experience (Brown, Chui & Manyika, 2011).

A further critical dimension is innovation driven by data insights. Through the strategic use of analytics, organisations can develop products and services that more accurately reflect market needs. This approach benefits not only the private sector but also public administration, where BDA contributes to optimising services and allocating resources more effectively (Gandomi & Haider, 2015).

BDA should therefore be viewed not as a passing technological trend but as a cornerstone of business competitiveness in the digital era. Organisations that adopt this technology strategically are better positioned to meet future challenges and capitalise on emerging opportunities (Popovič et al., 2018).

As Tawil et al. (2024) highlight, BDA allows organisations to derive strategic value by processing large volumes of information in real time. This capability enhances decision-making, optimises operations and improves customer experience while simultaneously driving innovation and strengthening competitive advantage (Coleman et al., 2016). Tawil et al., 2024 further observe that BDA tools enable managers to interpret data more accurately and react swiftly to market changes, aligning business strategies with dynamic environments.

From an operational efficiency perspective, a McKinsey report, notes that the application of predictive analytics within the BDA framework leads to substantial improvements in logistics, particularly in retail and healthcare, where operational costs can be reduced by as much as 60% (Manyika et al., 2011). These improvements arise from advanced analytical tools that support failure prediction and waste reduction (Coleman et al., 2016).

Beyond efficiency, BDA also elevates customer experience. Contemporary consumers expect highly personalised services and believe that companies should anticipate their needs and preferences (Schönberger, 2023; Coleman et al., 2016; Tawil et al., 2024). Organisations that successfully employ analytics to meet

these expectations not only enhance satisfaction but also foster long-term trust and loyalty (Schönberger, 2023).

The advantages of BDA extend across industries, including retail, healthcare, manufacturing and logistics, where data-driven insights support improved efficiency and decision quality. In retail, companies apply BDA to tailor offers and predict consumer behaviour, which increases conversion rates and strengthens customer retention (Santoro et al., 2019). In manufacturing, analytics enables process automation, large-scale customisation and predictive maintenance, reducing costs and boosting productivity (Gunasekaran et al., 2018). In finance, it is central to fraud detection and real-time credit risk assessment through algorithms that identify suspicious patterns and prevent losses (Davenport et al., 2012). In healthcare, BDA assists in predicting disease outbreaks, improving diagnostics and optimising treatments through predictive modelling based on extensive clinical datasets (Davenport et al., 2012).

Moreover, organisational knowledge management has benefitted considerably from BDA. Companies that implement structured data collection and sharing processes enhance their innovative capacity and strengthen competitive positioning (Samir, 2020).

The benefits of BDA are not confined to large corporations. SMEs, which make up roughly 99% of all European businesses, can also gain substantial value. By definition, SMEs employ fewer than 250 people and generate an annual turnover below 50 million euros (European Commission, n.d.). However, due to their smaller scale, they face obstacles such as infrastructure limitations, a shortage of skilled professionals, financial constraints and restricted access to advanced technologies (Tawil et al., 2024; Coleman et al., 2016).

For these firms, BDA can be decisive in establishing a competitive advantage. By using advanced analytics tools, SMEs can anticipate market trends, identify new business opportunities and mitigate risks associated with market entry

(Tawil et al., 2024; Coleman et al., 2016). The ability to make data-driven strategic decisions allows them to maximise growth potential while minimising investment uncertainty.

## 2.4 Barriers and Challenges to BDA Adoption

While BDA offers transformative potential, its adoption presents considerable challenges, especially for SMEs, which must navigate multiple obstacles before achieving tangible benefits (Gupta & George, 2016).

A key barrier is the lack of knowledge about BDA, including its applications and potential advantages. Coleman et al. (2016) point out that larger organisations often employ professionals with a broader understanding of analytics, whereas decision-makers in SMEs tend to be less familiar with such technologies, leading to hesitation in investment and resource allocation (Sivarajah et al., 2017).

Many SMEs also face difficulties in fostering a data-driven organisational culture (Gupta & George, 2016). Resistance to change is particularly strong among managers and employees accustomed to traditional decision-making methods, making the shift to data-based management more complex (Horváth & Szabó, 2019; Moktadir et al., 2019).

Beyond cultural and knowledge-related obstacles, the shortage of qualified professionals restricts firms capacity to exploit BDA effectively. The lack of experts capable of processing and interpreting analytical insights undermines successful implementation (Gupta & George, 2016). Demand for data scientists and machine learning specialists far exceeds supply, leading to rising salary expectations and making it difficult for SMEs to compete with large corporations for talent (Horváth & Szabó, 2019; Coleman et al., 2016).

Another significant difficulty is the need for robust technological infrastructure capable of real-time data processing and scalability. Many organisations still rely on outdated systems lacking the necessary power and speed (Alharthi, Krotov & Bowman, 2017). The exponential growth of data generated by the IoT demands sophisticated storage and processing solutions, which pose further challenges for firms without adequate infrastructure. The resulting complexity complicates investment decisions, as long-term needs and returns are hard to predict (Mahmoudian et al., 2023).

Building a strong infrastructure also entails high costs in hardware, software and skilled labour. For many SMEs, these expenses are prohibitive (Coleman et al., 2016). Additionally, reliance on cloud services or on-premises installations raises operational costs (Yaqoob et al., 2016; Horváth & Szabó, 2019). Combined with uncertainty about return on investment, these financial pressures discourage adoption (Moktadir et al., 2019).

Although BDA presents major opportunities for improved decision-making and competitiveness, adoption remains constrained by limited knowledge, resistance to change, a lack of skilled professionals, technological shortcomings and substantial implementation costs. Overcoming these barriers calls for strategic investment in education, infrastructure and financial planning, alongside frameworks that facilitate BDA integration within SMEs.

## 2.5 Current State of BDA Adoption in Portugal

Portugal is undergoing an ongoing process of digital transformation, but the integration of BDA remains limited. Only a small proportion of European companies employ this technology, and in Portugal the adoption rate is approximately 11%, underscoring the need for greater investment and awareness

(Santos, 2023). Moreover, many organisations still lack clear digitalisation strategies, delaying the integration of advanced analytical tools into management processes (Durão et al., 2019).

Nonetheless, awareness of BDA potential is growing. Portuguese firms are investing increasingly in technologies that drive efficiency and innovation. Recent studies indicate strong growth in IoT (+45.2%), Agile collaboration tools (+71.4%) and Big Data & Analytics (+42.3%), reflecting an expanding recognition of the need to modernise business processes (Durão et al., 2019). Literature also highlights that BDA enhances organisational agility, enabling companies to identify opportunities, expand into new markets and support strategic change (Mendonça & Andrade, 2018).

Despite its advantages, BDA implementation in Portugal faces serious challenges. The main barriers include organisational culture (42.9%) and budgetary constraints (40.3%). Managerial resistance and insufficient employee skills affect between 20% and 30% of businesses (Durão et al., 2019). Many companies remain reluctant to embrace new technologies because of rigid internal structures and limited understanding of data's strategic role. Furthermore, a shortage of specialised analytical skills hinders the creation of an environment conducive to digital transformation (Durão et al., 2019).

These challenges are particularly evident among SMEs, which face additional obstacles limiting their ability to use BDA effectively. Restricted financial resources and inadequate internal expertise prevent them from fully exploring this technology's potential. Research emphasises that organisational readiness is vital for successful adoption, making managerial support a decisive factor in promoting digital initiatives (Cintrão, 2022). Nevertheless, many companies still neglect staff training and the development of internal strategies that encourage data-driven management (Cintrão, 2022).

A further problem is the lack of robust technological infrastructure, especially among SMEs. Without sufficient investment in technology and cybersecurity, analytics implementation becomes complex and inefficient. Misalignment between departments also obstructs data integration and weakens analytical insight (Santos et al., 2023).

Although these challenges persist, trends indicate a steady increase in adoption. Portuguese organisations are becoming more aware of the strategic need for digital transformation, with growing emphasis on AI, IoT and BDA as enablers of competitiveness (Mendonça & Andrade, 2018).

Collaboration with universities, research centres and technology providers has also been crucial in expanding BDA use in Portugal. Partnerships with academic institutions supply access to specialised expertise and innovative technologies, facilitating more effective application of analytics. Public policy likewise plays an essential role in promoting this transformation. Government incentives should focus not only on post-adoption outcomes but also on preparing SMEs for digital transition (Cintrão, 2022). Investment in professional training is also key to ensuring that organisations possess the human resources needed to fully exploit these innovations (Santos et al., 2023).

In summary, these findings highlight the strategic relevance of BDA for improving decision-making, operational efficiency and innovation. They also point to persistent barriers, notably cultural resistance, financial constraints and limited analytical capabilities, that continue to constrain adoption, particularly among SMEs. In Portugal, the evidence is still scarce and often descriptive, offering limited insight into how SMEs are actually adopting and using BDA in practice. To address this gap, the next chapter outlines the methodological framework designed to examine how Portuguese SMEs engage with BDA, the challenges they face and the strategies they employ to overcome them.

### 3. Methodology

Drawing on the insights from the literature review, it became clear that the adoption of BDA within Portuguese companies, particularly among SMEs, remains limited despite its widely acknowledged strategic potential. This gap highlights the need to deepen understanding of how SMEs in Portugal engage with BDA. Accordingly, this study examines existing knowledge in those companies, explores perceived advantages and challenges, and analyses the role of organisational culture in shaping the adoption process. To guide this inquiry, the following research question was formulated:

- *How are Portuguese SMEs adopting and using BDA, and what factors influence this process?*

To address this research question, the study aimed to identify how Portuguese SMEs are currently adopting BDA tools and practices, while examining the organisational and technological factors that affect this adoption. The research also explored the perceived benefits and barriers associated with the implementation of BDA and assessed the role of organisational culture in facilitating or constraining data-driven decision-making. Finally, it intended to propose recommendations to support a broader and more effective adoption of BDA among Portuguese SMEs.

To fulfil these objectives, the study employed a qualitative research design, combining multiple case studies with semi-structured interviews. This approach was chosen for its ability to capture diverse perspectives and provide context-sensitive insights, allowing for a comprehensive understanding of the complexities surrounding BDA adoption in SMEs.

### 3.1 Research Method

The qualitative method was chosen because it allows in-depth exploration of developments within real-world contexts, preserving the natural sequence of events and providing detailed insights into human processes (Miles, Huberman & Saldaña, 2014). This approach is particularly beneficial as it promotes a nuanced understanding of the phenomena under study, can surface unexpected findings and supports the creation or refinement of theoretical frameworks (Miles, Huberman & Saldaña, 2014).

The case study method is well suited to examining specific, clearly defined situations within their natural settings, foregrounding the complexity of the environments in which they occur. It typically integrates multiple methods of data collection such as interviews, questionnaires, observations and document analysis, contributing to the development of innovative and empirically grounded theories (Eisenhardt, 1989; Eisenhardt & Graebner, 2007).

Using multiple case studies is advantageous due to replication logic, whereby each individual case functions like an independent experiment capable of supporting or challenging specific propositions, thereby strengthening the resulting theory. This methodological choice increases the robustness and reliability of the findings by grounding claims in diverse and well-substantiated evidence. Consequently, employing multiple cases enhances confidence in the results and enables broader explanation of the theoretical insights across contexts (Eisenhardt & Graebner, 2007; Miles, Huberman & Saldaña, 2014).

Regarding the number of cases, although there is no universally agreed ideal, selecting between four and ten is typically advised to achieve adequate theoretical complexity without being overwhelmed by data volume. Fewer than four may limit theoretical depth, and more than ten can become impractical. Some scholars recommend a minimum of five richly researched cases to ensure

methodological adequacy in multiple-case designs (Eisenhardt, 1989; Miles, Huberman & Saldaña, 2014).

### 3.2 Data Collection Procedures

The data collection process consisted of semi-structured interviews with two individuals in each of the three companies, totalling six interviews. Interview duration ranged from 30 to 45 minutes. Semi-structured qualitative interviews facilitate a collaborative and comprehensible dialogue between researcher and participants (Irvine, Drew & Sainsbury, 2013).

The companies included in this study were selected according to clear and coherent criteria designed to ensure both relevance and diversity. Each organisation qualified as an SME under the European Commission's definition, keeping the research focused on the intended scope of smaller businesses. The cases were also chosen to represent different sectors and organisational contexts, which made it possible to draw meaningful comparisons and gain a broader view of how BDA is being adopted across varied environments. Within each company, participants were identified based on their direct involvement in decision-making or data management, ensuring that the information collected reflected well-informed and practice-based perspectives.

Although the sample is not statistically representative of all Portuguese SMEs, its purposive nature allows for analytical depth and theoretical understanding rather than numerical generalisation, following the principles of multiple-case qualitative research outlined by Eisenhardt and Graebner (2007).

To strengthen the robustness and validity of the findings, multiple interviews were conducted within each company. This approach provided richer data and

reduced potential bias by capturing diverse perspectives and experiences, leading to a more comprehensive understanding of each case.

Semi-structured interviews were chosen for their flexibility: interviewees could express their views openly and interviewers could probe emerging topics in depth. This supported clarification of responses and allowed participants to confirm the adequacy and relevance of their contributions, strengthening the reliability and richness of the data collected (Irvine, Drew & Sainsbury, 2013).

Interview topics covered sources and types of data used by the companies (internal or external, structured or unstructured), the analytical techniques applied (including machine learning and statistical analysis), and concrete examples illustrating their use. The interviews also explored the existence and influence of a data-oriented organisational culture, identifying enablers and barriers to effective implementation of BDA, as well as how the insights obtained inform organisational decision-making.

All three companies are located in the Trás-os-Montes region of Portugal. The interviewees hold diverse roles and sit at different hierarchical levels within their organisations, ranging from executive positions to team managers and departmental staff. This variety enabled the collection of multiple perspectives on the use of BDA in the SMEs under study. All participants provided informed consent to take part in the research and to have their interviews recorded for subsequent transcription and analysis. Most interviews were conducted in person, with one completed online via Microsoft Teams.

The following figure presents the methodological flowchart, summarising the main steps from data collection to the discussion of results.

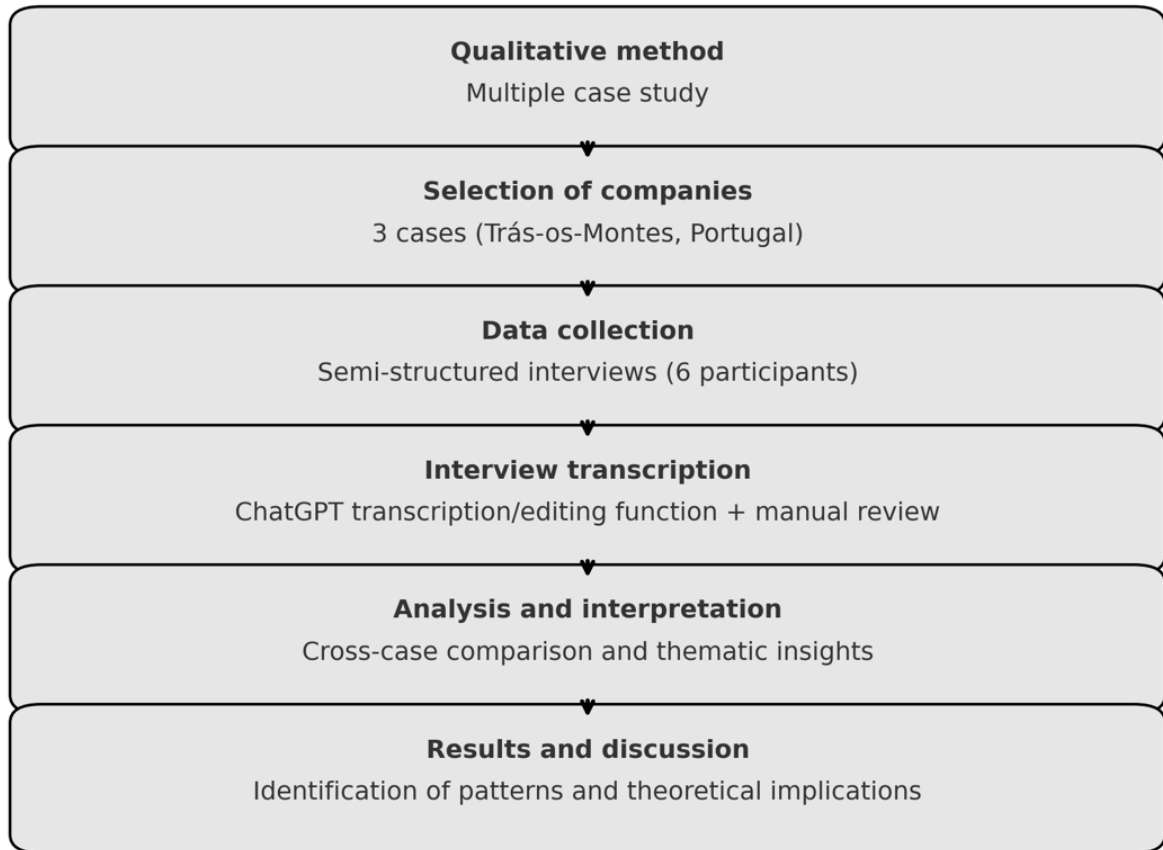


Figure 1 - Methodological Flowchart

### 3.3 Data Analysis and Interpretation

As noted above, the majority of interviews were conducted in person. The built-in recording and automatic transcription feature of ChatGPT was used throughout the process and proved useful for producing accurate transcripts. The interview conducted via Microsoft Teams was audio-recorded and later transcribed using the same ChatGPT transcription functionality. It was not necessary to edit or remove identifying information about companies or participants, as full permission had been granted for the use of all content. Transcripts were nevertheless reviewed to correct minor slips and to remove

natural speech repetitions or filler words that occurred during spontaneous conversation.

Upon completion of the data collection and transcription process, the material obtained was systematically organised for qualitative analysis. The subsequent chapter presents the empirical findings derived from the interviews, describing how the participating SMEs employ data, the analytical tools they use, and their perceptions of both benefits and challenges associated with BDA.

## 4. Presentation and Data Analysis

The purpose of this section is to present the data obtained from the interviews conducted with six participants belonging to three companies operating in different sectors. The data are described in an organised way, illustrating how these organisations make use of data, the levels of analytical maturity identified, and the participants perceptions of advantages, barriers, and future perspectives.

### 4.1 Company and Participant Profiles

The first company operates in the accounting and consulting sector, with around twenty employees and an annual turnover of approximately 500 to 600 thousand euros. As explained by one of the participants, *“Our core business is essentially accounting. We also handle human resource management (...) pure accounting takes up about 95% of our daily work”* (Interviewee 1). Another participant, responsible for operational management, emphasised the breadth of activity, stating that *“the core of the company is accounting, that’s what pays the bills. However, we also operate in several other areas: projects, human resources, and we provide support to entrepreneurs in everything we can”* (Interviewee 2).

The second company belongs to the retail sector, supplying dental materials and consumables to clinics across the country. It is a small structure with twelve employees and an annual turnover between 1 and 1.5 million euros. As the CEO described, *“BNH is dedicated to the trade of dental products for clinics. (...) We currently have twelve employees, a small but very dedicated team, and in 2024 we reached a turnover of around 1.5 million euros”* (Interviewee 3).

The third company is larger and operates in the veterinary pharmaceutical industry, employing fifty-three people and reporting a turnover of around

twenty-six million euros. As one of the managers highlighted, *“Novavet is a pharmaceutical company in the veterinary and nutrition field, selling consumables and clinical material for both livestock and companion animals. In 2024, turnover was around 26 million euros and the number of employees at the moment is 53”* (Interviewee 5). The administrator reinforced the idea of diversification, noting that *“Novavet is dedicated to several areas of activity, with the main one being the pharmaceutical distribution of veterinary medicines, which represents close to 90%. We also distribute surgical equipment, laboratory equipment, and pet food”* (Interviewee 6).

| Company   | Sector                             | No. of Employees | Annual Revenue (€ millions) | Interviewee   | Role                                        |
|-----------|------------------------------------|------------------|-----------------------------|---------------|---------------------------------------------|
| Company 1 | Accounting and Consulting          | 26               | 0,5 - 0,6                   | Interviewee 1 | Accountant and Team Leader                  |
|           |                                    |                  |                             | Interviewee 2 | Operations Manager                          |
| Company 2 | Retail – Dental Products           | 12               | 1 – 1,5                     | Interviewee 3 | Chief Executive Officer (CEO)               |
|           |                                    |                  |                             | Interviewee 4 | Financial and Accounting Department Manager |
| Company 3 | Veterinary Pharmaceutical Industry | 53               | 26 – 26,5                   | Interviewee 5 | Minor Partner and Product Manager           |
|           |                                    |                  |                             | Interviewee 6 | Owner and CEO                               |

Table 1 - Summary of companies and interviewees

## 4.2 Data Sources and Analytical Techniques

Across the three companies, internal data were reported as the primary basis for decision-making. In the accounting firm, the information largely originates from clients and partners and is usually received in structured and organised form. As noted by one participant, *“We mainly use internal data. We make the most of the information we can get from ourselves, from clients, and from partners. Normally, the data already come well organised and prepared, which makes the work much easier”*

(Interviewee 1). A similar view was expressed by another: *“The data we use are almost all internal: client data, our invoicing, the number of clients we have. It’s practically all internal and well structured”* (Interviewee 2).

In the dental retail company, the ERP system is the core source of information, centralising data on invoicing, stock and clients. The CEO explained, *“Our main source of data is the ERP we use, which is SAGE. That’s where all the information is, about invoicing, clients, products, stock, everything. The data are structured and organised, which makes our work much easier”* (Interviewee 3). Another participant added, *“The main source of data would be the internal data extracted from our database, from our ERP platform, where we can see all the necessary information about products, clients, regions, invoicing, etc.”* (Interviewee 4).

The pharmaceutical company shows greater diversity, combining internal ERP data with external sources, particularly in the context of e-commerce. As explained, *“The company’s data sources are diverse, both internal and external. (...) We also have all the data regarding producers, all computerised, as well as the e-commerce data. It is a consolidated database”* (Interviewee 6).

As for techniques, descriptive analysis was predominant. In the accounting firm, the approach is still simple, relying mostly on Excel: *“Everything is still very simple. We work everything in Excel, customised to our needs”* (Interviewee 1). The same was confirmed by another respondent: *“Here we mostly use Excel to analyse data”* (Interviewee 2).

In the dental retail company, descriptive methods dominate, but some attempts at predictive analysis were also mentioned: *“In terms of descriptive analyses, we monitor monthly sales performance for each product category. Then we do predictive analysis based on purchase histories, seasonally, and in that way, we can anticipate periods where demand for certain products will be higher”* (Interviewee 4).

### 4.3 Analytical Tools and Software

Excel was identified as the dominant tool in all companies, reaffirming its role as a basic but central resource for handling data. As one participant stated, *“At the moment it’s still quite basic. We mainly use Excel for analyses. We tried Power BI, but it hasn’t been fully implemented yet”* (Interviewee 3).

In the pharmaceutical company, however, the introduction of complementary tools is underway. As described, *“The tools used in the company are mostly Excel, but also Power BI, for which we are now receiving some training. And we are implementing a CRM, Salesforce, which will also help us to carry out more specific and detailed analyses of clients and suppliers”* (Interviewee 5). The other participant added that this new system will significantly increase efficiency: *“The CRM will allow us to do something that could take 15 or 20 minutes in just a few seconds, and therefore the analysis will now be carried out centrally through that platform”* (Interviewee 6).

Some respondents also mentioned the occasional use of AI applications, such as ChatGPT, to support specific tasks: *“We also use platforms such as ChatGPT and others to improve our work”* (Interviewee 2).

### 4.4 Internal Organisation and Data-Driven Culture

The way data are managed and shared varies according to company structure. In smaller organisations, the responsibility lies mostly with managers and team leaders. As one CEO explained, *“It’s me, as CEO, and the accounting area who deal most with the data. But these data are then shared among departments”* (Interviewee 3).

In the pharmaceutical company, however, data circulate more widely and are integrated into the organisational workflow: *“Our data are shared between departments. (...) They must be shared, they are and have to be shared. There is sharing across all departments: purchasing, commercial, accounting, marketing, and also administration”* (Interviewee 5).

The organisational culture also reveals different levels of maturity. In the accounting firm, the process is still at an early stage: *“To be honest, there is not yet a true data-driven culture. It’s a topic that has been discussed, but in practice not much is being done with it”* (Interviewee 1). Another interviewee emphasised the openness of the team, linked to its relatively young average age: *“We have a young average age, around 35 years, so there’s no resistance to adopting new strategies and ways of working. Everyone is oriented towards improvement and accepts new tools well”* (Interviewee 2).

In the dental retail company, the culture is still being built: *“It doesn’t fully exist yet. We are working for it to exist. We already use some data, but I can’t yet say that we have a true data-driven culture”* (Interviewee 3). In contrast, in the pharmaceutical company, the culture is already deeply embedded: *“There is a data-driven and digital culture in the company. It’s something that has been at the root of the company and its employees for several years”* (Interviewee 6).

## 4.5 Use of Data in Decision-Making and Key Performance Indicators (KPIs)

All participants acknowledged the relevance of data in supporting both strategic and operational decisions. As explained in the accounting firm, *“We always try to use the information we have to make future decisions, based on past analysis”* (Interviewee 1). In the dental retail company, data are used to guide

marketing efforts: *“We identified which months had the lowest turnover in 2024 and, with that, we started preparing campaigns and marketing actions so that in 2025 those months perform better”* (Interviewee 3). In the pharmaceutical company, data influenced structural decisions: *“We decided to acquire a warehouse because we saw that the company no longer had the capacity to meet the volume of purchases and sales”* (Interviewee 6).

The indicators most frequently used are financial: turnover growth, gross margin, number of clients, and profitability. One respondent emphasised that *“the main one is the growth and evolution of turnover, as well as the number of clients and potential clients”* (Interviewee 1). Another highlighted monitoring of margins and sales (Interviewee 4), while in the pharmaceutical company non-financial indicators were also monitored: *“Errors and complaints caused by mistakes in an order or its destination are verified and analysed”* (Interviewee 6).

## 4.6 Challenges and Barriers

Although the advantages of data use were clear, the interviews revealed several challenges that limit the implementation of more advanced analytical practices. Time was the most frequently mentioned barrier, particularly in smaller companies where day-to-day management consumes the majority of resources. As one interviewee put it, *“For me, the biggest barrier is really time. It’s not so much technical, financial, or cultural. It’s the lack of time to implement more and work more with information”* (Interviewee 1). In the pharmaceutical company, despite higher digital maturity, the scale of operations introduces another constraint: *“The big difficulty is having enough people and a growing workload that puts more pressure on each employee”* (Interviewee 6).

A lack of specialised human resources was also a recurring theme. In smaller organisations, there is often no dedicated role for data analysis, leaving responsibility to managers or accountants already burdened with other tasks. As one participant noted, *“It would be important to have someone dealing only with this part of the analysis, but we don’t have that person, and that ends up being a limitation”* (Interviewee 4).

Financial limitations further restrict the adoption of new technologies. As expressed by one respondent, *“The biggest barrier is financial, because we know that implementing technology has a cost”* (Interviewee 2). Investments in software and external consultancy require careful consideration, particularly in companies with smaller margins.

Cultural resistance was also mentioned, particularly among older employees less accustomed to digital tools: *“There is still some resistance, mainly from older people, who are not so used to working with new platforms”* (Interviewee 1). Nonetheless, this form of resistance appeared limited in scope and impact, as most employees, particularly in younger teams, showed openness to adopting new technologies and data-driven practices.

Despite these constraints, each company tried to deal with its challenges through practical and context-based actions. In the accounting company, the lack of time and financial resources was managed by simplifying processes and using adaptable Excel templates to make reporting tasks more efficient. The dental retail company, limited by a small team and restricted budgets, followed a gradual approach to technology adoption, making the most of its ERP platform and occasionally relying on external consultants to improve analytical work. In the veterinary pharmaceutical company, where the main difficulties were related to scale and workload, the introduction of Power BI and CRM systems aimed to improve coordination, reduce manual tasks and increase overall efficiency. These efforts show that, although the level of analytical maturity differs, all three firms

are taking concrete steps to overcome their limitations and to progress towards more data-driven operations.

## 4.7 Interventions and Future Directions

To overcome these obstacles, the interviewees suggested training initiatives and the use of external consultancy. As one participant argued, *“The main recommendation is to invest in training. It is the only way to gain the skills necessary to deal better with data”* (Interviewee 4). Another highlighted the importance of external support: *“Ideally, it would be to have someone internal, like an IT engineer or programmer, but since that is very expensive, it ends up being more advantageous to hire external services”* (Interviewee 2).

AI was described as an almost inevitable path. Some companies are already experimenting with AI-based tools: *“We already use artificial intelligence. We have robots that automate manual tasks, saving employees’ time. We also use platforms like ChatGPT. We believe that those who don’t embrace AI will eventually be left behind”* (Interviewee 2). Other participants mentioned projects under development, such as client chatbots (Interviewee 5), and some emphasised the competitive risk of inaction: *“Companies that do not implement artificial intelligence in their business may end up being pushed out of the economic landscape”* (Interviewee 6).

## 4.8 Perceived Benefits and Outcomes of BDA Use

Overall, the interviewees acknowledged that the use of BDA generates significant benefits for their organisations, particularly in terms of efficiency, error reduction and more informed decision-making.

In the third company, one of the administrators summarised these advantages by stating: *“The advantages are: greater speed, fewer errors, lower costs, more profitability”* (Interviewee 6). Along the same lines, another manager emphasised that data analysis makes it possible to *“draw the appropriate conclusions and adjust the strategy (...) and to detect errors more quickly and act on them”* (Interviewee 5).

In the other companies, participants also highlighted tangible benefits, though on a smaller scale. As one respondent explained, *“It allows us to understand, for example, the periods of greater or lesser demand, and in this way we can better prepare stock and sales”* (Interviewee 4).

Overall, the results presented illustrate the varying levels of analytical maturity and cultural readiness among Portuguese SMEs. These insights provide a foundation for interpreting how organisational characteristics, resources, and attitudes shape the process of adopting and using BDA. The next chapter discusses these findings in light of the theoretical perspectives outlined earlier, drawing connections between empirical evidence and existing literature.

## 5. Discussion of Results

This chapter discusses the results obtained from the interviews carried out with three Portuguese SMEs and relates them to the theoretical contributions presented in the literature review. The aim is to understand how these organisations are adopting and using BDA and to identify the factors influencing the implementation process, the main barriers, and the benefits achieved.

### 5.1 Contextual Overview

The findings reveal differing degrees of maturity in the adoption of BDA among Portuguese SMEs. In smaller firms, such as those in accounting and dental retail, BDA remains at an early stage, restricted mainly to descriptive analyses performed in Excel. In larger organisations, such as the veterinary pharmaceutical company, a more advanced level is evident, involving integrated ERP systems, Power BI and CRM (Salesforce), together with an organisational culture oriented towards data-driven decision-making.

This diversity supports what Santos (2023) and Durão et al. (2019) identified regarding the generally low rate of BDA adoption in Portugal, largely explained by differences in resources, size, and sector. As stated by Gupta and George (2016), the ability to adopt such technologies is strongly related to the availability of skilled human capital and suitable technological infrastructures.

The data used by the companies are mainly internal, drawn from ERP systems and accounting databases. Only a few organisations employ external information, for instance from e-commerce activity or partnerships, confirming the observations of Davenport, Barth and Bean (2012) and Gandomi and Haider

(2015), who emphasise the dominance of structured data in the early phases of adoption.

Descriptive analysis is the prevailing approach, aimed at understanding the evolution of financial and performance indicators. Some firms, however, are already developing predictive analyses such as demand forecasting and stock management. These practices are consistent with Tiwari, Wee and Daryanto (2018) and McAfee and Brynjolfsson (2012), who describe such progress as a natural stage in analytical development. Although prescriptive analysis remains limited, awareness of its potential shows a learning trajectory and continuous development.

Overall, Portuguese SMEs appear to be in a gradual process of adopting BDA, in line with the literature portraying analytical maturity as an evolutionary path dependent on resources, skills, and strategic vision (Popovič et al., 2018; Fosso Wamba et al., 2015).

## 5.2 Main Challenges Identified

The adoption of BDA in Portuguese SMEs is shaped by a combination of technological and organisational factors.

Technologically, the tools most frequently used are Excel and, at more advanced stages, Power BI and Salesforce. Choosing low-cost tools reflects a pragmatic adaptation to available resources, confirming Coleman et al. (2016) and Horváth and Szabó (2019), who describe this as typical of SMEs with limited investment capacity.

The lack of robust technological infrastructures and the poor interoperability of systems remain major challenges. Several firms rely on isolated, non-integrated software, which echoes Alharthi, Krotov and Bowman (2017) and

Yaqoob et al. (2016), who underline modernisation as a cornerstone of digital transformation. The gradual implementation of Business Intelligence tools in more digitalised enterprises shows positive progress and confirms the trend highlighted by Mahmoudian et al. (2023), whereby investment in analytical platforms represents a decisive step towards digital maturity.

On the organisational side, culture and leadership emerge as decisive elements. Younger firms or those with lower average employee age show greater acceptance of analytical technologies, reinforcing the role of innovation culture and openness to change emphasised by Gupta and George (2016) and Fosso Wamba et al. (2015). Conversely, in organisations with older staff profiles, some resistance to digitalisation and to systematic data use persists, as noted by Horváth and Szabó (2019).

Leadership and the involvement of senior management are also key. Cintrão (2022) stresses the importance of strategic orientation for successful adoption, which the cases analysed confirm: where executives actively support data-driven initiatives, digitalisation efforts are more consistent. The literature further highlights the relevance of data governance and interdepartmental information-sharing (Popovič et al., 2018), features likewise evident in companies fostering cross-department collaboration.

These findings suggest that the success of BDA relies not only on technological infrastructure but also on human and cultural capacity. Digital transformation is therefore both a technical and social process, demanding vision, leadership and an organisational culture aligned with evidence-based decision-making.

### 5.3 Barriers and Organisational Responses

The main barriers to BDA adoption in Portuguese SMEs mirror the constraints widely reported in the literature. Time scarcity is recurrent: day-to-day demands absorb available capacity and leave little room for experimenting with new analytical practices, an issue also noted by Moktadir et al. (2019).

A further limitation is the shortage of specialised personnel in data analysis, which restricts the development of internal solutions. This aligns with Gupta and George (2016) and Coleman et al. (2016), who associate the lack of qualified human capital with a structural impediment in SMEs. As a practical response, some firms resort to external consultancy. Nonetheless, this is recognised as a temporary arrangement that does not replace building in-house capabilities.

Financial constraints are equally significant. The investment required to implement Business Intelligence systems, modernise infrastructures or hire specialists is perceived as substantial relative to company size. Horváth and Szabó (2019) and Yaqoob et al. (2016) point out that, without external incentives or public support, SMEs tend to postpone digitalisation.

Despite these limitations, several mitigation strategies are apparent and consistent with theoretical guidance. Training and upskilling are the measures most frequently mentioned, in line with Coleman et al. (2016) and Santos et al. (2023), who identify capacity building as a catalyst for organisational change. The promotion of a data-driven culture, supported by active leadership and clear internal communication, is also a priority, reinforcing the role of organisational culture highlighted by Cintrão (2022).

Some companies adopt an incremental integration of tools, opting for simpler, accessible solutions before moving to more complex systems. This prudent, experimental approach confirms the observations of Durão et al. (2019) about the cautious nature of technological adoption among Portuguese SMEs.

In short, while the barriers reveal structural weaknesses, the strategies in place show growing adaptation and continuous learning, signalling steady movement towards analytical maturity.

## 5.4 Benefits and Outcomes

Despite the constraints, the interviews point to tangible gains from using BDA, particularly in operational efficiency, error reduction and higher-quality decision-making. These outcomes are consistent with McAfee and Brynjolfsson (2012), Davenport et al. (2012) and Kache and Seuring (2017), who document productivity improvements and competitive advantage when data are used strategically.

BDA also supports anticipation of trends and opportunity identification, especially through the analysis of sales patterns and customer behaviour. This is in line with Santoro et al. (2025) and Schönberger (2023), who describe the role of analytics in tailoring offers and forecasting market needs.

Another important effect is the strengthening of confidence in managerial decisions. In firms where analytical tools are used more frequently, decisions are faster and better substantiated, echoing Popovič et al. (2018) and Ferraris et al. (2019) on the link between data and strategy. Among more mature organisations, BDA is viewed as a core management foundation, which corresponds to the positions of Gandomi and Haider (2015) and Brown, Chui and Manyika (2011).

The progressive integration of AI solutions is regarded as the next step in analytical evolution, reflecting the broader trend described by Tawil et al. (2024) and Mohamed et al. (2024). Although still at an early stage, applications such as chatbots, task automation and analytical support are seen as inevitable for enhancing competitiveness and optimising processes.

In summary, the study highlights both the promise and the limitations of BDA adoption among Portuguese SMEs. While the benefits are tangible and increasingly recognised, full integration will require continued investment in skills, infrastructure and leadership commitment. These findings not only deepen understanding of digital transformation within SMEs but also offer practical guidance for policymakers and business leaders seeking to foster data-driven innovation in Portugal.

## 5.5 Practical and Policy Recommendations

Building on the barriers identified throughout this study, several practical measures can be proposed to facilitate the wider adoption of BDA among Portuguese SMEs. These recommendations operate at both the organisational and policy levels, combining internal capacity-building with supportive public strategies.

| <i>Level</i>                                             | <i>Recommendations</i>                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>Organisational<br/>(SMEs)</i></b>                  | Prioritise digital training and upskilling to strengthen analytical competences; promote a data-driven organisational culture; adopt affordable analytical tools such as Power BI or other cloud-based platforms; establish partnerships with universities and technology providers for knowledge exchange; and implement analytics gradually through small-scale pilot projects before large-scale expansion.                         |
| <b><i>Policy<br/>(Government /<br/>Institutions)</i></b> | Provide fiscal incentives, innovation vouchers and targeted funding to support SMEs in acquiring analytical technologies and specialised training; promote collaboration between SMEs and research centres; strengthen regional digital innovation hubs; and expand public training programmes to develop digital and analytical skills nationwide ( <i>see also European Investment Bank, 2019; Geneva Internet Platform, n.d.</i> ). |

Table 2 - Practical and policy recommendations for BDA adoption among Portuguese SMEs

Recent European and national initiatives reinforce the relevance of these measures. The European Investment Bank (2019) highlights that public support for Portuguese SMEs already encompasses *“a number of public initiatives and financial instruments ... including financial support, tax incentives and HR qualification programmes”*, which aim to enhance their digitalisation capacity. Similarly, the Portugal Digital Mission Structure identifies *“Supporting SMEs by providing tools and resources to help SMEs adopt digital technologies”* as a central pillar of the national digital transformation strategy (Geneva Internet Platform, n.d.; Presidência do Conselho de Ministros, 2020). These frameworks demonstrate the alignment between public policy and organisational action in promoting a more digitally mature economy.

Together, these recommendations address the main barriers identified in this study and suggest practical steps for bridging the gap between strategic intent and operational capability. By strengthening human capital, promoting collaboration across sectors and expanding access to analytical technologies, Portuguese SMEs can accelerate their transition towards a more data-driven and competitive business environment.

## 6. Conclusion

### 6.1 Summary of Findings

This study explored how Portuguese SMEs are adopting and using BDA and the factors that influence this process. The findings show that adoption is still in an early phase. Most companies rely mainly on simple, descriptive analysis supported by tools such as Excel, while only a few have begun to integrate more advanced platforms like Power BI or CRM systems. These first steps demonstrate a gradual move towards analytical maturity but also highlight the need for stronger investment in technology, skills and organisational change.

The research reveals that the adoption of BDA depends not only on technical readiness but also on people and culture. Leadership, openness to innovation and a willingness to base decisions on evidence emerge as central drivers of progress. Firms that display these traits are better positioned to embed analytics in their daily work. This supports earlier studies that underline the importance of leadership and cultural readiness for successful digital transformation (Gupta & George, 2016; Fosso Wamba et al., 2015; Cintrão, 2022).

Barriers identified in the study are consistent with those described in the literature. Financial limitations, lack of internal expertise and resistance to change continue to be the most common challenges (Coleman et al., 2016; Horváth & Szabó, 2019). Many firms do not have specialised staff who can interpret data and extract meaningful insights. As a result, they depend on external support or rely on simple tools, which provide some help but rarely lead to full integration of analytics into decision-making.

Even so, awareness of the value of data-driven management is clearly increasing. The companies analysed have recognised that using data helps to improve efficiency, speed up decisions and enhance accuracy. They also see data

as a source of innovation and competitive advantage. Although the level of adoption remains modest, the findings confirm that analytics can bring tangible benefits when aligned with business goals and supported by leadership commitment.

## 6.2 Limitations of the Study

This research has several limitations that should be taken into account when interpreting its results. The study included only three companies and six participants, which naturally limits the possibility of drawing broad generalisations. Although the selected firms operate in different sectors, they are all located in the Trás-os-Montes region, so the conclusions may not reflect the full range of experiences across Portugal. Therefore, the insights presented here should be interpreted within their specific regional and organisational context. Extending the research to other regions and industries could provide a more complete picture of national patterns of analytical adoption.

The qualitative design used in this study, while valuable for capturing detailed perspectives, relies on the participants own accounts, which may contain subjective interpretations. Their views could have been influenced by personal experience or company context. Despite careful data collection and analysis, qualitative research always involves some degree of interpretation by the researcher.

In addition, the technological environment surrounding BDA is changing rapidly. The interviews represent a snapshot of a specific period, and future developments in technology, policy or market conditions could alter the challenges and opportunities described here.

## 6.3 Recommendations for Future Research

Further studies could build on these findings by expanding the sample to include a wider range of Portuguese companies from different sectors and regions. Comparing firms with different levels of digital maturity could reveal how adoption evolves under diverse conditions and what factors accelerate or delay progress.

Future research might also combine qualitative and quantitative approaches. Larger surveys could test the patterns observed in this work and measure how common certain barriers or benefits are among Portuguese enterprises. Using both approaches would make it possible to keep the contextual depth of qualitative data while increasing reliability and scope.

It would be valuable as well to investigate how new technologies such as AI and Machine Learning are shaping analytical practices in smaller businesses. Understanding how these tools interact with culture, leadership and human capital could provide insight into the next stage of data-driven transformation.

Finally, longitudinal studies could follow companies over time to trace how they progress from basic to advanced analytical stages and how external factors such as public policy or collaboration with universities influence that journey. Tracking these developments would help explain the long-term effects of digital transformation on business competitiveness and sustainability.



# AI Generative Declaration

During the preparation of my written thesis, “The Adoption of Big Data Analytics in Portuguese SMEs: Drivers, Barriers and Organisational Implications”, ChatGPT was used for the following tasks: to improve grammar, clarity and academic tone; for checking internal coherence between sections; for assisting in identifying and summarising relevant findings from academic literature; to provide accurate translations to English, with the prompts used listed at the end of the document in the Prompts List section. After using this tool/service, I reviewed and edited the content as necessary, and I take full responsibility for the content of the work presented.

I also declare that I am aware of and respect the Artificial Intelligence Rules of Conduct of Católica Porto Business School.



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# Appendices

## Appendix 1 – Interview Guide

The following interview guide is presented in its original language (Portuguese), as the interviews were conducted with Portuguese companies. This ensures that the meaning and context of the questions are preserved.

1. Qual é o core business da empresa e qual a sua dimensão em termos de colaboradores e operações/volume de negócios?
2. Qual o seu papel na empresa e o seu background?
3. Quais as principais fontes de dados utilizadas pela empresa? São dados internos, externos, estruturados ou não estruturados?
4. Que técnicas analíticas são utilizadas na empresa? Por exemplo, machine learning, análise estatística, ...? (Gandomi & Haider, 2015; Yaqoob et al., 2016)
5. Que tipo de análise é feita depois de recolher os dados? Pode dar exemplos de casos concretos em que aplicaram análises descritivas, preditivas ou prescritivas? (Sivarajah et al., 2017; Tiwari et al., 2018)
6. Que tipo de ferramentas analíticas é utilizado na empresa? (Ex: Power BI, Python, R, ...) (Mahmoudian et al., 2023)
7. Relativamente às pessoas que trabalham com os dados, que atividades desempenham e em que departamento? Os dados são partilhados e integrados entre departamentos? (Fosso Wamba et al., 2015)
8. Acredita que existe uma cultura orientada para os dados na empresa? Que fatores contribuíram para possibilitar ou dificultar esta cultura? E o que poderia ser melhorado? (Fosso Wamba et al., 2015)
9. Utiliza a informação retirada da análise dos dados no processo de tomada de decisões? E de que forma? (Gupta & George, 2016)

10. Até que ponto as conclusões geradas através da aplicação de tecnologias BDA afetam os processos de tomada de decisão organizacional? (Gandomi & Haider, 2015; Gupta & George, 2016)
11. Quais os indicadores (KPIs) usados para avaliar se os projetos de BDA atingiram os seus objetivos?
12. Qual é o papel da cultura organizacional na implementação eficaz do Big Data Analytics? Quais são os desafios culturais mais comuns? (Fosso Wamba et al, 2015)
13. Quais as vantagens associadas à implementação de BDA na empresa? (Davenport et al., 2012; Kache & Seuring, 2017; Mcafee & Brynjolfsson, 2012; Tiwari et al. 2018)
14. Quais as principais barreiras à implementação de BDA na empresa? (técnicas, financeiras, culturais) (Coleman et al., 2016; Fosso Wamba et al., 2015; Kache & Seuring, 2017; Mahmoudian et al., 2023)
15. Que recomendações daria para ultrapassar este tipo de barreiras? (Coleman et al., 2016; Popovič et al., 2018)
16. A empresa considera a utilização de IA como um próximo passo na evolução do uso de dados?
17. No contexto destas questões, gostaria de acrescentar algo?

## Appendix 2 – Interviews

The interview transcripts are available in the following shared folder. The interviews were conducted in Portuguese and are therefore presented in their original language.

Link to shared folder: [Entrevistas](#)

## Appendix 3 – Summary Table of Analytical Maturity Levels

The Excel file available in the following shared folder contains a summary table comparing the different levels of analytical maturity across the participating companies.

Link to shared folder: [Quadro Resumo](#)

## Prompts list

“Improve the academic tone and clarity of the following paragraph.”

“Review the text below for grammar and style consistency across chapters.”

“Summarise the main findings of this article related to Big Data Analytics.”

“Check the coherence and logical flow between these sections of the thesis.”

“Translate the following section into English maintaining an academic and natural tone.”