

Potentials and Barriers of Using Big Data in Austrian SMEs

Walter Rath, Berndt Jesenko, Harris Gerzic

CAMPUS 02, University of Applied Sciences

Department IT & Business Informatics

Koerblergasse 126, 8010 Graz, Austria

walter.rath@lv.campus02.at, {berndt.jesenko,harris.gerzic}@campus02.at

Abstract. *This study explores the potentials and barriers of implementing Big Data in Austrian Small and Medium-sized Enterprises (SMEs). Based on expert interviews and qualitative content analysis, it reveals key opportunities such as improved efficiency, data-driven decision-making, and regulatory compliance. However, challenges remain in technological integration, financial resources, legal issues, and organizational change. The study offers practical recommendations and highlights the need for further research, contributing to a better understanding of Big Data as a strategic tool for strengthening SME competitiveness.*

Keywords. Big Data, SMEs, potentials, barriers, qualitative content analysis

1 Introduction

Big Data refers to an ever-growing, diverse, and dynamic volume of data that can hardly be managed using traditional data processing systems (Furht & Villanustre, 2016: 3; Zikopoulos et al., 2012: 10). Originally defined by the three dimensions of volume, variety, and velocity, the dimensions of value and veracity have since been added to better capture the potential benefits and data quality (Meier, 2017: 6–7). The challenges range from processing unstructured data in real time, to integration issues, and legal concerns such as data protection (Gadatsch & Landrock, 2017: 6; Furht & Villanustre, 2016: 5–6). Vossen et al. (2015: 3–4) distinguish four core perspectives for examining Big Data: technological, organizational, legal, and economic dimensions.

In both academic and business practice, Big Data is increasingly regarded as a strategic success factor—particularly with regard to data-driven innovation, automation potential, and improved decision-making. While large enterprises have already explored a variety of application scenarios, SMEs often face particular challenges: limited human, financial, and technical resources meet high demands for data literacy, data protection compliance, and infrastructure. At the same time, SMEs could benefit disproportionately from

data-driven approaches—such as through more efficient processes, personalized customer engagement, or new business models.

Against this backdrop, the question of how Big Data can be successfully implemented in SMEs is gaining considerable relevance. Identifying industry-specific potentials and practical barriers is a key prerequisite for developing and sustainably implementing data-driven strategies. Focusing on Austrian SMEs also makes it possible to take country-specific conditions—such as regulatory requirements, digital infrastructure, or funding landscapes—into account. The Research Question reads as follows:

“What potentials and barriers does the implementation of Big Data present for Austrian SMEs?”

This study examines the opportunities and barriers associated with the use of Big Data in Austrian SMEs. The objective is to derive practical recommendations through a systematic analysis that supports the successful adoption and utilization of Big Data. In addition to theoretical insights, practical experiences are incorporated to comprehensively capture the potential of Big Data for SMEs and to outline future strategic directions.

2 Background

The Big Data flow describes the entire process from data collection to the delivery of actionable insights. According to Furht & Villanustre (2015: 5), it comprises six key phases: collection, ingestion, cleansing, integration, analysis, and delivery. This workflow forms the backbone of data-driven applications and supports companies in effectively utilizing their data resources.

Data has become a key strategic resource today (Fasel & Meier, 2016: 13–15). Well-structured data management involves an appropriate data architecture, modern database systems such as NoSQL (e.g., MongoDB, Cassandra), and powerful analytical methods. NoSQL systems are optimized for large, distributed, and flexible data sets (Zomaya & Sakr, 2017: 17), while Hadoop enables distributed

processing across clusters using the MapReduce approach (Klein et al., 2013: 322).

The CAP theorem (Brewer, 2002) outlines a fundamental dilemma of distributed systems: consistency, availability, and partition tolerance cannot all be fully guaranteed at the same time (Meier, 2017: 13–14). For Big Data infrastructures, it is essential to consciously manage these trade-offs.

Big Data Analytics (BDA) extends traditional data analysis by incorporating various analytical approaches:

- Descriptive analytics answers: What has happened?
- Diagnostic analytics explains: Why did it happen?
- Real-time analytics reveals: What is happening right now?
- Predictive analytics forecasts: What could happen?
- Prescriptive analytics recommends: What should be done? (Dorschel, 2015; Schön, 2018)

These approaches enable companies to make data-driven decisions at different levels of complexity and to act more strategically.

BDA offers a wide range of opportunities, especially for SMEs. Due to their agility and flatter hierarchies, they are able to implement data-driven business models more quickly (Maroufkhani et al., 2023). In marketing, for example, customer interactions can be analyzed to create precisely tailored, individualized offers (Berger et al., 2014: 46). In production, the analysis of machine data leads to greater efficiency and quality, while in research and development, innovation cycles can be shortened (BITKOM, 2012: 37). BDA also provides valuable decision-making foundations and forecasting capabilities in logistics and management (Mantri & Mishra, 2023: 11).

Despite the potential, numerous barriers remain. From a technological perspective, poor data quality, limited data access, and interface integration issues complicate implementation (Sharma et al., 2021: 2). On the organizational level, unclear responsibilities, a lack of strategic planning, and low acceptance hinder progress (Alaimo et al., 2020).

Data protection presents a particular challenge in the SME context—the General Data Protection Regulation (GDPR) requires transparent processes, data security, and, where applicable, the anonymization of sensitive data (Karaboga, 2022: 277). Another significant obstacle is the shortage of skilled professionals in data analysis and IT—especially for smaller companies with limited resources (Maroufkhani et al., 2023).

Emerging technological advancements offer new opportunities for SMEs:

- Artificial Intelligence enhances analysis speed and decision-making (Aggarwal et al., 2021).
- Edge Computing brings data processing closer to the source—ideal for IoT and manufacturing (Satyanarayanan, 2017).

- Blockchain ensures data security and traceability (Hellani et al., 2021).
- Quantum Computing will enable the resolution of highly complex problems in the long term (Montanaro, 2016).
- Privacy-Enhancing Technologies (PETs) such as Federated Learning or Differential Privacy allow for data protection-compliant analyses (Shokri & Shmatikov, 2015).

These trends illustrate that BDA is not just a tool for process optimization in SMEs, but remains a key driver of innovation and competitiveness.

3 SMEs in Austria in the Context of Big Data

According to the EU definition, SMEs are classified as enterprises with fewer than 250 employees and either an annual turnover of up to 50 million euros or a balance sheet total of up to 43 million euros (EU Commission 2003/361/EC). This definition is also applied in Austria and, to a large extent, in Switzerland. Typical characteristics of SMEs include close personal management, low formalization, high flexibility, and strong customer proximity (Mugler, 2008: 31–32).

Compared to large enterprises, SMEs differ not only in size and revenue but also in structure, management, financing, and organization (Pfohl, 2013). SMEs often operate with flat hierarchies, short decision-making paths, and personalized market approaches—factors that provide agility on the one hand, but also imply limited resources on the other.

Economic Influence. SMEs account for approximately 99% of all businesses in the DACH region and are responsible for over 60% of total employment. In Austria, they contribute around two-thirds of total employment and play a crucial role in economic performance and innovation capacity (Pfohl, 2013: 49; Mugler, 2008: 43).

Areas of Application for Big Data. Big Data offers SMEs opportunities for increased efficiency, customization, and process improvement across many areas (Dorschel, 2015: 104). In marketing, it enables precise customer segmentation, targeted campaigns, and personalized offerings (BITKOM, 2012: 36). In research and development, Big Data shortens innovation cycles through faster data analysis and idea validation (BITKOM, 2012: 37). In production and logistics, it supports process optimization and predictive maintenance. In the financial sector, Big Data enables scenario planning, fraud detection, and real-time analysis. In IT, it enhances security, performance, and resource efficiency.

Use in SMEs. Despite its great potential, the use of Big Data in SMEs remains limited. Reasons include the lack of IT infrastructure, limited human resources, and the assumption that Big Data is only relevant for large enterprises (Wang et al., 2016: 11). Many SMEs also

underestimate the value of their own data. Nevertheless, it is evident that data-driven solutions can significantly enhance efficiency, innovation capacity, and competitive position even for smaller companies.

Status Quo. According to Deloitte (2014), 87% of the surveyed SMEs expect a significant increase in data volume. Nevertheless, according to Seufert (2014), only 15% have gained practical experience with Big Data. The Data4KMU study (2021) shows that while many companies recognize the importance of Big Data, they have yet to develop concrete strategies. There is a clear need to catch up in the implementation of data-driven approaches.

Opportunities and Potential. Big Data can enhance the innovative capacity, productivity, and customer loyalty of SMEs (Hung, 2016; Markl et al., 2013). Integrating it into existing systems such as ERP solutions or leveraging external data sources (e.g., social media) can lead to new insights and business models (Gadatsch & Landrock, 2017: 14). Predictive analytics enables early market responses, and data-driven decisions improve the quality of strategic actions (BITKOM, 2012: 14).

Barriers. Despite these opportunities, SMEs face numerous obstacles: lack of technical know-how, high costs, missing concepts, and a low sense of urgency are cited as the main barriers (Seufert, 2014; Data4KMU, 2021). Technological challenges such as data silos, data quality, or data protection, as well as organizational issues like change management, complicate implementation (Markl et al., 2013; Vossen et al., 2015).

Big Data and Privacy. Handling personal data is legally particularly sensitive. The EU General Data Protection Regulation (GDPR) requires transparent, secure, and legally compliant data processing (Article 6 GDPR). Companies must uphold user rights, protect sensitive data, and provide a lawful basis for data processing. Violations can result in reputational damage and substantial fines.

4 Methodology

To answer the research question, a qualitative, exploratory approach was chosen. The core basis consisted of semi-structured expert interviews guided by a predefined framework based on Big Data potentials and barriers identified in the literature. The four analytical categories—technical, organizational, economic, and legal—structured both the interview guide and the subsequent evaluation.

Interviews enable in-depth insights into individual experiences and company-specific conditions (Dresing & Pehl, 2018). The chosen semi-structured format allows for flexibility in the flow of conversation while ensuring comparability of responses (Bortz & Döring, 2006: 218). The 10 interviewees represent a diverse group of professionals in leadership and digitalization

roles across various industries. They include Chief Digital Officers, managing directors, and IT executives from sectors such as IT services, insurance, CAD software development, civil engineering, advertising, construction, water treatment, fitness, waste management, and the church sector. This range ensures insights from both traditional and digitally advanced industries.

The qualitative content analysis according to Mayring (2015) serves as the methodological framework for the systematic evaluation of the interviews. The content is categorized deductively along the four main dimensions, complemented by inductively developed subcategories. The approach includes defining units of analysis, developing a category system, and gradually reducing the material to extract key statements. The aim is a theory-driven and transparent interpretation of the interview data.

Based on the developed set of criteria, key potentials such as strategic advantages, process optimization, or customer retention were considered, along with typical barriers (e.g., data protection, lack of resources, or expertise) (Markl et al., 2013; King, 2014).

In addition, practical recommendations were derived from the literature. These include partnerships with Big Data providers, the use of existing process data, targeted training, and the standardization of legal templates to ensure data protection compliance (Gadatsch & Landrock, 2017). These recommendations were incorporated into the development of the interview guide and the discussion of results.

Finally, the author reflects on three key strategic questions from an SME perspective:

- (1) Where can Big Data be usefully applied within the company?
- (2) What internal prerequisites must be met?
- (3) What data is available, and how can it be processed?

5 Results

The qualitative content analysis reveals that Austrian SMEs exhibit widely varying levels of experience and development paths in dealing with Big Data. It becomes clear that the implementation and use of data-driven technologies are highly dependent on the specific industry, business objectives, and the available technical and human resources. While some companies are already strategically relying on data-driven decision-making processes, others are still in an exploratory or preparatory phase. The following sections summarize the key findings according to the categories “Industry-specific expertise,” “Company profile,” “Areas of application,” and “Potentials.”

Industry-Specific Expertise. The industry-specific nature of how Big Data is handled became particularly evident in the interviews. For example, in a church

organization, the entry into data processing began with the digitization of historical parish registers. The aim was not only to make administrative processes more efficient but also to create a basis for academic analysis. Although it is a rather traditional institution, it became clear that Big Data is also seen there as a tool for structural modernization.

In contrast, in the field of medical technology, Big Data technologies are already being used for advanced diagnostic processes. One company reported the targeted use of artificial intelligence for pattern recognition in medical data, which led to a significant improvement in diagnostic quality. Here, Big Data is not merely considered a supporting element but a central component of product development.

In the construction industry, the application is structured differently. A property developer described how external data sources are analyzed to better understand buyer profiles and to tailor real estate projects to specific target groups. The analysis helps to avoid poor investments and anticipate market developments at an early stage. In the advertising industry, on the other hand, an operational perspective dominates. Real-time analytics are used to immediately evaluate and control advertising campaigns. This ability for ongoing optimization is seen as essential for precisely addressing customer needs and minimizing waste coverage.

Concrete applications were also evident in the waste management sector. By integrating sensors to monitor container fill levels, more efficient route planning was achieved. This not only led to cost savings but also to improved customer satisfaction. Overall, it is clear that the level of expertise, industry-specific challenges, and objectives play a key role in determining how extensively Big Data has already been integrated.

Company Profile. The statements of the interviewees show that the use of Big Data varies not only by industry but also by individual company. In the real estate sector, for example, the strategic analysis of external data sources for better targeting was described as a key competitive advantage. By linking this data with existing customer information, it becomes possible to develop new projects more precisely and to improve market access efficiency.

In the advertising industry, the importance of real-time data was once again emphasized. The ability to immediately evaluate and optimize ongoing campaigns was, according to one respondent, critical to economic success. This involves not only technical performance but also the interpretation and evaluation of the collected data.

A company in the waste management sector highlighted how data-driven decisions contribute to resource efficiency. Automated systems have reduced the effort required for route planning while also improving the company's environmental footprint. In the medical technology sector, a strong focus on process optimization was also evident. AI-supported

applications enable continuous quality assurance in diagnostics and, according to the interviewee, are considered pioneering for the entire business model.

These examples demonstrate that Big Data contributes in various ways to improving efficiency, quality, or the achievement of strategic objectives—depending on the company's level of maturity and strategic focus.

Areas of Application

The range of possible Big Data applications in SMEs is as diverse as it is practical. This became particularly evident in the waste management sector, where sensor technology is used to monitor container fill levels in order to optimize route planning. This not only results in time and fuel savings but also improves service quality and the company's environmental footprint.

In the medical technology sector, the focus lies on analyzing medical data to enhance diagnostic accuracy. By identifying specific patterns, error rates were reduced and diagnoses became more precise, ultimately benefiting patient care. One interviewee emphasized that this technology will also play a key role in preventive approaches and personalized medicine in the future.

Even institutions such as churches are now recognizing the potential of data-driven strategies. By digitizing historical records, more targeted fundraising campaigns can be developed. The deliberate use of digital communication tools—based on existing data—significantly increases the effectiveness of such initiatives.

In the real estate sector, data-driven planning processes have also become established. The evaluation of external data sources makes it possible to identify demographic trends and market developments early on. As a result, projects can be tailored more precisely to target groups, which not only offers economic advantages but also enables more efficient use of resources.

In the advertising industry, real-time optimization is at the forefront. The ability to react immediately to changes in customer behavior not only improves the efficiency of marketing activities but also significantly strengthens customer loyalty.

The interviews demonstrate that Big Data is no longer merely a technical tool but is increasingly being seen as a strategic asset that can sustainably influence the competitiveness of small and medium-sized enterprises across almost every sector title.

6 Conclusion

This paper set out to explore the question: “What potentials and barriers does the implementation of Big Data present for Austrian SMEs?” The findings reveal that Big Data offers a wide range of strategic and operational opportunities for SMEs—such as improved efficiency, real-time decision-making, and

innovation potential—while also confronting them with substantial challenges in terms of infrastructure, data protection, and organizational readiness. The analysis of expert interviews across various industries showed that the degree of Big Data adoption varies significantly depending on sector, company size, and available resources. These insights formed the basis for the concrete technological, legal, and organizational recommendations presented in the previous chapter, which constitute the main contribution of this study to both research and practice.

From a technological perspective, SMEs are gaining new room to maneuver—through AI, cloud computing, or automated analytics. These technologies enable faster processing of large volumes of data and open up space for strategic decision-making. The advertising sector, for instance, uses tools like BigQuery for real-time campaign analysis, while construction companies perform external data comparisons for targeted audience planning. Economically, data-driven optimizations can make investments more efficient and demonstrably increase return on investment. From a legal standpoint, automated documentation, encrypted data storage, and GDPR-compliant systems offer new possibilities for ensuring regulatory standards. However, the legal framework remains a major challenge for many SMEs. In particularly sensitive fields such as medical technology or marketing, comprehensive compliance measures and regular audits are required. Finally, from an organizational perspective, it is evident that data-driven processes demand profound changes in corporate culture—both at the leadership level and among employees. Acceptance, training, and participative change management are essential success factors in this regard.

This paper provides valuable insights into the potentials and barriers of Big Data implementation in Austrian SMEs. However, the results must be viewed in light of certain methodological and conceptual limitations, which also offer starting points for further research and practical development. The qualitative content analysis is based on ten semi-structured interviews with experts from various industries. Despite the broad industry distribution, the generalizability of the findings is limited. Subjective assessments, varying interview styles, and the small sample size may influence the validity of the results. Additionally, the interviewees' statements are strongly shaped by individual experiences and organizational contexts—and thus cannot be easily transferred to all SMEs. Moreover, Big Data is a highly dynamic field that is subject to constant technological and regulatory changes. The tools, challenges, and solutions discussed in this paper reflect a specific point in time and require continuous updating. The focus on the Austrian context—with its specific legal, economic, and structural conditions—also limits the transferability of the findings to other countries or regions.

Despite these limitations, the paper opens up a variety of promising approaches for future research. A broader quantitative study with a larger sample could systematically capture patterns and correlations—for example, between Big Data usage and business success. Industry-specific analyses could also help develop more differentiated recommendations, such as for the healthcare, construction, or logistics sectors. Furthermore, longitudinal studies would be useful to observe technological and organizational developments over time and to identify sustainable success factors. Another line of research concerns the integration of new technologies such as AI, cloud, or edge computing into SMEs. Understanding how these tools can be adapted, scaled, and used economically is of high practical relevance. Interdisciplinary perspectives are also essential: the interplay between technological implementation, legal requirements, and human acceptance offers rich potential for economic, legal, and social science approaches. For practice, the paper leads to a clear conclusion: Big Data is not a passing technological trend but a strategic tool that can significantly shape the future viability of SMEs. The potentials range from more efficient resource utilization and optimized market analysis to compliance with regulatory requirements. At the same time, successful implementation requires structural adjustments, cultural change, investments in know-how, and a professional approach to data protection. SMEs should not view Big Data as an isolated IT project, but as part of a broader transformation process. Building technical infrastructure, establishing data governance, and training employees are not one-off tasks, but part of continuous strategic development. Only if technological, economic, legal, and cultural requirements are aligned can Big Data fully unfold its potential—as a key technology for innovation, efficiency, and competitiveness in the SME sector.

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