

Gordon Institute of Business Science

University of Pretoria

**Integrating Big Data Analytics (BDA) into the decision-making process to
enhance strategic agility in mining operations.**

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A research project submitted to the Gordon Institute of Business Science,
University of Pretoria, in partial fulfilment of the requirements for the degree of
Master of Business Administration.

3 November 2025

ABSTRACT

Due to the increasing complexity of mining operations, market volatility, and sustainability requirements, the need for agile and data-driven decision-making has arisen. Big Data Analytics (BDA) gives predictive insights and operational responsiveness that improve strategic agility. Although technological advancements have determined Big Data Analytics as a transformational tool, its incorporation into decision-making processes in the mining sector remains underexplored.

For this reason, this study explored the integration of Big Data Analytics (BDA) into decision-making processes to enhance strategic agility in South African mining operations, thus addressing a gap in empirical research on BDA adoption in the mining sector. The study adopted a qualitative exploratory design involving eighteen (18) semi-structured interviews with mining professionals involved with BDA and BDA experts (manufacturers/ developers) operating in the mining space.

A thematic analysis of the responses generated seven main themes: Leadership and governance, data readiness, proactive intelligence, operational excellence, data accessibility, people-centric approach and pragmatic implementation. Emerging as foundational enablers were leadership alignment and data quality. Results suggest that effective BDA adoption requires considerable support from top executives, the availability of an appropriate data architecture, ethical governance, and continuous stakeholder engagement. It enhances the theoretical understanding of the Resource-Based View (RBV) and the Technology-Organisation Environment (TOE) frameworks within the mining sector.

Further research is still needed to analyse the long-term impact of BDA on performance and to develop customised capability-building frameworks for other industries.

KEYWORDS

Big Data Analytics; Strategic Agility; Decision-Making

PLAGIARISM DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Jaqueline Raputsoe

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Date

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GLOSSARY

AI	Artificial Intelligence
BDA	Big Data Analytics
BDAC	Big Data Analytics Capabilities
BDAMC	Big Data Analytics Management Capabilities
DDD	Data-Driven Decision
DMRE	Department of Mineral Resources and Energy
ESG	Environmental Social and Governance
OEM	Original Equipment Manufacturer
RBV	Resource Based View
SA	Strategic Agility
TOE	Technology Organisation Environment
MHSA	Mine Health and Safety Act, Act 29 of 1996

1. CHAPTER 1: THE NEED FOR THE RESEARCH

1.1 Research problem

The study aimed to understand how integrating Big Data Analytics (BDA) into decision-making processes may improve strategic agility in mining operations.

The mining sector has to operate in an extremely dynamic environment due to the intensity of market volatilities and operational complexities, along with the rising sustainability requirements (Gruenhagen & Parker, 2020; Qi, 2020). Agile organisations have strategic agility that allows them to adapt to changes in their operating environment (Sarwar et al., 2025). A critical success factor for business operations has been to perceive, respond and adjust to changing situations quickly (Sarwar et al., 2025). Various industries have benefited from BDA because it enables organisations to act with agility, efficiency, and innovation by transforming enormous complex data into actionable insights. Successful organisations were found to be those that can respond to abrupt and unforeseen market shifts by adopting new technologies to enhance business competitiveness (Alyha et al., 2023). Such is relevant for mining.

The mining industry has had to face an increasingly difficult operating environment throughout the decades, which includes declining commodity prices and changes to the economic policy (Qi, 2020). Due to a growing list of environmental and social requirements, coupled with the need to improve production capacity at deeper deposits with lower grades of ore, the mining value chain must continually enhance its processes (Sanchez & Hartlieb, 2020). The mining sector has employed new technologies to overcome these challenges, incorporating automated and remotely controlled machine equipment and smart monitoring systems that collect and process data. There is a growing need for BDA to be incorporated into decision-making for improving strategic agility in mining operations (Sanchez & Hartlieb, 2020; Qi, 2020).

Miners have long been viewed as conservative when it comes to the acceptance of new technologies. Yet, when it comes to the adoption of BDA into the mining operations, this view is changing revealing how BDA integration into the mining sector will be both inevitable and necessary (Qi, 2020). Moreover, Mikalef et al.

(2021) and Sarwar et al. (2025) added that the incorporation of BDA in an organisation can enhance its dynamic agility, thereby leading to more effective operational efficiency and competitiveness, which is a necessity in mining operations given the increasing operational challenges in mining. Tackling these issues, the mining industry has started using new technologies, such as automated, remotely controlled machines, along with advanced data monitoring systems. However, it is often missing suitable frameworks to transform data into the needed outcome.

According to Mining Magazine Australia (2022), mining companies have invested in automation, cloud-based services and artificial intelligence to enhance the predictive capacities of their operations and monitor activities in real time. Due to a failure to interface with the mining operators' framework, a large amount of data has been produced. BDA is regarded as a tool to make sense of the vast data assisting firms to process the big data into meaningful information and transform it into strategic intelligence (Awan et al., 2021; Dubey et al., 2019). The smart intelligence improves the firm's decision-making by enhancing its speed and quality enabling the firms to make timely decisions in complex situations (Awan et al., 2021; Dubey et al., 2019). Abbasi et al. (2016) indicated that BDA helps in making informed decisions through empirical evidence. In addition to investing in BDA, firms must also invest in big data analytics capabilities (BDAC) to speed up insights generation and data understanding for strategic agility (Mikalef et al., 2019).

Based on the discussion above in the subject mining environment, which is constantly evolving, the focus of the study was on understanding how BDA integration into the decision-making process enables strategic agility in mining operations, as well as the organisational enablers and barriers influencing the process.

1.2 Purpose statement

The study aimed to investigate the key success factors for integrating big data analytics (BDA) into decision-making to enhance strategic agility in mining operations.

Organisations wishing to leverage extensive data for strategic decisions must identify critical success factors for big data analytics. Sarwar et al. (2025) described big data as information that is large, complex, precise, useful and rapid across a pool of databases. The BDA employs advanced algorithms for assessing and transforming the unstructured raw data into useful information, which helps businesses to support the strategic management processes (Sarwar et al., 2025; Xie et al., 2022). Big data architectures are networks formed by multiple devices along with processors and databases that generate and analyse big data. These architectures are needed for the effective use of the data (Rialti et al., 2019). Mining companies can generate value by leveraging this intelligence for better decision-making and enhanced strategic agility.

BDA represents the collection and analysis of various spectrums of data from direct and indirect sources. The direct sources include example such as satellite imagery, GPS and geo-scientific data. In the mining sector, indirect sources refer to the human aspect (safety and worker positions), the process (drilling, blasting, rail, dispatch and conveyors, etc) and asset condition (machine and equipment health) (Qi, 2020). When different data sources are integrated together, the mining operation improves decision-making, procedures become safer, workflows become optimised, predictive maintenance is facilitated, resulting in greater efficiency and output (Qi, 2020).

BDA has become a necessity to extract meaningful insights for decision-making (Awan et al., 2021; Dubey et al., 2019). In another study titled Enhancing Circularity Performance, BDA and BI&A were found to positively affect data-driven insights and decision-making and seen as a stronger predictor of quality decision-making (Awan et al., 2021). According to Müller et al. (2018) findings, data-driven decision-making (DDD) companies had output and productivity levels that were 5–6% above what was expected, given the company's level of investment and use of information technology.

However, despite BDA potential, numerous businesses constantly struggle to align analytics strategic intent because of cultural resistance, lack of analytical skills and fragmented governance (Talaoui et al., 2023). It was therefore the intent of this study to determine the critical success factors that may enable BDA integration.

1.3 Context

1.3.1 BDA

The volume of data generated across industries is at an all-time high as businesses seek ways to apply BDA to create value for their operations (Constantiou & Kallinikos, 2015; Mikalef et al., 2019). According to Mikalef et al. (2019), big data is an essential source of first-hand knowledge. Organisations that develop big data analytics capabilities (BDAC) have demonstrated the ability to enhance business efficiencies and stay abreast with economic and environmental changes. This leads to identifying operational bottlenecks and inefficiencies (Mikalef et al., 2019). Research studies have demonstrated the benefits BDA can have for operational performance and supply chains (Dubey et al., 2019). Sarwar et al. (2025) acknowledged big data analytics management capabilities (BDAMC) as an organisational capability for aligning its structure, business strategies, and information system strategies to proactively adapt to changes in the external business environment, an important promoter of the strategic agility of an organisation.

1.3.2 The need for BDA integration into decision-making in mining towards strategic agility

Empirical studies have gradually recognised the integration of BDA into decision-making as a critical enabler of strategic agility. It empowers organisations to generate timely, meaningful insights that enhance the quality and speed of decisions in complex environments (Awan et al., 2021; Dubey et al., 2019). Awan et al. (2021) and Wamba et al. (2017) discovered that combining BDAC with business intelligence and analytics, improved decision-making quality which was essential for firms to respond to dynamic industry challenges and anticipate opportunities.

An existing study established that BDA enables firms to create and acquire useful knowledge resources, which help in promoting organisational learning and the long-term competitive advantage necessary for strategic agility. Firms that have adopted BDA to support decision-making are more successful and resilient against environmental changes and resource distribution (Awan et al., 2021; Wamba et al., 2017). A major move towards attaining sustainable growth and operational excellence especially for the mining organisations is the transition from intuition-based to fact-based decision-making.

1.4 Business and Theoretical Need

1.4.1 Theoretical need

Although much is known about the long-term benefits of using BDA, there is a significant knowledge gap that addresses the factors affecting business processes during the implementation of BDA (Talaoui et al., 2023). Further research needs to address the challenges that arise from the adoption of the technology (Talaoui et al., 2023). The purpose of this study was to investigate the key success factors needed to embed BDA into the decision-making in order to enhance operational agility in the mining operations. The objective of this research was to develop BDA integration guidelines for operational agility in mining, thereby closing a knowledge gap.

Xie et al. (2022) recognised the research gap too. The authors called for exploring the scenarios where BDAC can contribute positively to an organisation's performance and agility considering the context and environmental dynamics surrounding the use of BDA. As the number of companies undertaking big data initiatives increases, so does the lack of understanding of how companies convert the potential offered by these technologies into profitable business opportunities (Mikalef et al. 2019). According to Mikalef et al. (2021), additional data is needed on the impact of the BDAC and alignment with business strategy on organisational performance. Further research on this issue in other industries and business contexts is also required.

1.4.2 Business need

The research study attempts to provide the necessary theoretical frameworks, empirical evidence and practical guidance that help a mining operation utilize BDA for strategic agility. In this regard, the critical success factors were considered.

Numerous empirical studies extensively cited in the literature on the digital economy identify BDA as potentially impacting firms' management and enhancement of operational performance (Gupta et al., 2019; Popovic et al., 2018). According to Awan et al. (2021), BDA is vital to the process of undertaking valuable insight or data analysis from large data sets used for making decisions. BDAC is a key element of strategic agility to enable businesses to improve their knowledge management procedures to respond and adapt to a changing environment quickly. This ability allows an organisation to expect and position against the external environment, thereby improving performance (Sarwar et al., 2025).

The mining industry is a complex and volatile environment subject to changing regulations and commodity prices. This calls for data-driven decisions. In order to tackle these challenges, mining operations need to embrace innovations and emerging technologies to remain competitive (Qi, 2020). Although the focus of the available literature on mining is limited, it does point out the potential of BDA as a tool for enabling better decision-making and strategic agility. Consequently, this makes it a worthwhile prospect for the mining sector.

BDA role in enhancing strategic agility is critical in the mining or extractive industries given the inherent uncertainties of the sector and the need for operational responsiveness. As reported by Alyahya et al. (2020) and Qi. In 2020, it was stated that BDA use in decision-making process is an essential business need to advance agility, foresight and enable strategic actions. BDA equips organisations with the tools and resources needed to deal with a dynamic environment. The dynamic business scenario consists of adaptation and proactivity trying to make the best out of the available data leading to improved decision-making quality (Alyahal et al., 2023; Awan et al., 2021; Sarwar et al., 2025). These BDA capabilities are essential for mining operations to be resilient

and effective. A structured framework to achieve data-driven agility in mining operations was the urgent business need that this study aimed to fulfil.

1.5 Conclusion

BDA enables the mining business to respond quickly to change, enhances decision-making, and offers long-term competitive advantage (McKinsey, 2018). Successful BDA integration depends on the factors that facilitate their adoption, BDAC and BDAMC. The mining environment is increasingly complex and dynamic. It requires the integration of BDA into decision-making to enhance strategic agility and operational responsiveness. To fill the identified gap in the literature, the study looked into the key success factors needed to adopt BDA in the mining context by leveraging the existing literature.

2. CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, the literature on BDA incorporation in decision-making with the objective of improving strategic agility of mining entities was reviewed. BDA characterization along with strategic agility and successful execution skills were identified. This chapter also covered the organisational strategies and key success factors for integrating BDA into business operations. The analysis of the adoption and impact of IOT technology was further guided by theoretical frameworks such as the Resource-Based View (RBV) and Technology-Organisation-Environment (TOE). The analysis was finally contextualised by taking into account relevant laws and industry best practices.

2.2 Key constructs

2.2.1 BDA Integration into decision-making

The use of BDA as a decision-making tool has become an important strategic agility for organisations to foresee, adjust and respond to fast-changing shifts in the environment. In high-uncertainty mining operations where safety and productivity challenges are present, BDA can assist in turning available data into useful information that helps make organisations responsive, efficient and competitive.

As per findings by Dehkodaei et al. (2023), BDA offers more leverage to businesses to deliver practical inputs, which assist improved operational decisions in complex supply chain. However, the report cautioned that success would be limited by gaps in the knowledge of managers, bad governance, and lack of finance. According to Merhi (2021), BDA can assist companies in transforming large and complex datasets into meaningful information. Additionally, a study by Merhi (2021) found that better quality decisions are made when data quality, execution and system integration are aligned. For mining organisations, flexibility in their capital-intensive operations was a particular area of focus.

Serazzi et al. (2023) stated that the level of contribution of BDA to decision-making depends on the alignment of strategies and organisational objectives. According to the study, the alignment ensures that insights are created and successfully transform into strategic decisions that make operations and markets more adaptable. Sarwar et al. (2025) further state that BDA applies complex algorithms for the assessment and conversion of unstructured data, which modifies the raw data into the useful information.

According to Awan et al. (2021), the decision-making process essentially comprised the gathering, processing, interpreting, and combining information to arrive at an informed decision, which was fundamentally constrained by the information processing capacity. Sheng et al. (2021) reported that BDA also assist with decision-making on the speed of response, thus improving delivery speed and customer responsiveness. Additionally, Awan et al. (2021) and Rialti et al. (2019) established that BDA facilitates the extraction of relevant information and its interpretation, providing solutions regarding decision-making, which is subsequently linked to descriptive, predictive, and prescriptive approaches to support the decision-making process.

According to Mikalef et al. (2019), when organisations integrate BDA into their operations and practices, decision-making becomes data-driven enabling managers to make decisions based on data insights from events that have transpired rather than relying on instinct. Therefore, there is a shift towards fact-based decision-making when BDA is utilized to its maximum potential. Moreover, according to Awan et al. (2021) and Mikalef et al. (2019), decision quality is made dependent on the extent to which firms have established their big data analytical capabilities (BDAC), explained as the firm's ability to deploy technology and talent effectively to capture, store, and analyse data. When organisations possess data-driven insights, they are able to take more rational decisions and respond in quick time. These insights are vital and positively correlate with a firm's decision-making capability (Chen et al., 2022). According to the research of Talaoui et al. (2023), BDA was found to be essential in responding to COVID-19 pandemic and future unforeseen shocks, confirming its value in enhancing resilience and agility when the future is uncertain.

Despite the literature findings supporting the ability of BDA to improve performance and responsiveness, the majority of the studies focused on manufacturing, telecommunications environments, supply chain, retail, finance and healthcare sectors, which limits its applicability in the complex and asset-intensive context of mining operations (Dehkhodaei et al., 2023; Merhi, 2021; Mikalef et al., 2019). The gaps that have been mentioned previously formed the basis of the research in this study to help develop and guide a framework. In essence, by exploring through empirical evidence, how mining organisations can develop and use both human and technological BDA capabilities to improve evidence-based decision-making.

2.2.2 Strategic agility

Strategic agility is becoming broadly recognised as an essential dynamic capability that helps organisations adjust to changing circumstances swiftly, aligned with wider business goals. With uncertainty on the rise, it is growing ever more important for mining organisations to maintain strategic alignment and be more than just adaptable. According to Turi et al. (2023) strategic agility is the alignment of an organisation's project efforts with the larger goals and objectives of the organisation. Similar opinions shared by Centrobelli et al. (2022) stresses the strategic agility as the ability of the organisation to be extremely responsive to the changing needs and wants of the customers as well as operational risks and problems. As a result, strategic agility is a skill that businesses in changing environments require, it is a very helpful ability that can make businesses cope with and adapt to change (Tarba et al., 2023; Xie et al., 2022). Industrial responsiveness is pivotal in agile sectors like mining, where resilience and competitiveness are essential.

Recent studies highlight that BDA is vital to deriving timely and factual insights that inform both strategic and operational decisions (Akter et al., 2016; Sarwar et al., 2025; Shamim et al., 2019; Wamba et al., 2020). As Sarwar et al. (2025) study found, strategic agility is an organisational-level dynamic capability trait, characterised by changes an organisation makes in its structures, processes, and products. BDAMC is a core enabler of this agility, helping an organisation learn to interpret and act upon large and complex data sets. The study conducted by Shamin et al. (2019) discovered that organisations with robust

data management procedures incorporate leadership commitment, technological infrastructure, and human skills into their data-driven strategies, thereby enhancing the quality of decision-making. Similarly, a study by Akter et al. (2016) established a hierarchical model of BDAC which consists of management, technology and talent sub-capabilities which create agility by connecting analytics to performance outcomes and business.

To add to this Qaffas et al. (2023) also found in their studies that BDA capability improves business intelligence infrastructure and it increases reactivity and decision-making efficacy of an organisation. According to Wamba et al. (2020), BDA dynamic capabilities significantly enhance agility and adaptability and even more so in highly dynamic environments. The literature suggested that BDAM operative capabilities are enhancing the capacity to integrate information from all divisions, producing insights at real time and converting those to actions forming the basis of building strategic agility. According to Shamim et al. (2019), organisations improve the speed and quality of decisions by infusing analytics into strategic management. Furthermore, Talaoui et al. (2023) highlight that BDAMC provides strategic agility in dealing with information in the company and its external business environment.

Despite the fact that Literature does not point out the relationship between strategic agility and data analytics use in the mining industry, the strategic agility as described does highlight its potential (Qi, 2020; Sarwar et al., 2025). As observed by Sarwar et al. (2025), capabilities such as BDAMC, which offer information resources and dynamic capabilities for adaptation, are regarded as key to enabling strategic agility, by assisting organisations in identifying opportunities and threats, and to make quick decisions leading to agility.

The mining industry faces operational challenges on both social and environmental ends, including a high fatality rate, pollution and evolving regulatory requirements (Hermanus, 2007). The mining sector is spiked by volatility and uncertainty. There is a need for data-driven insights to enable mining operations to make decisions that are empirically based and thus strengthen their ability to anticipate changes and remain resilient in the face of complex and dynamic global challenges.

2.2.3 Key success factors for BDA

The effective integration of BDA requires a complementary blend of organisational resources, competencies, and culture that goes far beyond technical proficiency (Mikalef et al., 2020; Shamim et al., 2019; Wamba et al., 2020). As Mikalef et al. (2020) pointed out, in order to promote data-driven value creation, BDA should be viewed as a socio-technical competence that integrates technology, human talent and managerial procedures. To be successful, a business needs both intangible and tangible resources that enhance its capacity to collect, process, and convert data into useful information. The effective utilisation and value realisation of BDA were possible due to various factors described below.

Management, talent and technology were the three components that supported the development of BDA according to Mikalef et al. (2020). To get insight, a company collects, stores, and analyses data through professionals with the right skills to understand data science and the business context (Mikalef et al., 2020). It is considered essential for a company to realise its returns on BDA investments. Consequently, the strong BDAC were essential as they proved that the company could successfully combine its data infrastructure, analytical technology and human skills (Akter et al., 2016; Mikalef et al., 2020). Likewise, Shamim et al. (2019) found that BDAMC which includes leadership, governance and cultural preparedness, are major determinants of quality decision-making. Sarwar et al. (2025) assert that strong management skills (BDAMC) which go beyond the technical skills, have been identified as critical for the profitable use of BDA in an organisation and thus leveraging intelligence from diverse sources to formulate impactful strategies. These new managerial skills would allow strategic use of analysis-derived knowledge to boost the innovation and agility of the company. Also, Qaffas et al. (2023) further argue that the ability of firms to attract talent that utilises big data capabilities, strengthens business intelligence infrastructure, which in turn improves firm performance by improving the speed and quality of managerial decisions.

Mikalef et al. (2020) noted that the dynamic capabilities that align BDAC with operational capabilities were also a crucial success factor important to adapting

to the changing environment and allow business flexibility. Wamba et al. (2020) and Rialiti et al. (2019) argue that the flexibility of a BDA infrastructure allows businesses to respond to market fluctuations as they can ensure continuous access to data in real-time. Having adaptable data platforms and operational systems enables enterprises to turn what analytics uncovers into action. Organisational learning and data-driven culture were identified as success factors of increased decision-making effectiveness (Awan et al., 2021; Mikalef et al., 2020). According to Mormura and Sakagawa (2023), using data-driven learning for strategic planning helps create a culture in the firm that is proactive and responsive. According to their study, this will enhance the BDAC and its impact on firm performance. Successful adoption of BDA also depends on strategic alignment, which is integrating BDA applications with the company processes and the overall strategic objectives of the business (Mikalef et al., 2020). Studies have found that proper data-driven decision-making can help an organisation run more efficiently and improve the quality of data-driven decisions and insights (Muller et al., 2018).

Analysed collectively, these literature findings suggest that an integrated ecosystem of skills, structures and systems that enables data-driven decision-making is essential to the successful implementation of BDA. Organisational learning and data-driven culture appeared as fundamental enablers and were ranked the first priority (Awan et al., 2021; Mikalef et al., 2019). When organisations create a culture of experimentation, curiosity and evidence-based thinking, it enables employees to use data with confidence and certainty. In sectors like mining, having this type of culture is important for production, maintenance and safety decision-making that have serious consequences. Management commitment was seen as crucial in ensuring that business analytics investments fit business strategy and objectives. According to Sarwar et al. (2025), BDAMC consists of leadership behaviours that facilitate the application of analytics, foster cooperation between functions and ensure alignment between data initiatives and business objectives. However, when managers are not involved, BDA is usually either incoherent or does not offer proof of value.

The literature review indicates that strategic alignment was consistently identified as a key success factor for BDA integration, in addition to the key success factors discussed. According to Akter et al. (2016), Analytics Capability Business Strategy Alignment (ACBSA) means aligning analytics objectives with that of the organisation. ACBSA is significant because it ensures that analytics investments lead to the success of the organisation. This enabled companies to use data to make daily decisions, allowing them to be flexible. This alignment could have predictive maintenance analytics aligned with production objectives, as well as environmental and safety analytics aligned with risk management, for mining operations. Technological adaptability and good governance ensure that analytics initiatives remain ethical and can continue to develop. Richardson et al. (2021) study confirmed that this is a major success factor, companies need to take measures to ensure that analytics-driven insights are used ethically, including ensuring privacy, accuracy, ownership and accessibility of the data.

Five interrelated success factors were repeatedly pointed out in the literature: (1) a strong data-driven culture that fosters organisational learning, (2) strong BDAC and BDAMC which blend managerial and technological skills, (3) flexible and dynamic data infrastructure, (4) strategic alignment of analytics with business goals and (5) ethical governance that encourages data integrity and transparency. However, these critical success factors for the effective integration of BDA were largely from sectors such as manufacturing, telecommunications, supply chain, retail, finance and healthcare sectors (Dehkhodaei et al., 2023; Merhi, 2021; Mikalef et al., 2019). To assess applicability to mining operations and to expand the set of relevant factors for the successful integration of BDA within mining operations, the study analysed these success factors in detail throughout the study.

2.2.4 Approach to integrate BDA within decision-making

BDA integration into organisational decision-making is a complex process that demands ethical governance, leadership involvement, a culture shift, and alignment between analytics capabilities and strategic objectives. As the term is defined by Mikalef et al. (2020), this consists of embedding analytics in the nervous system of the organisation so that insights can, without delay, influence decisions at both the strategic and operational levels. As discussed by Awan et

al. (2021) and Sultan et al. (2024), building a data-driven culture is the first step which helps in making decisions based on analytical data as opposed to management intuition, thereby preventing bias in the decision-making process.

Many empirical studies indicate that a data-driven mindset and leadership commitment are essential for successful BDA integration. As an illustration, Koohang et al. (2023) found that BDA leadership helped the performance, innovation and talent development of people by enabling them to understand data insights. According to Shafqat et al. (2025), the attitude of top management plays a moderating role in the association of BDA skills and performance, which necessitates executive sponsorship for adopting analytics. As Sultan et al. (2024) added, the combination of managerial and technological skills together with a data-driven culture improves business performance and strategic alignment. According to Awan et al. (2021), BDAMC is essential as it improves the quality of decisions helping in integrating BDA with the decision-making process. The study by Al-Sai et al. (2020) further supports the convergence of culture and leadership as a success factor in analytics-driven transformation. According to the scholars, the success of BDA integration was dependent on governance readiness, organisational learning and leadership commitment.

Talaoui et al. (2023) found that aligning BDA initiatives with the current decision-making framework ensures accountability and continuity in the way insights inform actions. In addition, analytics-influenced decisions can be consistently implemented in organised governance processes like risk assessments, operating dashboards and planning cycles. Al-Sai et al. (2020) identified the five pillars of BDA integration success as organisational, technological, people, data management and governance. This finding supports the view that BDA integration must occur in a systematic manner not in technology isolation.

Furthermore, research found that agility improves when data analytics and data strategy are aligned dynamically. As indicated by Rialti et al. (2019) and Wamba et al. (2020), such alignment is crucial within ever-changing industrial contexts as it facilitates data translation into adaptive decisions. According to Choi et al. (2022), further information on the use of analytics must be taken at the management levels as decision makers at different levels have a different

outlook for the use of analytics. As per the study, it was found that strategic preparedness and context were more endorsed by middle-level managers whilst operational managers were in favour of data accuracy and compliance.

The study revealed that there are three important and interrelated strategies (or approaches) necessary to integrate BDA into decision-making. These three strategies or approaches are strategic alignment, capability development and cultural embedding (Akter et al., 2016; Mikalef et al., 2019; Ogbuke et al., 2022; Shamim et al., 2019; Sultan et al., 2024; Woolley, 2019). In addition to the three approaches, Wolley (2019) argued that the use of analytics is legitimised by the trustworthiness in data oversight through fairness, transparency and permission. Similarly, Ogbuke et al. (2022), argued that in the absence of clear governance and data ethics guidelines, organisations run the danger of undermining stakeholder confidence and impeding integration. Furthermore, Richardson et al. (2021) underscored the importance of organisations having a clearly defined approach that supports the use, design and implementation of BDA to ensure ethical use of data.

There was therefore an important need for exploring the mining sector specific approach to BDA integration into decision-making, which current literature has not addressed.

2.3 Models and Frameworks

The integration of BDA into decision-making to improve strategic agility, necessitated a strong theoretical basis that clarifies the contextual factors influencing technology adoption as well as the resources driving competitive advantage. For the structure of this study, the Resource Based View (RBV) and Technology Organization Environment (TOE) frameworks were used (Barney, 2001; Nguyen et al., 2022). Although a number of theoretical models and frameworks were relevant to understanding how BDA is integrated into the decision-making process to improve strategic agility, for the purpose of this research RBV and TOE frameworks were used for structure (Barney, 2001; Nguyen et al., 2022).

2.3.1 The Resource Based View (RBV) Theory

According to Braney (2001), the RBV is a theoretical perspective that explains the difference between businesses that do better than others, through the possession and effective utilisation of valuable, rare, inimitable and non-substitutable (VRIN) resources. The RBV framework has demonstrated how resources and competencies are deployed differently around different organisations. Furthermore, such disparities may be sustained over time, leading to better performance (Braney, 2001). The essential resources for firms engaging in digital transformation had been acknowledged in literature which comprises of not just physical assets but includes information, technological infrastructure, managerial skills and organisational learning (Mikalef et al., 2020). Awan et al. (2021) noted that BDA is a strategic tool that enhances an organisation's ability to cope with information, which makes it possible to make better and faster decisions. Likewise, Mikalef et al. (2020) emphasised that BDAC is a dynamic ability that transform data into informative knowledge that enriches organisational decision-making quality and speed.

According to Wamba et al. (2020), research has extended the RBV framework to demonstrate how analytical capabilities create dynamic capabilities for organisations to sense and respond to changes. The use of data analytics to remain agile and creative was demonstrated by both BDAC and BDAMC. Sultan et al. (2024) discovered that BDAC alignment with strategic objectives improves organisational performance in data-driven sectors. In addition, Koohang et al. (2023) identified data talent and leadership skills as essential intangible resources to improve performance and creativity.

Using the RBV framework in a mining context provided insights into how different management skills, analysis capabilities and data structure can lead to sustainable competitive advantage. The aim of the study was to examine how mining firms could develop and use these unique analytic-based resources to achieve strategic agility, applying RBV framework (Awan et al., 2021; Mikalef et al., 2020).

2.3.2 The Technology Organisation Environment (TOE) Framework

TOE intends to give a robust, empirical and flexible framework to understand the process of decision-making on the adoption of technology, as well as the technology itself (Nguyen et al., 2022). Although the RBV framework deals with the internal abilities of the company, the TOE framework provides a broader framework explaining the behavioural intentions and the implementation of innovation at the company. According to Nguyen et al. (2022), the three interconnected dimensions of the TOE framework, which consist of technological, organisational and environmental, together affect innovation adoption. The technology context includes the features of the technology which are the relative advantage, compatibility and complexity. According to Mikalef et al. (2019) and Al-Sal et al. (2020), two features essential for success in BDA adoption are the infrastructure maturity factor and integration capacity. Shafgat et al. (2025) and Koohang et al. (2023) elaborated on the organisational context, emphasising that managerial skills, quality of talent and leadership helps in bringing analytics into decision-making. External pressures such as government regulatory requirements, sustainability requirements and consumer pressure were identified as driving forces behind BDA adoption (Ogbuke et al., 2022; Sultan et al., 2024).

The adoption dynamics in the mining context could be better understood by applying the TOE framework, which considers the complexities of mining operations, regulatory requirements, safety, environmental, and economic factors. Simultaneously, it was also helpful in demonstrating how internal preparedness (leadership, data infrastructure, and organisational learning) and external forces (ESG requirements, decarbonisation legislation) interact to enhance or inhibit the success and pace of BDA integration. According to Nguyen et al. (2022), the TOE framework is a flexible and empirically supported framework, which is fitting for application within the mining context.

2.3.3 Integrating RBV and TOE in the study

This integrated strategy provided support for the hypotheses of Mikalef et al. (2020) and Wamba et al. (2020) that the interaction between contextual enablers and resources drives analytics-driven performance. This study, through the lens of the aforementioned frameworks, examined how mining firms manage the

development of internal capabilities with external adaptability to convert analytical spending into strategic agility.

Combining the RBV and the TOE frameworks provided a strong theoretical foundation for the study on how a mining company's decision to implement and use BDA may create BDAC to enhance its strategic agility and performance in a volatile industry like mining.

2.4 Legislation/Regulations

According to the Mine Health and Safety Act 29 of 1996 and Regulations (Mine Health and Safety Act, 1996), in view of the fact that the study was located in the South African mining context, the BDA integration into decision-making so as to ensure better strategic agility in mining operations was an important study. The Act mandatorily requires employers and employees to recognise hazards and take steps to prevent or control them to enhance the health and safety of workers at the mines (MHSA, 1996). Research conducted by Dubey et al. (2019) and Gunasekran et al. (2017) found that organisations can enhance strategic agility through the incorporation of analytics into operational systems to detect and respond to changes. This is important because the MHSA (1996), requires employers to assess and control risks through established, effective monitoring systems or other means to improve health and safety. The legislation requires employers to report accidents, severe illnesses and events that may pose risk to health (MHSA, 1996).

The MHSA (1996) presented the operational requirements (risk management, monitoring, reporting, investigation, training) as well as the crucial area of health and safety. The incorporation of BDA can greatly enhance decision-making relating to these operational requirements. Research by Wamba et al. (2017) and Dubey et al. (2018) found that analytics driven monitoring systems improve visibility and traceability, ensuring compliance while lowering downtime in the supply chain. The finding illustrates how incorporating BDA in decision-making process for mining operations can improve safety and risk management. Moreover, Ogbuke et al. (2020) stressed the importance of ethical management and governance of data, which aligned with the MHSA (1996) principles of accountability, monitoring and employee protection. Richardson et al. (2021)

also highlight concerns about the ethical use of BDA and emphasise the importance of an ethical guideline governing the use.

The necessity of adhering to and performing well within this regulatory framework, offered a compelling motivation for investigating how BDA might improve strategic agility in mining operations, through operational risk management and adaptation to changing operational, ethical and safety standards (Dubey et al., 2019). In the presented study, findings indicated that data-driven agility and legal compliance can assist mining operations in becoming safer, more agile and more sustainable.

2.5 Best practice

2.5.1 Other sectors

To enhance strategic agility in the decision-making process, some best practices and important success factors from other sectors have been identified. The literature involves a range of sectors and research contexts, including manufacturing, supply chain, retail, finance and healthcare, among others.

Literature highlighted that best practices for **manufacturing** include strengthening data infrastructure development, cross-functional cooperation, and leadership dedication. According to Al-Sai et al. (2020), for the successful integration of BDA, data quality, management support and governance were identified as critical success factors. According to Dubey et al. (2019) and Wamba et al. (2020), the most efficient and effective manufacturing firms utilised analytics within their operational decision systems to enhance supply chain responsiveness and agility. This is particularly the case when backed by strategic alignment and dynamic capabilities.

For the **healthcare industry**, Alyahya et al. (2023) found that effective analytics use necessitates strong governance, interoperability, cloud integration and workforce training. Evidenced based decision-making enhanced patient safety, care planning and resource allocation at hospitals with data-driven cultures. These findings were also echoed by Mikalef et al. (2020), posing that technology,

talent and culture work together to produce the biggest influence on decision-making.

In the **supply chain management**, BDA has been used to improve supply chain management's predictive decision-making and transparency. As demonstrated by Ogbuke et al. (2022), data-driven supply chain networks enabled businesses to predict disruptions and improve logistics which enhanced operational efficiency, ethical compliance and traceability. Additionally, Rialti et al. (2019) emphasised that real time visibility gives analytics enabled businesses agility, enabling decision makers to quickly adapt to shifts in the environment and demand.

The **retail industry** offered the most advanced developed applications of analytics integration. BDA on browsing and purchase history of consumers, was used by Amazon to forecast demand and streamline logistics, leading to quicker deliveries and increased operational effectiveness (Xie et al., 2022). Based on a study by Sarwar et al. (2025), Protector& Gamble made considerable use of BDA on customer data from multiple sources, to generate insights that guided the creation of new products and services based on consumer wants.

To create unified consumer insights, **financial services** such as Nedbank integrated a variety of data sources including transactional, geolocation data and credit card, to obtain comprehensive consumer insights, which allowed for targeted marketing and even the development of new service package for consumers (Mikalef et al., 2020). Sultan et al. (2024) further noted that integrating BDA capabilities with business strategy, directly enhanced innovation speed and performance in Saudi banking and tourism organisations.

These sectoral insights demonstrated an existing opportunity for leveraging these lessons to the mining sector. Although behind in data-driven integration, assessing the adoption and applicability of these success integration factors, enabled mining organisations to be able to enhance decision-making and overall strategic agility.

2.5.2 International best practice

The use of BDA for strategic benefit by organisations across different contexts has been researched with empirical evidence and a literature review. Awan et al. (2021) emphasised the need for organisations to build BDAC because the benefits of BDA for agility and performance do not stem from the technology only, but from the overall capabilities of the organisation as well. Their analysis of Czech manufacturing companies showed that by integrating data-driven insights into day-to-day operations, business intelligence and BDAC systems greatly enhanced decision-making quality and circular economy performance. This is consistent with the findings by Mikalef et al. (2020) who discovered during a study of Norwegian companies, that BDAC improves dynamic capabilities that support marketing and operational performance such as market sensing and technical response, hence indirectly strengthening competitive advantage.

Also, Wamba et al. (2020) conducted a cross-industry study. Here, the authors found a link between the strong managerial commitment and infrastructure of BDA and better levels of adaptability and agility. It is particularly true in volatile markets. In line with these results, Koohang et al. (2023) stated that data-driven culture and leadership capability are common predictors of analytics success. The moderation effect of top management support on the relationship between BDAC and firm performance, as pointed out by Shafqat et al. (2025), denotes that leadership engagement can be deemed as a global best practice for integration of analytics.

Sultan et al. (2024) studied Saudi tourist organisation in the Middle East and found that integrating analytics with business strategy improves long-term performance and innovation speed, hence reaffirming the need for strategic alignment to global scale. Similarly, by facilitating a quicker response to changes in the market and environment, BDAC helped Saudi Arabia managers maintain long-term innovation and agility (Alyahya et al., 2023).

Chen et al. (2022) and Liu and Fang (2021) state that analytics integrated across functions, supported by open information flows and shared data platforms, promoted cross-functional decision-making and operational coherence in East Asia. The findings suggested that an organisation-wide perspective to analytics,

which sees the data from marketing, operations and finance being melded to impact strategic decisions, was one of the global best practices.

Corporate execs use negotiation, persuasion, and other soft skills regularly. Southwest Airlines has been using social media to identify trends and gain insight into customer preferences and behaviour, as well as to shift different aspects of their business operation. It allows the organisation to make real-time changes to its marketing and service delivery activities. These companies were similar to Procter & Gamble, Amazon and General Electric, who had institutionalised analytics in maintenance optimisation, demand forecasting and product creation with a gainful outcome on responsiveness and efficiency (Dubey et al., 2019; Sarwar et al., 2025; Mikalef et al., 2020; Xie et al., 2022). The companies that were successful had ethical governance, competent talent, data infrastructure, and leadership vision.

It is an important practice creating formal governance frameworks aimed at ensuring data privacy, transparency and trust, from an ethical and governance standpoint (Ogbuke et al., 2022). According to Ogbuke et al. (2020), regulation and compliance, organisational learning and leadership commitment play a supportive role in the long-term adoption of BDA across different economies. According to the RBV theory, analytical abilities are considered strategic assets. Furthermore, the TOE model proves that the external pressures and contextual preparation may become significant contributory factors towards adopting this. All these are in line with our studies.

Numerous industries have successfully employed BDA for improving strategic agility. This includes the manufacturing industry, aviation, tourism, and healthcare. However, this international literature review showed that there is a research gap concerning the mining industry. Research from various sectors has uncovered best practices that highlight a comprehensive approach beyond incorporating BDA technology only. The findings from the studies were both important and relevant to this research, as they were used as a yardstick for the integration of BDA and understanding the CSFs needed in the mining sector. In order to improve decisions made using data, this study seeks to address a big

research gap by determining how mining firms, particularly in South Africa, may develop and implement their very own BDAC and BDAMC.

2.6 Summary

Based on the literature review, Big Data Analytics is becoming a key enabler of innovation, strategic agility and data-driven decision-making across industries. The successful integration of big data analytics (BDA) requires developing organisational competencies, leadership commitment, ethical governance, and building a culture of critical thinking. Studies of a number of industries, such as supply chain management, manufacturing, health care, and finance, have suggested that organisations which link strategy and analytics are more competitive, agile and responsive.

Literature tends to point out that technology alone is insufficient for the successful integration of BDA. All these aspects are essential for shaping a data-driven culture, strong organisational capabilities and leadership commitment. Firms that derive significant value from analytics are those that invest in analytical expertise, encourage cross-functional collaboration and align data initiatives with the organisation's strategy. A very high-quality leadership are important for embedding the analytics into daily decision-making. This makes sure all decisions are made using analytics. The literature further highlighted that when organisations adopt continuous learning, people can analyse and implement analytical insights which drive performance and sustainability, resulting in agility and innovation. These shared best practices, emerging from industries exhibiting BDA maturity, offer the potential to be learnt and adapted by the mining space.

The literature indicated, however, important shortcomings and limitations. Despite much research on BDA in manufacturing and supply chain management and service industries, there is a big gap in the understanding of the use of BDA in the mining industry, particularly in South Africa. The mining industry has its unique challenges, including operational challenges, the obligations imposed by the MHSR regulatory requirements in respect of environment and safety, and changing market conditions. To tackle these issues, we need predictive data that

will help us make decisions that will improve safety, efficiency and compliance. However, there have been few empirical studies on how mining operations could leverage BDA to improve strategic agility and decision quality.

The gaps in the literature suggest that further context-specific research is necessary on issues like organisational culture, leadership readiness, regulatory requirements that influence analytics adoption, and on technology-related issues, especially in mining and similar industries. In view of the research gap, this study examines how mining companies might create and incorporate BDA into the decision-making process for improving strategic agility. Based on RBV and TOE, the study intended to determine how internal capacities, and external factors work in tandem to enhance the integration of analytics.

3. CHAPTER 3: RESEARCH OBJECTIVE AND RESEARCH QUESTIONS

The objective of this qualitative exploratory study was examining the success factors that are critical for the integration of BDA into the decision-making process to improve strategic agility in mining operations particularly in the South African context.

The mining industry is a conventional industry that has been under significant economic and operational pressure such as rising production costs, environmental demands, unstable commodities market and safety regulations restrictions. Exploring how digital technologies like BDA could support mining organisation in achieving resilience and agility in their strategic response, was the reason why this study was both timely and relevant. BDA has significant potential benefits for operations and strategy, but faces notable challenges in implementation, and the specific mechanism through which BDA capabilities enhance outcomes like strategic agility are still unclear and not yet understood within this context (Qi, 2020).

Therefore, this study aimed to fill the knowledge gap by identifying the key successful factors for integrating BDA into decision-making processes and building on the existing literature to generate context-specific understanding for mining organisations in South Africa. In doing so, the study responded to references in literature for studies relating BDA management capabilities with dynamic abilities such as agility, resilience and innovation in unpredictable context such as mining (Mikalef et al., 2020; Qi 2020). The thematic literature review was used to formulate the research questions, with the main research question expanded into four research questions that served to guide the research process.

3.1 Research questions

Research Question 1

What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?

This research question aimed to explore the critical success factors that enable the effective integration of Big Data Analytics (BDA) into the decision-making process in mining organisations. Drawing from existing literature, this proposition examined the ways in which leadership backing, a data-driven culture, robust Big Data Analytics Management Capabilities (BDAMC) and strategic alignment impacted the effectiveness of BDA adoption (Mikalef et al., 2019; Mikalef et al., 2021; Sarwar et al., 2025). This research question sought to identify the primary facilitators that enable mining organisations to leverage BDA for enhanced decision-making and strategic agility.

Research Question 2

What is the role of BDA in the microprocesses of strategising?

According to Talaoui et al. (2023), BDA facilitates quicker information flows, scenario planning and enhanced agility, all of which aided in the creation of strategies. Their findings suggested that BDA was a strategic capacity as well as technological instrument that effects routines decision-making processes and enables managers to quickly anticipate and adjust to changes in the environment. It was therefore the intent of the research question to investigate the role of BDA in the microprocess of strategy with an emphasis on how analytics influence and inform routine managerial procedures.

Research Question 3

What are key recommendations for integrating BDA into the decision-making process towards enhancing the strategic agility of mining operations?

The goal of this research question was to provide practical recommendations for effectively incorporating BDA into decision-making processes in order to improve strategic agility of mining operations. This proposition sought to identify practical measures that mining organisations can implement such as strong governance structures, adaptable IT infrastructure and capacity building initiatives based on the existing body of research (Alyahya et al., 2023; Chen et al., 2022; Talaoui et al. 2023; Xie et al. 2022). In the mining industry where operational, safety and regulatory concerns make BDA integration both crucial and complicated, the objective was to apply global best practices.

Research Question 4

What is an approach for the integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations?

Based on the findings of Alyahya et al. (2023), Awan et al. (2021) and Xie et al. (2022), this research question aimed to explore the approaches by which BDA can be integrated into organisational culture, aligned with current strategic procedures and maintained through continuous learning. It intended to provide structured integration framework that gives mining companies a road map for enhancing their strategic agility by balancing technological capabilities and organisational factors.

4. CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

The study had a focus on integrating of Big Data Analytics (BDA) into the decision- making process towards enhancing the strategic agility of mining operations. A qualitative research approach was conducted to deeply explore the role of BDA integration to enhance the strategic agility of the mining operations. Critical success factors for adoption were investigated. Qualitative research allowed for deep insight into BDA in the organisational setting, it was rather useful in uncovering aspects that can potentially enable or hinder performance gains which might not have been captured by quantitative research (Mikalef et al., 2019). Zhu and Li. (2023) research also supported the use of qualitative research method to uncover specific mechanism through which BDA integrates into decision-making processes and influence on strategic agility.

A qualitative research methodology was therefore appropriate to offer contextual, in-depth, and exploratory insights that are crucial to comprehending the complicated and dynamic characteristics of the BDA integration in decision-making for strategic agility.

4.2 Purpose of research design

The purpose of the qualitative research approach selected for this study was to gain a deeper insight into how big data analytics (BDA) can enhance decision-making processes and improve strategic agility in mining. Critical success factors for adoption were considered. To answer the research questions, the descriptive research approach, which provides an account of something that is happening (Saunders & Lewis, 2018), was selected. Using this approach gave a thorough understanding of the context in terms of the mining industry. Through semi-structured interviews with key players in the mining sector, rich data were collected due to the research design.

4.3 Philosophy

The research philosophy consists of a collection of beliefs and assumptions referring to the construction and nature of knowledge (Saunders & Lewis, 2018). In their view, interpretivism focuses on human subjectivity, while positivism focuses on generalizability and objectivity (Saunders & Lewis, 2018). For this

research study, the adoption of interpretivism research philosophy was significant. It was done to help derive insight into how BDA can be incorporated into the decision-making process to improve strategic agility and the critical success factors to enable adoption. The interpretivist philosophy helped to better grasp the interplay between BDA and organisational inertia (Mikalef et al., 2021). For this research, the work context was visited so that critical success factors could be identified in determining how big data analytics is currently being utilised in decision-making.

The interpretivist point of view was useful in understanding the BDA and organisational inertia dynamics (Mikalef et al., 2021). The interpretivist approach studied the understanding and experience of individuals in mining operations with respect to the role of BDA in decision-making and its influence on their agility. The approach helped in revealing the hidden, often unspoken meanings and assumptions through using BDA for making decisions (Talaoui et al., 2023). This allowed the researcher to understand the human aspect of BDA and to realise the main elements for having successful implementations.

4.4 Research approach selected

According to Saunders and Lewis (2018), induction is a research method that seeks to generate theories from previously collected data. On the other hand, deduction is a method of research in which evidence is collected to test a theory. Two approaches for developing or verifying theories are used. This study followed an inductive approach whereby decision-making-related BDA professionals working in mining were interviewed to explore the functioning of BDA in detail. According to Saunders and Lewis (2018), the induction approach helps us understand the context in which research is conducted. When it comes to mining, this was very important. Most studies on mining have been on the manufacturing, IT and business-to-consumer side.

4.5 Methodological choices

The study was undertaken using a monomethod approach by conducting semi-structured interviews of teachers and students. For the research study, the primary data were collected by a qualitative method of semi-structured

interviews. A single method was adequate to gain insights into this topic, so it was chosen. An interview is referred to as an established tool to collect opinions, beliefs and experiences of stakeholders involved (Mikalef et al, 2021; Mikalef et al, 2019). This method has enabled the mining industry because of its complexity. This was very important in answering the intricate “how” questions of how BDA is embedded in decision-making and how this leads to and influences strategic agility (Mikalef et al., 2021).

This method also enriched the process of reasoning in an inductive manner that builds on theory and not test (Mikalef et al., 2020). Since the study was very early, using an inductive approach to research the integration of BDA, decision-making and strategic agility in the context of mining was appropriate. According to Yin (2009), complex and evolving phenomena are best studied within their natural environment through the use of the inductive method. The research was able to extend beyond existing theoretical knowledge and develop insights specific to the mining sector.

4.6 Strategy

A case study strategy was employed for the research to ascertain how BDA can be embedded into the decision-making in order to make the mining sector more strategically agile and the key factors to its success. According to Saunders and Lewis (2018), a case study strategy permits the collection of data through various means like interviews, observation and documentary analyses. This strategy was suitable for the present study as the information was obtained from various stakeholders within the mining context, namely software developers, OEMs and BDA mining professionals. The multiple sources of data enabled triangulation of the data to enhance reliability, depth and validity of the findings.

4.7 Time horizon

A cross-sectional research strategy was adopted for the study (Saunders & Lewis, 2018). However, the cross-sectional approach was limiting; its practical approach allowed for the exploration of the human and industry contexts surrounding the integration of BDA into decision-making within a reasonable

timeframe. The research findings paved the way for a longitudinal study, given the scarcity of BDA research data within the mining industry (Qi, 2020).

4.8 Population

A universe or population is made up of all objects involved in any kind of investigation (Mishra & Alok, 2017). Saunders and Lewis (2018) define a research population as a group of people, things or events that share traits that are found interesting by the researcher. The choice of population was key to the study's relevance and breadth, and, for this qualitative study, the research population consisted of the mining sector, including BDA professionals, Original Equipment Manufacturers (OEMs), software developers, and mining professionals with exposure to BDA. Through interviews with those directly involved with BDA-type capability building, data-based decision-making and strategy formulation in the field, the report findings are anchored in the ground realities and scenario analysis of the sector.

4.9 Unit of analysis

The study's problem guided the choice of the scientific unit of analysis. This choice was aimed at having a comprehensive and in-depth understanding of how BDA capabilities are built, managed and utilised for decision-making and agile strategic operations within the mining sector (Saunders & Lewis, 2018). The mining sector in South Africa (SA), Gauteng, Mpumalanga and Northern Cape was used as the unit of measurement for this study. The BDA professionals generously supported this research study. They include the Business Development Managers, Business Leaders, Operations Managers, and Technical Managers from mining houses, as well as from BDA software providers (OEMs/Software developers). The choice of population provided mining experts an opportunity to narrate their own experiences and views with respect to the adoption of BDA in the mining context. This provided rich insights for the study and is reflected in the findings.

4.10 Sampling method and size

The study will focus especially on mining sector BDA practitioners as they are the principal BDA data source that can answer the research question. As per the

recommendations of Saunders and Lewis (2018), an appropriate sample size will be covered. This study employed non-probability sampling, specifically purposive sampling, to select BDA professionals within the mining industry (Saunders & Lewis, 2018; Yin, 2009). The sampling method targeted individuals who had good experience and exposure to BDA in the mining industry and could provide useful information regarding the research problem.

Participant screening criteria for the research included:

- Industry: Mining
- Companies that offer mining software in the industry.
- People who mine have been exposed to BDA.
- The participants' engagement with big data analytics (BDA), as well as their relevant knowledge of decision-making and strategy in the context of mining.
- Individuals with over 5 years of experience in the mining industry

Following this criterion, a sample of 18 BDA mining professionals was selected. The sample contained 10 participants who were directly working at mining organisations and 8 participants who were OEM/software providers (see Table 1 below). According to Hennink et al. (2017), as cited in Pina et al. and others, it is believed that data saturation occurs after conducting between 9 and 17 interviews. The size of the sample was guided by the data saturation and theoretical saturation of the study. Data saturation and theoretical saturation ensured the credibility and validity of the content collected. In other words, the content collected through the in-depth interview aligned with the literature review.

Saturation, as defined by Hennink and Kaiser (2022), occurs when new problems, insights, and other data stop emerging and the same data appear repeatedly. A sample size of 18 subjects was thus deemed sufficient to provide participants for rich data required to capture the complexity and diversity of the research topic and exhibit content validity (Hennink & Kaiser, 2022). After carrying out the 18 interviews, it was seen that the ideas had repetition. Therefore, it was determined that saturation had been reached.

Table 1: Interview population for the research study

Mining Organisations	OEM/ Software Provider
10 Business Development Managers	8 BDA Professionals

The participants identified and selected according to the screening criteria above were formally invited to participate in the study, with agreed interview scheduled dates and times convenient for the participant and held in their preferred professional space. To ensure confidentiality and rigor in the research process, an interview guide and consent form were prepared, and Microsoft Teams was tested for audio recording and transcription prior to conducting interviews.

4.11 Measurement instrument

For this particular study, semi-structured interviews were used as an instrument for data collection, which followed a developed interview guide (Appendix B) with probing questions strategically structured to explore insights into the research problem and to answer the research questions in detail, allowing the data collection processes to leverage on the expertise and experiences of the interviewees (Saunders & Lewis, 2018). A total of 12 open-ended questions were organised according to four sections covering critical success factors for BDA integration, the role of BDA, the recommendation and approach. These questions were structured to be completed through the interview process within 45 to 60 minutes. All the interviews were scheduled on Microsoft Teams.

A consent form was shared to obtain interviewees' permission before the interview was conducted (see Appendix B). The aim of the study was to seek the perspectives from BDA professionals and not that of the organisation they represent; thus, no permission was sought from the mining companies and OEMs themselves. Prior to commencement of each interview, interviewees were made aware that their anonymity would be maintained, that their participation was voluntary, and that they may withdraw at any time without penalties.

4.12 Data gathering process

The qualitative data for this research were gathered from BDA professionals and experts in the mining industry, which followed a systematic approach comprising semi-structured interviews carried out virtually within the interview guidelines. This exploratory research method aided the collection of rich empirical data (Mikalef et al., 2019). The interview guideline was pilot tested with a BDA professional from the OEM space with extensive BDA knowledge within the mining sector. This was done to ensure that the interview guideline was clear, relevant and suitable for the study, and to ascertain the correct time allocation for the interview (Braun & Clarke, 2006). As a result, the interview guideline as well as the time for the interviews were restructured to 45 to 60 minutes to ensure that the data collected is rich, reliable and valid.

A schedule for the interviews was made according to the availability of first-choice participants. Following confirmation of their availability by phone, each participant received an email outlining the research's goals and thanking them for their willingness to participate. Prior to conducting the interviews, a formal email invitation (Appendix D) was sent out along with a consent form (Appendix C). Following ethical clearance and approval, the interviews were carried out from the 1st to the 17th of September 2025, scheduled for 60 minutes. Participants shared their signed consent forms prior to the interviews to acknowledge consent.

The study used carefully structured interviews consisting of open-ended questionnaires to acquire as much detail from the participants (Appendix A). The interview questionnaire consisted of 12 questions, which were divided into four sections covering critical success factors for BDA integration, the role of BDA, the recommendation and approach. All interviews were held on Microsoft Teams, which was convenient for the participants as they were mostly based across different provinces. Additionally, the interviewees were asked prior to the commencement of the interview for their consent to enable audio recording and the use of video for the interview. The table below summarises the duration of the interviews, with an average interview duration of 53 minutes.

Table 2: Interview duration

Description	Quantity
Number of interviews	18
Total interview duration	16 hours 14 minutes
Average duration	53 minutes 79 seconds
Shortest duration	34 minutes 49 seconds
Longest duration	1 hour 19 minutes 25 seconds

Data Storage: A Google Drive was created by the researcher for the purpose of storing all interviews recorded, the audio recordings, video recordings, Microsoft Teams word notes taken during the interview and the transcribed data. For the respondents' confidentiality, the transcripts and recordings have been anonymised, and only the researcher has access to the drive. The data will be stored for a period of no more than 10years.

4.13 Analysis approach

For data analysis, the thematic analysis technique was used to identify patterns and recurring themes, allowing for insightful conclusions to be drawn from the qualitative data in this study (Braun & Clarke, 2006; Cenamor et al., 2017; Linde et al., 2021). The computer software ATLAS.ti and Microsoft Excel were used for data preparation, including transcribing, cleaning, and coding (Muhr, 2004). A total of 18 interviews were conducted over a period of 16 hours and 14 minutes, with the longest lasting 1 hour and 19 minutes and 25 seconds and the shortest lasting 34 minutes and 49 seconds. The audio and Microsoft Teams were used for transcribing the procedures. To ensure the validity of the recordings, each transcript was cleaned and corrected before the coding phase. The process entailed listening to the audio recordings of each interview while going through the transcribed Microsoft Teams script to fix and clear errors. To further ensure the transcripts were free of errors, the cleaned transcript was read during coding.

4.14 Data interpretation

A systematic approach was used to analyse the unstructured interview data collected. ATLAS.ti, a computer-aided qualitative data analysis software, was used to analyse all 18 interview transcripts (Paulus et al., 2019). It has the

capability to create codes, themes, and relationships through thematic maps. The process entailed representing key themes, AI-coded transcripts, followed by axial coding, grouping similar codes into categories that represent key themes, aiding ease of analysis (Graue, 2015). A crucial component of thematic analysis, which is constant comparison, was used to continuously compare data points, codes and emergent themes (Braun & Clarke, 2006). What the researcher also sought to identify were the divergent cases and outliers, which reveal alternative explanations within the data, ensuring that the research question is fully understood and findings are correctly interpreted (Saldana, 2008). After determining and organising the themes, a narrative synthesis was produced, which provides a comprehensive and logical argument on the findings (Braun & Clarke, 2006; Saldana, 2008).

The technique used to analyse the data adopted Braun and Clarke (2006) as its guide. Their research offered a versatile approach for recognising, recounting, and elucidating patterning in datasets (see figure 1). Such an arrangement enables the research study to draw inferences from the data and create an extensive understanding of the research issue, which is further supported by the perception of participants regarding BDA adoption.

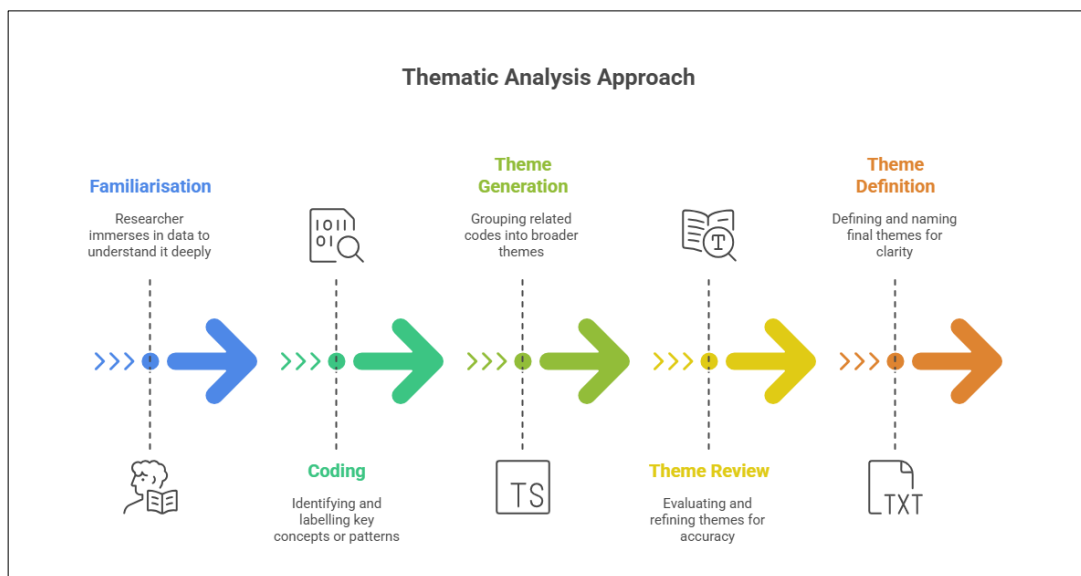


Figure 1: Thematic analysis approach adapted from Braun & Clarke (2006)

Source: Created by Author

4.15 Quality control

It is important to maintain the validity, reliability and trustworthiness of qualitative research through quality control. For this research, the initial step in quality control was taken to ensure that the interview guide and data collection instrument were clear, precise, and appropriate, aligning with the study's objective (Golafshani, 2003).

Validity: It refers to the degree to which findings correspond to the stated objectives of the study (Saunders & Lewis, 2018). In other words, how accurately does the data gathering technique measure what it is supposed to? To ensure validity, a thorough selection of the participants was made, which included only participants with relevant BDA experience and exposure specifically within the mining sector (Campbell et al., 2020). This strict adherence to the choice of participants aimed at maintaining consistency and reliability of the data collected.

Reliability: Reliability is achieved when the data collection techniques and analysis processes produce consistent outcomes (Saunders & Lewis, 2018). Careful attention was exercised by the researcher during semi-structured interviews by following a standardised interview guideline to ensure that the same questions were asked to all participants to maintain consistency, see Appendix B. To achieve a deeper understanding of the themes from the BDA professionals' participants, the questions were designed in a consistent and uniform manner. Additionally, in line with the research topic, emerging codes and themes from the interviews were compared rationally, without predefined categories, to ensure reliability.

Dependability: Saunders and Lewis (2018) stress applying quality control measures using reflexivity and peer review, to ensure the accuracy and precision with which data collection and analysis are done produce consistent results. To help identify potential biases or discrepancies in the researcher's analysis, a thorough method and record of the research study were maintained, supplied, and monitored through supervisory reviews. In addition to standardising interview questions across all participants, the research methodological choices

proposed in the planned phase were adhered to in this study to promote consistency.

Credibility: A qualitative methodological choice was selected as the most optimal approach for answering the research questions, thereby ensuring the study's credibility. The unit of analysis for the research study, as highlighted in section 4.9, was also to maintain credibility by only selecting BDA professionals with experience within the mining industry, providing valid and supported data (Saunders & Lewis, 2018). The researcher used the respondent's triangulation method to connect the different emerging themes narrated by the participants to validate the results and ensure the outcomes are reliable (Mikalef et al., 2019). The strategy facilitated the exploration and confirmation of the veracity of the qualitative outcomes by looking at a research query from different angles (Yadav, 2022).

Transferability: The concept of transferability in this research study was illustrated by providing a detailed account of the research context, participants, and setting of the study, as shown in section 4.9, ensuring that similar research in the same context can be conducted using the same methods (Johnson et al., 2020). The framework further provides sufficient documentation and guidelines through the interview guide and the approach to data collection that is repeatable and where the findings can be transferred to contexts facing the challenge of integrating BDA into their operations, like the mine context.

4.16 Ethical Considerations

Ethical clearance was obtained from the GIBS ethical clearance committee prior to the research being conducted, see Appendix E. Participants gave their consent to participate in the study by signing the consent form prior to the interview, Appendix C. The participants were also advised that anonymity and confidentiality would be maintained as per the consent form, Appendix C, which was further reiterated before the commencement of the interview process. Furthermore, participants were advised that their participation was voluntary and that they had the right to withdraw at any time without penalty. Participants were also informed that their identities would be kept confidential.

4.17 Limitations

Although this study on strategic agility and BDA in the mining industry will offer insightful information, it has several limitations which may impact the study's scope and validity. Qualitative research methodology provides insightful information through an in-depth examination of the perspectives and experiences of persons engaged in the process; however, it also comes with its own limitations. The study undertook a non-probability sampling method, which limits the generalisability of the findings for all organisational settings, as it was context-specific to the mining industry in South Africa (Mikalef et al., 2019; Saunders & Lewis, 2018). However, the research attempted to address this limitation by inviting participants across different mining organisations and provinces, including the BDA OEM providers.

Purposive sampling gave the researcher the opportunity to interact with people who had relevant experience and views to the research topic, providing a targeted and contextually rich viewpoint, however the results are not as broadly applied as those obtained by probability sampling. Given qualitative data is subjective by nature and influenced by personal opinions, the study aimed to overcome this drawback by employing semi-structured interviews for rigorous data collection and further employing triangulation to increase credibility of the findings. However, interviewer's subjectivity might have occurred during interviews and data analysis, considering the researcher's profession as a mining engineer and experience in both mining operations and OEM BDA system provider.

Acknowledging these limitations enabled the researcher to rigorously adhere to a systematic and methodologically sound approach to ensure the validity and reliability of the research findings and conclusions and thus contributing to business and academic body of knowledge.

5. CHAPTER 5: ANALYSIS AND RESULTS

5.1 Introduction

This chapter builds on the methodology chapter presented in Chapter 4, which outlined the research processes and decisions that were taken in this study. It presents the findings of the qualitative study, focusing on the emerging themes under each research question. The thematic analysis of the data facilitated a rich, nuanced understanding of big data analytics (BDA) adoption in the mining context. Five major themes and thirteen (13) distinct categories were identified. These themes and categories capture the multifaceted nature of BDA implementation. The findings present the themes: reactive to proactive intelligence; operational excellence and competitive edge; the pillars of data readiness; human and cultural barriers; and a people-centric change strategy.

5.2 Participants to the study

Table 2 below shows a total of 18 participants who took part in the research study. Participants' names were kept confidential by allocating unique identifiers, such as P01 for participant one. The participant makeup consisted of Original Equipment Manufacturers (OEM), software developers and mining professionals with exposure to BDA. The participants had a diverse range of years of experience in the mining industry, from 15 to 26. The participants have experience in both hardrock surface and underground mining, with only one participant, P13, with softrock/ coal mining experience.

Table 3: Interview participant profile

Participants No	Role	Field	Years in the Mining Sector
P01	Global Trans4Mine Manager	OEM	26 years
P02	Applications Engineer	OEM	19 years
P03	Sales Support Portfolio Specialist-FDM, Digitilisation	OEM	19 years
P04	Operations Manager Southern Africa-Parts	OEM	23 years

P05	Adoption Team Manager: Falls of Ground	OEM	23 years
P06	Manager Operating Model and Business Continuity	Mining	22 years
P07	Business Improvement Manager	Mining	21 years
P08	Engineering Manager- Operations Management&Fleet Management	Mining	23 years
P09	Business Line Manager	OEM	23 years
P10	Reporting Specialist Process Improvement	Mining	18 years
P11	Head of IT Mining	Mining	19 years
P12	Business Line Manager- Automation	OEM	19 years
P13	Operations Director	OEM	25 years
P14	General Manager-Mining	Mining	21 years
P15	Heah Mining Operations & Engineering Leader	Mining	22 years
P16	Section Manager Technical	Mining	15 years
P17	Principal Mining Engineer- Underground	Mining	18 years
P18	Head of Engineering	Mining	18 years

5.3 Analysis and findings from the empirical study

The study set out to investigate the success factors critical to integrating BDA into the decision-making process to improve strategic agility in mining operations. To address the research objective, the research answered four specific research questions (see Chapter 4) framed on: the critical success factors needed to enable the successful integration of big data analytics into the decision-making process, the role of BDA in the microprocesses of strategising,

recommendations for integrating BDA into the decision- making process towards enhancing the strategic agility of mining operations and an approach for the integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations. A total of 183 codes (see Appendix F) were identified across 18 participants. The participants. The following sub-section presents the distribution of codes for each participant. The following sub-section presents the distribution of codes for each participant.

5.3.1 Distribution of codes per participant

Out of 18 transcripts, 183 codes were established (see Appendix F). The frequency of codes for each participant is shown in Figure 2 below.

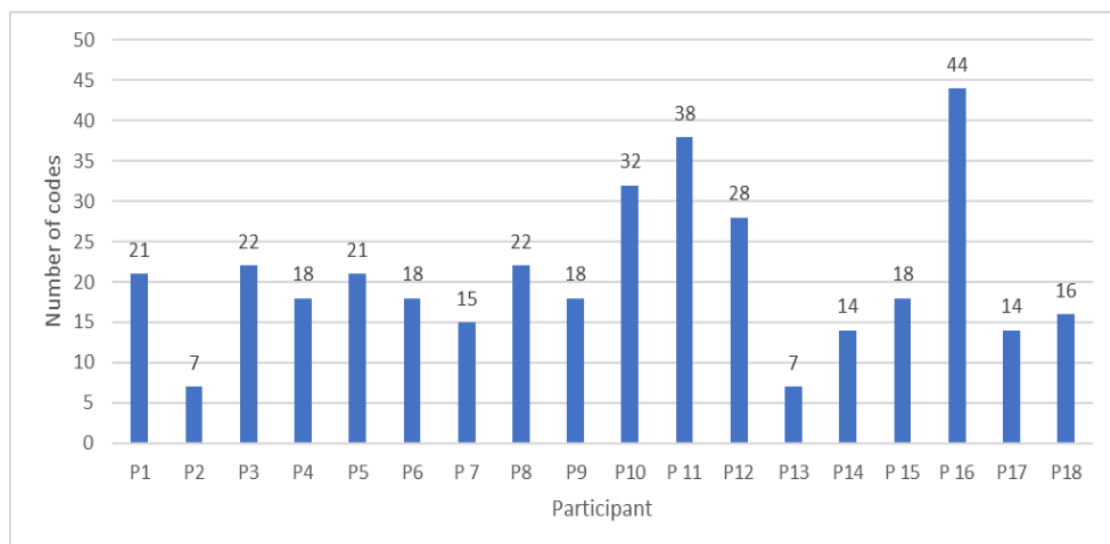


Figure 2: Number of codes per participants

Source: Created by Author

Figure 2 indicates that the number of codes across eighteen participants varied in density and volume. This highlights a 10 (32 codes), 11 (38 codes), 12 (28 codes) and 16 (44 codes). This high number of codes reflects characteristics associated with data saturation, a core principle in qualitative research (Ahmed, 2025). Although the last five interviews (14-18) continued to yield a high volume of codes, a critical analysis showed that the codes were nuanced variations of concepts established in earlier transcripts, with no new themes emerging.

5.3.2 Themes identified

The study's thematic analysis followed the methodology outlined by Braun and Clark (2022). The process began with data familiarisation in phase one, where the transcripts were read and re-read (Braun & Clark, 2022). The second phase was the generation of initial codes. The study yielded a total of 85 codes from all sixteen participants. The codes were carefully examined, duplicates removed and combined into categories (subthemes) and themes. For example, themes such as leadership and governance were accompanied by subthemes: stakeholder engagement and top management support. The fourth stage involved reviewing the themes to ensure they aligned with the research questions and did not overlap. The fifth stage involved determining the significance of the themes, such as ensuring they aligned with the codes and subthemes. Finally, the findings were presented in stage six, which constitutes this current chapter.

The thematic coding and analysis were carefully designed to address the research objectives highlighted in Chapter 4. Table 4 presents the identified categories and themes, aligned with each research question.

Table 4: Study themes overview

Sub-themes	Theme	Research Question
Top management support	Leadership and Governance	Research question 1: What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?
Stakeholder engagement		
Leadership orchestration of BDA adoption		
Data foundation	Data Readiness	
Data governance and ethics		
Predictive capability	Shift from Reactive to Proactive Intelligence	
Enhance decision quality		

Resource optimisation	Operational Excellence and Competitive Edge	Research question 2: What is the role of BDA in the microprocesses of strategising?
Strategic agility and resilience		
BDA facilitates data access and flow	Data accessibility	
Building organisational capacity		
Change management	People-Centric Strategy	Research question 3: What are the key recommendations for integrating BDA into the decision-making process towards enhancing the strategic agility of mining operations?
Structure implementation of BDA and governance		
Stakeholder engagement and communication		
Training and development		
Foundational leadership steps	Pragmatic Approach	Research question 4: What is an approach for the integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations?
Structured and iterative rollout		

In answering the research questions, 12 major themes were identified after conducting thematic analysis. In addition, the data analysis yielded 19 categories. These are fully discussed in the preceding subsections.

5.4 Research Question 1 Results

Research Question 1: What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?

The first research question sought to identify the critical success factors required to enable the successful integration of big data analytics into the decision-making process to enhance strategic agility in mining organisations. Three major themes that emerged were: leadership and governance, data readiness, and a shift from reactive to proactive intelligence. The themes, subthemes and codes are represented in Table 5 below.

Table 5: Them 1 sub-themes and codes

Codes	Sub-themes	Theme	Research Question
Top management support	Top management support	Theme 1: Leadership and governance	RQ1: What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?
Leadership drive			
Executive literacy and communication			
Stakeholder Collaboration and Engagement	Stakeholder engagement		
Stakeholders buy-in			
Cross-functional collaboration			
Collaborative vision			
Strategic Alignment	Leadership orchestration of BDA adoption		
BDA as a Foundational Anchor			
Business-Value Alignment			

5.4.1 Theme 1: Leadership and governance

One of the most prominent critical success factors raised by participants is leadership and strategic governance. Under this theme, three sub-themes were identified, as seen in Table 6 (RQ1 Themes, sub-themes, and codes). These are: top management, stakeholder engagement, and strategic orchestration.

Table 6: Theme 1 sub-themes, codes and frequency

Major Theme	Sub-Theme	Code	Frequency
Leadership and Governance	Top management support	Top management support	13
		Leadership drive	3
		Executive literacy and communication	2
	Stakeholder engagement	Stakeholder Collaboration and Engagement	7
	Strategic orchestration	Strategic Alignment	4
		BDA as a foundational anchor	2
		Business-value alignment	2

5.4.1.1 Top management support

The data indicate that top management's behaviour and attitudes impact the successful implementation of BDA. The perception was shared by all 18 participants who emphasised the role of top management support, leadership drive and executive literacy and communication as vital to BDA implementation. Regarding top management support, participants emphasised that vocal championing and tangible endorsements from executives help to legitimise BDA initiatives in the organisation. Participant 1 specifically emphasised the importance of diffuse leadership, with leadership ideas regarding BDA diffusing throughout the organisation. Participants 10 and 11 echoed the following:

P1 "I think it is always a top-down approach where everything needs to start with if Top management buys into and wants to implement the specific big data analytics."

P10 "I think the tactics mining companies can use is, I think, first of all, it has to be leadership driven, the top people in the organisation must drive them."

P11 “If the leaders are already aligned to that, it is very difficult to implement anything that needs to speak against, because then there is obviously going to be pushback from all angles.”

The above transcripts highlight the role of leadership in aligning the organisation with BDA as a strategic direction. Participants' expressions indicate that leadership drive is a critical success factor. Most participants emphasised that organisations that successfully implement BDA are led by committed project leaders who ensure all necessary resources are channelled towards it.

While participants agreed that top leadership support and leadership drive are key, a leader who does not understand and clearly communicate the value of the strategic change plays a key role in shaping other leaders' attitudes towards BDA. This view was echoed by P13, who stated:

P13 “That needs to flow through the different levels of management, and there has to be that feedback loop to the people that actually do the work to make sure that they have a belief.”

The above can be understood as an affirmation that top management takes the initiative to implement through leadership strategies, one of which is communication. This support facilitates the acquisition of resources and helps overcome resistance to adopting BDA.

5.4.1.2 Stakeholder engagement

An overwhelming majority of participants (18) concurred that BDA implementations require stakeholder involvement for it to be effective. The participants described the role of stakeholder involvement in ensuring communication and introducing BDA projects, addressing employees' fears about adoption, and outlining a vision that creates certainty about BDA. The participants noted that engagement should not be a one-off activity but a continuous process spanning all project phases. For example, P6 and P16 stated:

P6 “You will have to involve them from the start. Furthermore, as we intensify the implementation, they cannot be left behind.”

P16 “So what is important is that stakeholder engagement must be done all the time and in all phases. You know from the phase where you start, while it is still a concept.”

Other participants underlined the operational benefits of stakeholder engagement as follows:

P7 “You know it, it makes it easier for you to collaborate and integrate with your stakeholders.”

P15 “So we therefore need to include the internal stakeholders management in the management of the internal stakeholders. It is more about demonstrating the recipe than the recipe itself, and then allowing that pilot area to apply the data. “

An analysis of participants' perceptions of the role of stakeholder engagement in BDA indicates that stakeholder engagement reduces uncertainty, fosters collaboration, and enhances responsiveness. These are critical success factors for successful BDA adoption.

5.4.1.3 Leadership orchestration of BDA adoption

The way BDA implementation is conceived, and the processes and decisions taken to implement it, influence its success. Eight participants highlighted that leadership plays a role in articulating a clear vision, aligning organisational culture, and ensuring that processes and decisions are structured to support BDA adoption. For example, P8 described how embedding data analytics into BDA adoption of a “utopian strategy” helps shift organisational culture, a point also supported by P11. Sharing a related view, P12 noted that strategic direction informed by BDA reduces the time required to make sense of business performance. As a result, the decisions are made faster. Some participants, such as P14, out that middle and senior managers often lack data literacy,

underscoring the need for structured training to enhance leaders' understanding of BDA. Participants highlighted the following:

P8 "Your role in this bigger utopian strategy that is grounded by these data analytic salient points is very important for your strategy. With your strategy in place, you change your culture."

P11 "Because then employees can see that this is already enforced at the top, which makes your life a lot easier when you are dealing with any of the other employees at the lower ranks for them to then align with the business."

P12 "It is so it reduced the amount of time it used to take us basically to understand the business; you are now able to, you know, make sense of what is happening within your business."

P14 "Understanding is key, people in middle to senior management may not understand the data. Training courses for HODs can be very effective."

The participant insights suggest that successful BDA implementation is anchored on deliberate leadership orchestration that integrates vision, culture and capability across organisational levels.

5.4.2 Theme 2: Data readiness

The theme of data readiness emerged as a crucial factor in BDA adoption in a mining organisation. Fifteen participants pointed out that utilising BDA requires individuals who are highly digitally literate not just to read data not only to read data, but also to execute. The theme was supported by two subthemes: data foundation and data governance and ethics.

Table 7: Theme 2 sub-themes and codes

Codes	Sub-themes	Theme	Research Question
Trust in data	Data foundation	Data readiness	Research question 1: What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?
Data integration			
Data accessibility & interpretability			
Cross-functional data - Contextualization			
Shared data interpretation			
Data accuracy, integrity, and management	Data governance and ethics		
Data Quality, Governance and Security			
Ethical handling of data			
Strategic data selection			

5.4.2.1 Data foundation

The theme of data governance and ethics is linked to data readiness, presented in the previous section. The data indicated that participants were concerned about how data is managed and handled. Fifteen participants highlight that BDA cannot be effective without a workforce that is both digitally literate and strategically equipped to manage, interpret and apply insights from the data. As indicated in Figure 2, the most prominent aspects of data readiness include: trust in data (11 participants), data quality (9 participants), data accessibility and interpretability (8 participants), strategic data selection (8 participants) and data foundation (8 participants). The following transcripts sum up participant perceptions regarding data quality in BDA adoption in the mining organisation:

P5 “Trusting environment where you let the data speak for itself, and then we can explain and rather than trying first to understand this data and then craft a message all the way up right.”

P10 “I think the first one will probably be data quality and accessibility because, without access, you will not be able to get any insights.”

P15 “What is the level of quality of the data? How has it been signed off? Are you having? How often has this data been reviewed? Moreover, what problem are you on? How often has this data been reviewed? What problem are you trying to solve? Then you look into those kinds of elements forecasting. After all, there is so much data as well.”

P17 “It is not even picked up as an item, which is as important as installing ventilation, so maybe having access points underground that would kind of help unlock being able to receive your data as quickly as possible, and that is easy.”

The main concern raised was data trust. The participants noted that confidence in is essential before data can drive decision-making. For example, P5 stated the need for a “trusting environment where you let the data speak for itself.” Participant 15 highlighted the importance of reviewing and signing off on data quality to ensure reliability. Participants perceived the critical role of BDA in strategising as reliable and high integrity, providing the raw material for strategising—reliable, high-integrity data. The findings show that most participants indicated that BDA primary role is to transform raw operational data into a trusted asset that the company could use for implementing its strategies. The participants indicated that quality data, data verifiability, data standardisation and data integration are key in achieving a holistic BDA implementation.

Closely linked to data quality, P10 pointed out that data quality was vital for preventing flawed decisions. Another key aspect that emerged from the data is data accessibility and interpretability. Participants 8 and 17 described how establishing underground access points could “unlock being able to receive data quickly”. Data integration across multiple platforms was also raised, with P4 indicating that data should not remain siloed in one department but be linked across functions to reflect its impact.

5.4.2.2 Data governance and ethics

The findings indicated that data governance was vital for preventing flawed decisions. Participants expressed their views on how data governance and ethics contribute to data readiness the successful integration of big data analytics into the decision-making process.

P2 “You do not wait for people's input necessarily on a personal level and it is not about my opinion or I do not try to skew the information.”

P3 “And then I think with some of our specific experience customers that we have worked with to keep it anonymous.”

P4 “So the accurate understanding of the level of variation that's in the data, I think, is one critical factor.”

The evidence presented above demonstrates that successfully implementing BDA requires the ability to handle the information ethically. This entails not tampering with data accuracy and using anonymity when necessary. Overall, the findings suggest that data governance is a critical success factor for the effective implementation of BDA.

5.4.3 Theme 3: Shift from reactive to proactive intelligence

The theme indicates that a critical success factor for BDA in integrating big data analytics into the decision-making process is a shift from reactive to proactive intelligence. The theme had two subthemes: predictive capability and enhanced decision quality. The codes for these subthemes are presented in Table 8 below:

Table 8: Theme 3 sub-themes and codes

Codes	Sub-themes	Theme	Research Question
Predictive maintenance			
Forecasting and predictive planning			
Scenario planning			
Proactive culture			
Navigating market volatility			

Optimising life-of-mine strategy	Predictive Capability	Shift from reactive to proactive intelligence.	Research question 1: What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?
Informed decision-making	Enhance Decision quality		
Integrated decision-making			
Unbiased information			
Operational data insights			
Uncovering hidden strengths			
Long-term information			
Analytics for business insights			

5.4.3.1 Predictive capability

The findings on the theme of predictive capability indicate strong consensus on its importance. The data shows that 14 out of 18 participants contributed codes to this theme. The most prominent code was predictive maintenance. Participants highlighted that predictive maintenance was crucial for minimising downtime and optimising asset life.

The data showed strong consensus among participants (14 out of 18) that predictive capability is a core benefit of BDA. The most frequently cited code was predictive maintenance, with participants explaining that BDA can minimise downtime, extend asset life and optimise resource allocation. For example, P5 noted that big data enables “assessing risks” in decision-making to measure their impact. Participant 8 described BDA role in operational planning by identifying workforce gaps in advance. Detailed perceptions raised by participants are presented below:

P4 “I would anticipate that strategy stays fairly static over long periods, that very senior executive team needs to be analysing data for market trends and understanding commodities that they might want to target as part of their plans, etc.”

P5 “What big data brings is the ability to look at data but also assess the risks so that you can see more or less the level of risk that you have in any of those decisions that you are taking.”

P3 “You become predictive and not firefight the whole time. So, I think it is vital to see that, in essence, some of the benefits. “

P10 “So big data plays a critical role in setting realistic targets for the organisation. Which is backed by data and rule scenarios, right? Like scenario planning, forecasting, and also optimising.”

The perceptions suggest that shifting from reactive to proactive intelligence, enabled by predictive capability and enhanced decision quality, is a cornerstone of successful BDA integration in the mining organisation. Predictive maintenance and human oversight ensure algorithms are applied effectively. These actions enable the organisation to anticipate risks, optimise strategies and strengthen agility.

5.4.3.2 Enhance decision quality

The findings were widely supported by most participants, with an overwhelming 17 participants emphasising aspects of enhanced decision quality. The high number of codes on ‘informed decision-making’ and ‘fact-based decision-making’ highlights that decisions must be supported by verifiable data to be effective. This represents a core cultural and procedural shift that participants deemed crucial for success. Participants indicated that holistic and integrated decision-making are important critical success factors for BDA implementation in the mining sector.

This theme was strongly linked to the theme of data quality discussed in Section 5.5.2 (Data readiness). The findings indicated an overwhelming consensus

among participants (17 out of 18). They highlighted that enhanced decision quality is a critical success factor for the integration of BDA in the mining sector. The dominant codes were: “informed decision-making” and “fact-based decision-making”. These codes suggest that participants viewed a fundamental shift in decision-making culture and procedures as essential. The participants indicated the following:

P6 “Once we get there, we understand the role. It is important to imagine the role is just going to make factual decisions.”

P7 “Data-driven decision, which is a function. You can be efficient and productive and realise profits.”

P2 “It is fact-based decision-making. You are not guessing, you are basing it on actual events and actual information that you are seeing.”

P17 “Economic indicators can help you have a strategic plan, depending on external factors as they change. You can always stay afloat.”

The statements presented above imply that BDA creates transparency and accountability, thus reducing subjectivity or politically influenced decision-making. Participants also pointed to the need for decisions that account for interconnected impacts across the mining value chain in order to prevent silo-based sub-optimisation:

P4 “At the end of the day, it is about consolidating the different thoughts... that would take 10 people sitting in a meeting, for a mine manager to have a certain direction.”

P5 “Getting more frequent, nuanced views might help decision makers to move quickly.”

These sentiments underscore the importance of BDA in synthesising multiple sources of data. This allows for making decisions that remain agile under changing conditions. The findings emphasise that decisions should be fact-

based, holistic, and adaptive. What is important to note is that participants opined that BDA does not replace human judgment but augments it by providing integrated and reliable insights.

5.4.4 Summary of Results: Research Question 1

Research question 1 sought to identify the critical success factors enabling the successful integration of big data analytics into decision-making to enhance strategic agility in mining organisations. The findings revealed three critical success factors essential for integrating BDA into decision-making to improve strategic agility in mining organisations. The findings revealed that leadership and governance were the most prominent critical success factors. The findings highlighted the key role that leadership plays in driving BDA initiatives. The theme was supported by three subthemes: top management support, stakeholder engagement and leadership orchestration. The findings indicate that top management support played a critical role in championing, providing tangible endorsement, and allocating resources to BDA initiatives. In addition, continuous and inclusive engagement with all stakeholders from the project inception is crucial for fostering collaboration and ensuring buy-in. Lastly, it aligns BDA with the organisation's core vision. They articulate a clear data-driven culture and ensure that all processes are designed to support the adoption of BDA in the organisation.

The second theme was data readiness, which emphasised that effective BDA implementation is influenced by data quality and governance. This theme emphasises the importance of data foundation, data governance, and ethics. Data foundation entails that the successful implementation of BDA depends on establishing data accessibility and interoperability, and cross-functional integration. In terms of data governance and ethics, the findings revealed that robust quality, accuracy, integrity, and security are crucial for the effective implementation of BDA.

The third theme was the shift from reactive to proactive intelligence adoption. This factor was presented as a key strategic benefit of BDA implementation. It is characterised by predictive capability, where BDA enables predictive maintenance, forecasting and scenario planning. This helps mining

organisations anticipate market volatility and optimise their strategies. Proactive Intelligence also enhanced decision quality. The findings revealed that BDA integration leads to more informed, fact-based decision-making. Overall, the findings show that well. Successful BDA integration is not just a technological transformation but also a strategic one.

5.5 Research Question 2 Results

Research Question 2: What is the role of BDA in the microprocesses of strategising?

The second research question asked: What is the role of BDA in the microprocesses of strategising?

One central theme, operational excellence and readiness, and two sub-themes (resource optimisation and strategic agility and resilience) emerged from the thematic analysis.

Table 9: Theme 4 sub-themes and codes

Codes	Sub-themes	Theme	Research Question
Operational optimisation	Resource Optimisation	Operational excellence and competitive edge	Research question 2: What is the role of BDA in the microprocesses of strategising?
Process optimisation			
Resource utilisation			
Productivity			
Identifying bottlenecks			
Value chain analysis			
Enhanced agility	Strategic agility and resilience		
Real-time decision-making			
Faster problem-solving			
Market responsiveness			
Business resilience			
Opportunity identification			
Operational to strategic linkage			
Business continuity insights			
Informed expansion and market cycle analysis			

5.5.1 Theme 4: Operational excellence and competitive edge

The second research question asked, What is the role of BDA in the microprocesses of strategising? Three major themes and six sub-themes emerged from the thematic analysis. The theme of operational excellence and competitive edge was established. The subthemes of resource optimisation, strategic agility, and resilience supported it. The theme of operational excellence and competitive edge describes how BDA drives efficiency and effectiveness at the operational level to create sustainable advantage in the competitive market.

5.5.1.1 Resource optimisation

Participants expressed that BDA, if effectively implemented, can help an organisation optimise its resources. The theme emerged as a crucial operational benefit of BDA. The data indicates that BDA is not perceived as a mere reporting tool but as an active mechanism for driving efficiency and eliminating waste across mining operations.

Participants' perceptions about resource misappropriation can be further categorised under operational optimisation, process optimisation and resource utilisation. Participants further highlighted that the direct application of BDA refines and approves core activities. The focus extends from simple efficiency to smarter asset deployment. The following transcripts summarise participants' perceptions of the role of BDA on resource optimisation:

P8 "I need to reduce my breakdowns. I need to increase my availability. I need to decrease my costs. I need to increase the time that my people spend on planned maintenance."

P10 "It also helps with operational optimisation in the sense that a lot of these analyse. You could have done it by the time you studied in the field, or by using these massive Excel spreadsheets."

P7 "To streamline that process, make it less paper reliant. You do the inputs live when you can, and it does not add an extra activity away from the mining that needs to happen."

P18 “The more you are able to show the use case for the big data and what value can actually be derived from it.”

The findings show that participants acknowledged BDA ability to identify bottlenecks. BDA was seen as crucial in strengthening operational excellence and enabling smarter resource deployment, real-time responsiveness and continuous process improvement.

5.5.1.2 Strategic agility and resilience

The theme of strategic agility and resilience indicates the transformational role of BDA in extending organisational capability from operational efficiency to strategic foresight, adaptability and resilience. Although only six participants highlighted this theme, they raised crucial ideas, suggesting that agility is grounded in BDA ability to enable real-time decision-making. For example, participants highlighted that it is challenging to extract live data from complex mining environments, but stressed that once this information is archived, real-time visibility is indispensable. The participants echoed the following statements:

P5 “ It is not like you can easily get real-time information from a mine in the middle of face cutting, which might be affected by the constraint of the bandwidth.”

P10 “It is very important to be agile; otherwise, you basically run yourself out of business.”

P15 “When it comes to critical moments... we know that certain data really need to be presented. Currently, we are doing something we call business resilience.”

The above excerpts indicate that real-time capability underpins an organisation’s adaptability to be market responsive and to engage in, enabling market responsiveness and opportunity identification. It can be concluded that the findings highlight that by harnessing analytics to monitor trends and shifting conditions, mining firms can align strategic priorities with external changes.

5.5.2 Theme 5: Data accessibility

The theme of data access and flow was raised as a critical success factor for adoption. This section regards data accessibility as a facilitator of data access and flow. The theme of data accessibility is presented through two subthemes: BDA facilitates data access and flow and building organisational capacity. These two subthemes reflect how BDA empowers the mining organisation in the microprocesses of strategising.

Table 10: Theme 5 sub-themes and codes

Codes	Sub-themes	Theme	Research Question
Infrastructure and technology / Readiness	BDA facilitates data access and flow	Data Accessibility	Research question 2: What is the role of BDA in the microprocesses of strategising?
Connectivity Infrastructure			
Robust and scalable technological infrastructure			
Real-time insights and scalable cloud platforms			
Infrastructure for remote operations			
Tools as enablers			
Fit-for-purpose system design			
Talent and Skills / Upskilling	Building organisational capacity		
Analytical Capability			
Data Accessibility and Interpretability			
Modernising regulatory and qualification frameworks			

5.5.2.1 BDA facilitates data access and flow

The theme of data access and flow was raised as a critical success factor for adoption. This section regards BDA as a facilitator of data access and flow.

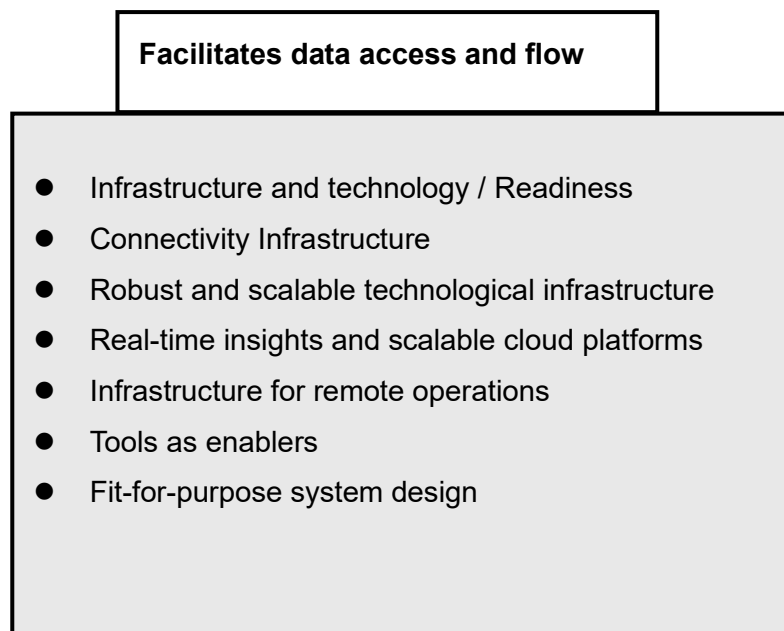


Figure 3: Codes for data access and flow

Source: Created by Author

This sub-theme captures the role of BDA in developing the conduits and pathways that deliver trusted data to the right people at the right time, thus facilitating dynamic microprocesses of strategising. Codes such as robust technological infrastructure, scalable cloud platform and connectivity infrastructure underscore the role of BDA in providing the high-performance capabilities necessary for real-time data collection. The participants echoed the following:

P6 “So the other thing that I see that is important from the data is what you need. We need stability.”

P8 “I think operational readiness. Organisational readiness: Elon Musk wants to take us to Mars. Are we ready for it? And are we ready for it? Is someone closer to Mars than where we are right now? You understand? So those are those factors.”

P10 “And with all the infrastructure in place, you're actually able to get data in real time and respond proactively.”

P11 “When you start analysing closer to real time and as close to every shift as possible, you're able to track your trends. You're able to see the minute details that impact your production.”

P18 “Easy to understand and to make sure that whatever decision is being made, it mitigates a lot of down pits, whether it's using historic data or it's trying to predict something that never happened.”

The findings highlight that the concept of fit-for-purpose system design indicates that these systems must be tailored to the specific decision-making contexts of the mining industry. The data further shows that the ability to provide infrastructure for remote operations is particularly important to ensure that strategic insights are not limited to a central office but are available across distributed operations.

5.5.2.2 Building organisational capability

This theme emphasises the importance of human, cultural and leadership elements required to leverage the technological pillars effectively. It focuses on the people side of BDA utilisation in the mining context. The theme that BDA helps to build organisational capability.

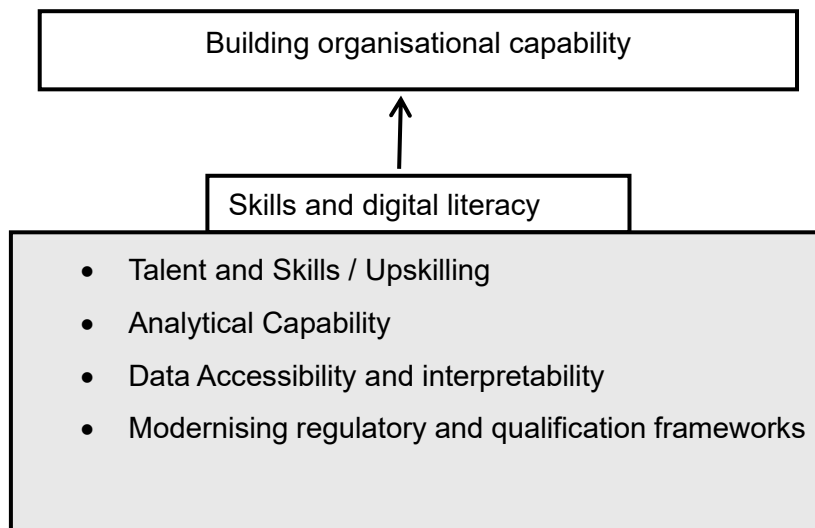


Figure 4: Codes under building organisational capability

Source: Created by Author

The data reveals that while the mining industry recognises the need for enhanced skills and digital literacy as a critical success factor for BDA implementation, it remains a significant challenge. One of the major concerns identified by participants is the skilled workforce/upskilling as a necessity. This subject was raised by 5 participants (P3, P5, P9, P10, P11), who shared the consensus that technical infrastructure alone is not enough without the human expertise to leverage it. In addition, Participant 1 emphasised the importance of analytical capability, highlighting the importance of not just having basic BD literacy but the ability to derive meaningful insights from the data. The participants echoed the following:

P4 “I think getting people to feel comfortable with data, the training courses that we do with people and across all levels in the company, all different roles that people are exposed to data and opportunity, allowed to work with it on their own.”

P10 “An organisation should be prioritising, upskilling their workforce to be able to use such tools.”

P11 “So if you do not have competent people, the infrastructure to support all of those things can actually all fall apart.”

P13 “Understanding is key, people in middle to senior management may not understand the data. Training courses for HODs can be very effective.”

The transcripts presented above indicate that training across all levels was repeatedly highlighted as essential for embedding a data-friendly culture in the mining organisation. For example, P4 observed that when employees are exposed to data and allowed to work with it on their own, it creates comfort and confidence. However, P13 noted that targeted training is necessary for middle and senior managers.

The data indicates that the role of BDA in the microprocesses of strategising is to help in aligning technological and policy infrastructure. This view was shared by five participants who emphasized that BDA supports microlevel strategising only when organisational systems, policies and operational practices are compatible with technological requirements. The participants raised issues such as restrictive IT policies in the mine, incompatible software and misaligned operator practices, which can hinder the flow of actionable data (P1, P12). The participants noted that BDA ownership was essential for embedding insights into strategic actions. The following excerpts summarise participants' views regarding the role of BDA in building organisational capability.

P5 “It is not technology for technology's sake. So, I think one of the key things in my view is how do we align big data? I'll use the word big data capabilities with the organisation capabilities as well.”

P1 “Continuous improvement, you know you always have to be able to look back and review, like, OK, what is working, what is not working and tailor-make solutions.”

P12 “What technology or what systems are out there, and which ones are then suitable as well as compatible with your IT?”

These insights suggest that BDA facilitates microprocesses of strategising by connecting leadership direction, operational data, and policy-compliant infrastructure, ensuring that decisions are informed, timely, and integrated across organisational levels.

5.5.3 Summary of Results: Research Question 2

Research question 2 sought to establish the role of BDA in the microprocesses of strategising. The findings revealed two key themes: operational excellence and competitive advantage, and data accessibility as an enabler of strategising. The findings revealed that BDA directly influences the microprocesses of strategising through resource optimisation and strategic agility, and resilience. On resource optimisation, the findings revealed that BDA enables efficient analysis of operations, resulting in process optimisation, enhanced resource utilisation increased productivity. In addition, BDA adoption enhanced real-time decision-making and faster problem-solving. These efficiencies enhanced the mining organisations' overall market responsiveness and business resilience.

The findings also revealed that data accessibility was an enabler of strategising. BDA adoption effectiveness was dependent on data accessibility and usability. This theme indicates that the infrastructural and human factors were key enablers that allowed strategising to happen effectively. One of the factors is data access and flow. The findings showed that BDA provides the technological grounding for strategising through robust and scalable infrastructure and uninterrupted connectivity. The second factor was organisational capability. The findings revealed that technology alone is insufficient to ensure effective implementation of BDA. Mining organisations require the necessary talent, skills and analytical capability. Therefore, in the absence of these, the organisations are required to engage in targeted upskilling and cultural shift to ensure employees at all levels can interpret and use data, and embed data-driven decision-making into the daily operations of the mine.

5.6 Research Question 3 Results

Research Question 3: What are the key recommendations for integrating BDA into the decision-making process towards enhancing the strategic agility of mining operations?

This research question focused on key recommendations, suggested by the participants, for integrating BDA into the decision-making process towards enhancing the strategic agility of mining operations. This recommendation was shared by all 18 participants through different lenses presented as codes. A major theme that emerged was people centred strategy with change management, training and empowerment identified as crucial aspects.

Table 11: Theme 6 sub-themes and codes

Codes	Sub-themes	Theme	Research Question
Intensive and personalised change management	Change Management	People-centric Strategy	Research question 3: What are the key recommendations for integrating BDA into the decision-making process towards enhancing the strategic
Change management and communication integrated			
Paramount importance of change management			
Start small with pilots / new technologies			
Use-Case Driven Approach	Structured Implementation of BDA and governance		
Focus on 'Burning Platforms			
Realistic Roadmaps & Managed Expectations			
Continuous stakeholder involvement	Stakeholder Engagement and Communication		
Co-creation and buy-in			
Identifying stakeholder needs			
Building data comfort through training and exposure			
Empowering change champions			
Injecting diverse skills and Perspectives			

Skilled Workforce / Talent and Skills / Upskilling	Training and Development		agility of
Skills Gap & democratisation			mining
Coaching & Applied Learning			operations?
Building Data Comfort through Training & Exposure			

5.6.1 Theme 6: People-centric strategy

The people-centric strategy emerged as a key recommendation for enhancing BDA implementation in the mining organisation. This recommendation was shared by all 18 participants through different lenses, presented as codes. Change management, training and empowerment were identified as crucial aspects of the people-centred strategy.

5.6.1.1 Change management

The people-centric strategy emerged as a key recommendation for enhancing BDA implementation in the mining organisation. This recommendation was shared by all 18 participants through different lenses, presented as codes. Change management, training and empowerment were identified as crucial aspects of the people-centred strategy.

A people-centric and cultural strategy emerged as a key strategy to facilitate the implementation of BDA in the mining organisation. The data indicate that all 18 participants contributed to this theme. First, they indicated the importance of intensive and personalised change management, with six participants contributing. The participants indicated that intensive and personalised change management is important to navigate resistance and build trust in BDA (P5, P6, P7, P10). Further, the participants recommended taking measures that empower mine employees, such as building data comfort through tailored training and exposure, simplifying data tools and injecting diverse skills and perspectives to promote inclusivity. The participants indicated the following:

P4 “And if we are moving from a state of not recognising the value of data or being able to work with the data and to make better quality decisions, you know, through data. Then, if we are not, if we are not communicating

value around developing those things from level 1 competence to level 10 competence.”

P6 “And for me, the change management is getting everybody on board. I need to understand that.”

P11 “I think you do need some form of change champion when you are introducing it so that everyone gets to be on board and understands what the business stands to gain by this and how they can shift you, especially with your competitiveness.”

The data also revealed that participants recommended embedding a data-driven culture through strategic hiring (P4) to promote a predictive mindset and demonstrate the value of BDA in securing buy-in (P10). The findings indicate that a people-centric change management approach is critical for successful BDA implementation in the mining organisation. Participants emphasised that intensive and personalised change management helps navigate resistance, build trust and ensure employees understand the value of data in decision-making.

5.6.1.2 Structured implementation of BDA and governance

A structured implementation of BDA and governance emerged as a key aspect that facilitates the implementation of BDA in the mining organisation. The theme was shared by 14 participants who advocated for pragmatic, risk-managed rollover rather than a large-scale transformation. The participants highlighted the following sentiments:

P5 “The other piece is more about how we make sure that the ideas are not so far ahead of where the organisation is at. That you can realistically apply them right and roll them out, and that is the challenge, right?”

P7 “Phased Pilot-to-Scale Implementation, to measure, put metrics, set metrics, and measure some key KPIs systems. To have real-time monitoring can easily determine if there are incidents or accidents.”

P12 “Your system needs to be in trouble or needs to be fully integrated into the system. It makes life easier for the users because, as I said, people just want technology basically to simplify their lives and not complicate it.”

Participants recommended introducing small pilots and targeting low-hanging fruit (P3, P7, P10, P15, P18), and utilising these opportunities to demonstrate quick wins and build organisational confidence. Participants, however, cautioned that the phased approach should be guided by realistic roadmaps and managed expectations, informed by cost-benefit analysis (P5, P10). Other participants, such as P3, P5 and P6, concurred that establishing a strong foundation for data standardisation governance and ethical frameworks is recommended to ensure data reliability.

From the perceptions of participants, it is reasonable to conclude that structured implementation and governance facilitate the integration of BDA into micro-processes of strategising by providing controlled, measurable, and trustworthy mechanisms for embedding data-driven decision-making into organisational routines.

5.6.1.3 Stakeholder engagement and communication

The findings indicated that a significant number of participants (8) were of the view that proactive stakeholder engagement and communication were crucial for building support for BDA in the organisation and ensuring alignment throughout the organisation. Stakeholder engagement was seen to include early and continuous involvement of all stakeholders in the process. In addition, participants indicated that there is a need to build ongoing confidence in stakeholders through a commitment to showcasing proven use cases and leadership storytelling.

P8 “So storytelling of a journey that another person went through when they did the same process, tried and tested at another company or as part of a thesis, the journey map of this current value driver tree for a company. That would definitely assist.”

P3 “The development of the user requirements involves all the stakeholders mapping out exactly what you are trying to achieve.”

P14 “To take the people along. You will need to take the people along. And sometimes I know it is many people who can be very demanding and very robust and want this thing to happen.”

Based on the recommendations provided by participants, the study established that proactive and continuous stakeholder engagement is critical for successful BDA implementation. The participants emphasised that involving stakeholders early and throughout the process fosters organisational alignment, builds trust and ensures support for BDA adoption initiatives. These insights suggest that stakeholder engagement must be a continuous process to underpin the effective integration of BDA into the mining organisation's practices.

5.6.1.4 Training and development

Another crucial recommendation that participants identified as crucial for the successful adoption of BDA is skills development through various initiatives. Eight participants (P3, P5, P9, P10, P11, P13, P14, P15) concurred about the need for enhanced BDA skills enhancement, but they differed on the nature of skills development they preferred.

P13 “The guy at the top has a belief in data. If the people at the bottom do not understand it. So, I think training is incredibly vital.”

P14 “It might be good that as mining businesses we put a little bit of effort in, in, in getting people trained to understand data, to interpret data and form patterns.”

P15 “Continuous training is the key to sustaining the momentum. You will lose the momentum if you do not have that kind of refresher training.”

The evidence presented above reveals that successful BDA implementation is fundamentally a human-centric challenge that can be addressed through dedicated training and development initiatives. Stressed by the participants was

a need for a cultural shift facilitated by BDA oriented training. This involved empowering change champions to lead the transformation and using coaching and applied learning. Participants emphasise that training should be continuous to ensure that employees sustain the momentum. Overall, the evidence suggests that the effective adoption of BDA hinges on the ability of leaders to provide an environment for effective training and development.

5.6.2 Summary of Results: Research Question 3

This research question proffered key recommendations, based on participant perceptions, for integrating BDA into decision-making processes of mining operations. The findings underscored people centric strategy as fundamental to successful integration of BDA, seen as a key enabler for enhancing BDA implementation. Four key elements were identified as the foundation to people centric strategy that is: proactive and integrated change management, pragmatic implementation, stakeholder engagement, and training and development. Proactive and integrated change management was identified, with stronger emphasis on intensive and personalised change management, and empowering change champions to drive BDA implementation. In addition, structured, pragmatic BDA implementation focused on using pilots and targeting urgent problems to demonstrate quick wins, the use of a case-driven approach and realistic roadmaps.

The findings revealed that continuous stakeholder engagement and communication were crucial from the beginning in order to solicit stakeholder buy-in from stakeholders. Lastly, the findings suggest the need for comprehensive training and development initiatives on BDA capacity building. This includes building data comfort, which ensures that employees are trained to understand, interpret and trust data, investing in continuous training for existing employees and injecting diverse skills into the mining organisations.

5.7 Research Question 4 Results

Research Question 4: What is an approach for the integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations?

The approach that can be implemented to enhance the integration of BDA in the decision-making process was proposed as a recommendation by the participants. The findings revealed a pragmatic approach to integration. This included foundational and leadership steps and structured, iterative rollout as subthemes.

5.7.1 Theme 7: Pragmatic approach

This theme was supported by two sub-themes: foundational leadership steps and structured rollout and iterative approach.

Table 10: Theme 7 subthemes and codes

Codes	Sub-themes	Theme	Research Question
Ensure decisions are fact-based and transparent.	Foundational leadership steps	Pragmatic approach	Research question 4: What is an approach for the integration of BDA into the decision-
Top-down, transformational leadership			
Data governance and management			
Modernising Regulatory and Qualification Frameworks			
Pilot, phased implementation	Structured and iterative rollout		
Holistic, phased approach			
Structured methodology with change management			
Change management and integrated communication			
Realistic system integration			
Fit-for-purpose system design			

			making process towards enhancing the strategic agility of mining operations ?
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5.7.1.1 Foundational and leadership steps

The importance of effective leadership was a prominent feature in all transcripts. The data indicate that participants overwhelmingly suggested leadership as an essential and strategic direction that must be established before any BDA technical rollout begins. Some echoed participants views are quoted below in support of leadership as a strategic force for the implementation and driving of strategic direction.

P14 “You know, people are talking about AI and how mining is going to be in the future. The people in leadership positions are the ones that must drive this. My view is that the approach that must be taken, is that we need to be decisive as the leadership of businesses that this is the direction that we want to go, it starts from the top. We can educate the people.”

P8 “So how you are going to sway the company or the organisation or your team to where you need to go? It must be leadership driven, not transactional, transformational.”

P10 “I think the tactics mining companies can use are, first of all, it has to be leadership driven. There must be appetite by the top people in the organisation to be able to make decisions informed by big data.”

These views from the participants regarding the importance of leadership are further presented in Table 12 below.

Table 12: Related codes and frequency (sub-theme 5.8.1.1)

Code Name	Frequency
Top-down Transformational leadership	15
Data governance and management	9

The data presented in Table 12 shows that the implementation of BDA is not a single action but a structured and phased journey that should prioritise strong foundations, iterative learning and cultural adoption. Participants highlighted that the first phase involves the establishment of foundational and leadership steps where the leadership in the organisation provide strategic vision and authority. In addition, this leadership provides a robust framework for data governance and management.

5.7.1.2 Structured and Iterative Rollout

A structured and iterative rollout of BDA was presented as a crucial approach to the implementation of BDA in the mining organisation. The majority of participants pointed to different approaches, such as pilot, phased implementation, holistic, phased approach, structured methodology with change management, realistic integration and fit-for-purpose system design, as indicated in Table 13 below.

Table 13: Structured and iterative rollout approach to BDA codes

Code Name	Frequency
Pilot, phased implementation	5
Holistic, phased approach	4
Structured methodology with change management	3

Code Name	Frequency
Change management and integrated communication	4
Realistic system integration	2
Fit-for-purpose system design	2

The structured and iterative rollout approach was endorsed by participants (P3, P4, P6, P7, P10, P11, P15, P18). They highlighted that the approach rejects a big-bag implementation in favour of a phased, pilot-based strategy. This approach was also identified as a recommendation under findings for Research Question 3. These approaches, however, differ in their philosophical orientation. For instance, the phased rollout emphasises iterative execution, while realistic system integration emphasises pragmatic planning. The participants raised the following suggestions:

P5 “So often you find that some great initiatives do not actually hit the ground, just purely because they are not launched well, or at least they are not applied to the context in the organisation.”

P6 “And for me, the change management is getting everybody on board. I need to understand that.”

P8 “Knowing your audience and how they interpret and what they can interpret from history, where it has worked well, how those strategies of change have gone over?”

P10 “Scale up as you get comfortable... there is no way you can just roll out new systems for the entire mine. You can probably start with a small section, get it stabilised and then scale up as you go.”

P15 “And obviously the higher up you go to your executive and so forth, then that becomes the linkage in terms of how different levels are to be

operated. On your shop floor, it must become like a daily routine; it must be something that really needs to be done.”

The participant recommendations presented above indicate that a structured iterative rollout of BDA is considered essential for effective implementation in the mining organisation. As indicated in Table 13, there was strong support for pilot, phased implementation and holistic phased approaches. In addition, a structured phased approach for real time incremental adjustment was supported by participants, seen as a way of achieving stakeholder buy-in. Change management and communication were also key aspects of the theme which were emphasised. This highlights that gradual, managed BDA adoption is desirable. Participants 6 and 8 viewed change management and communication as crucial in ensuring adoption across all organisational levels.

5.7.2 Summary of Results: Research Question 4

This question presented approaches for the integration of BDA into the decision-making process to enhance the strategic agility of mining organisations. The findings revealed a pragmatic approach to BDA implementation, characterised by two subthemes: foundational leadership steps and structured iterative rollout. The findings revealed that before any technical rollout, the approach should begin with establishing a strong strategic and governance foundation, which includes top-down, transformational leadership, establishing data governance and management, and committing to fact-based decisions. Secondly, it was a structured, gradual and methodical approach.

5.8 Overall Summary: Results summary in relations to empirical findings

This chapter was dedicated to the presentation of qualitative findings. The study provided a detailed understanding of the critical success factors essential for the integration of BDA into decision-making processes to enhance strategic agility in the mining industry. Drawing on the insights of the 18 participants, the study results underscore that the adoption and integration of BDA is best regarded as a strategic transformation rather than merely a technological undertaking. Success demands commitment from leadership, high-quality data, cultural integration, and a structured approach.

Research Question 1: Critical success factors

The study identifies the critical importance of leadership and governance in validating and advancing BDA initiatives. Crucial to obtaining buy-in, participants suggested a visible executive sponsorship coupled with top-down support and clear communication in articulating the strategic value of BDA. Organisational alignment is achieved when leadership orchestration is deliberate in providing direction and coordinating stakeholder engagements. Leadership support was established as a catalyst in promoting conditions conducive to the success of BDA, including allocation of resources, skill development and promoting a culture that values data-driven decision-making.

The importance of data readiness closely aligns with leadership. The study indicated that the key to effective decision-making critically relies on trust of the data, along with data quality, accessibility of the data and interpretability. According to participants, the absence of reliable and timely data undermines the credibility of BDA initiatives and thus impeding the ability to deliver strategic value. The findings indicate that to address this, organisations must invest in strong data governance frameworks, data verification standards to be made clear and allow for system integration to eliminate silos. This readiness transition from reactive responses to proactive intelligence, enabling mining operations to optimise assets, anticipate risks, and improve the quality of decision-making.

Research Question 2: Role of BDA in strategizing

Participants observed that BDA facilitates real-time responsiveness, optimisation of resources and process efficiency, which enhances a mine's capacity to adapt to fluctuating market conditions. The findings highlight the significance of BDA in improving operational excellence to achieve competitive advantage. BDA is recognised as a key catalyst for strategic agility, extending its benefits beyond operational efficiency. It also offers insights that are crucial to empower organisations to undertake strategic initiatives such as demand prediction, integrate operational activities and enhance business resilience. The transformative potential hinges on the development of organisational capability, specifically workforce upskilling, analytical literacy, and coordination of IT infrastructure and policies to facilitate the seamless flow of data.

Research Question 3: Key recommendations

From the perspectives obtained, the participants find that a people-centric strategy is fundamental to the successful integration of BDA. To address resistance and build trust in data-driven processes, change management targeted initiatives to empower people are essential. A phased structured implementation approach to demonstrate immediate benefits before a full adoption, was supported by participants as a means of building employee confidence. Continuous stakeholder involvement and transparent communication are identified as essential practices for achieving alignment and retaining momentum throughout the entire implementation process.

Research Question 4: Implementation approach

Finally, the findings from the study lead to a proposed approach to BDA integration centred around robust foundations, progressive implementation and cultural integration. Participants also stressed the importance of leadership in defining the vision and putting in place governance frameworks prior to commencing with technical implementation, while communication and change management remain continuous. These practices, over time, will lead to an organisational culture that embraces data-driven decision-making. A defined approach will ensure that BDA is seen as a temporary initiative but as an organisational capability that supports agility and competitiveness of the operation.

Overall, the study's findings indicate that the use of BDA in mining is a strategic shift rather than just a technological undertaking. The effectiveness of BDA is dependent on alignment of systems, people and policies to facilitate data-driven decision making within the business. For mining organisations integrating BDA into organisational culture and governance procedures is essential, as this will promote agility, resilience and long-term competitive advantage.

6. CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

This chapter aims to discuss in detail the empirical findings and provide valuable insights into the key critical success factors for integrating BDA into decision-making processes to enhance agility in the mining industry. The discussion is structured around the four research questions and the themes identified during the empirical study. Research findings from data analysed and established in Chapter 5 will be discussed in detail by comparing and contrasting each research question to the findings from existing literature covered in Chapter 2.

6.2 Research Question 1: Critical Success Factors

Research Question 1: What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?

The purpose of the research question was to identify the critical success factors that enable the successful integration of BDA into decision-making processes, specifically for the mining sector, as there is already an extensive body of knowledge from other industries. According to Mikalef et al. (2021) and Sarwar et al. (2025), integrating BDA in an organisation enhances its dynamic agility which, in turn, improves operational efficiency and competitiveness. In addition, Mikalef et al. (2020) in their study, point out that BDA is no longer a technical skill but rather requires a range of organisational characteristics and resources needed to produce the desired results and support organisational competitive advantage. There is a growing body of research examining the advantages of BDA and its application across a variety of industries, however, little is known about how such integration can be implemented effectively in the mining context (Mikalef et al., 2020; Qi, 2020; Sarwar et al., 2025).

Research Question 1 aimed to identify the critical enablers attributed to successful use and value realisation of BDA. The discussion of Research Question 1 was explored in detail, with the three main themes identified. The

three themes include leadership and governance, data readiness and a transition from reactive to proactive intelligence.

The study found that the most critical enablers for facilitating successful BDA integration are data readiness, governance and commitment from leadership. Participants established leadership commitment as the cornerstone of successful integration of BDA. This commitment was said to be demonstrated primarily through executive sponsorship, clear strategic vision and top-down communication, deemed crucial for driving organisational alignment and support. Data readiness was also seen as equally important. An emphasis on confidence in analytics was said to be undermined by the absence of reliable, accurate and easily accessible data. Therefore, the reliability of the data was also seen as a key enabler to high-quality decisions and proactive intelligence. Additionally, the study found that organisational cultures that support evidence-based, standardised data systems and robust governance frameworks are all critical for successful BDA integration. This was also confirmed in the literature, as discussed in the sections below.

6.2.1 Theme 1: Leadership and governance

Theme one findings established leadership as an enabler of BDA implementation, with participants stressing the importance of strategic direction and management buy-in. As stated by P10, the integration must be leadership-driven with P1 highlighting the importance of a top-down management approach as key to driving buy-in, stressing that leadership support provides projects with legitimacy and a shared objective. According to Mikalef et al. (2020), executive sponsorship is for resource mobilisation owing to organisational inertia, which is accepted for the study. Sarwar et al. (2025) similarly support BDAMC as a capability primarily shaped by leadership and is nurtured through the creation of key initiatives that enhance strategic agility. Furthermore, Mikalef et al. (2020) and Sarwar et al (2025) found that the most important drivers of BDAMC is leadership commitment, which legitimises the initiative and mobilises resources. Participants stressed the necessity for leaders to accept BDA as a strategic priority and to allocate financial resources towards its implementation. Leadership role was emphasised by participants as going beyond sponsorship that it demands active, transformational communication and cultivation of data

literacy at all levels. Through continuous feedback loops, confidence and organisational alignment can be achieved enabling successful adoption of BDA. When the benefits of data-driven decision making are adequately addressed by leaders, opposition is reduced and adoption rate promoted (Chen et al., 2022). Rialti et al. (2019) support these findings by arguing that governance and alignment processes aid the information flow required for BDA to assist in decision-making.

The study findings offer unique contribution by highlighting the crucial role of continuous stakeholder engagement and communication as an essential component of governance for BDA implementation. Participants said engagement should be an ongoing effort rather than a one-time effort. P6 stated that the involvement of stakeholders is paramount right from the start, as they cannot be left behind. This is especially so as the implementation intensifies. Nguyen et al. (2022) acknowledge organisations' readiness as key to the adoption of technology. However, most of the past studies have focused on alignment from the leadership aspect as opposed to the operational engagement. Given the socio-technical complexity of the mining sector, worker participation for safety and compliance is crucial; therefore, the emphasis on engagement at all levels is justified.

6.2.2 Theme 2: Data readiness

Data readiness was another important element for the effective adoption of BDA, as stated by 83% of responders. According to P5, a trusting environment is a place where you let the data speak for itself. Similarly, P10 emphasised data quality and accessibility as a priority to facilitate better insights. Robust data foundation for successful implementation of BDA, emerged as a critical success factor. This is because the quality of decision making relies on the quality and accessibility of data. Participants sentiment aligns with that of Rialti et al. (2019), who found that actionable insights are supported by data governance, quality of data and systems integration. In the absence of such preparedness, there is a risk that analytics insights may not have credibility or intended influence undermining an organisation's strategic agility. According to Awan et al (2021) and Mikalef et al (2019), the authors argue that BDAC is a significant construct

that impacts decision-making quality in an organisation. Aligning with the views of the participants when it comes to organisational data readiness.

A number of participants linked infrastructure adequacy directly to data readiness observing that technical limitations such as infrastructure bottlenecks and unreliable underground access points may impede the flow of data. The study by Dubey et al. (2019) confirms this perspective, noting that the timeliness of analytics driven choices, depends heavily on the speed and reliability of the data pipeline. This contextual element demonstrates how infrastructure constraints to data flow must be taken into consideration in mining, something less obvious in other sectors such as retail or healthcare.

Moreover, efficiency was not the only aspect that participants associated with regulatory compliance for safety. P15 highlighted that regulatory standards and safety requirements are increasingly intersecting with BDA preparedness in mining, and this makes the assessment and approval of data quality essential for forecasting. Inefficiencies and low profitability are the focus of the majority of the generalised BDA literature (Dubey et al., 2019; Mikalef et al., 2019). In mining, however, data readiness is both a technological enabler and an essential condition for operational resilience, worker safety and compliance.

The findings and interpretation are consistent with the literature, suggesting the strategy for integration requires intentional investment in data governance frameworks, robust infrastructure and trust-building in the integrity and accuracy of data. These foundations will foster the integration of BDA insights into decision-making.

6.2.3 Theme 3: Shift from reactive to proactive intelligence

The third key success factor was the operational and organisational shift from reactive intelligence to proactive intelligence in problem-solving. Predictive capacity was a key value proposition of BDA, as stated by participants. P3 summed up this transition by saying that you stop firefighting all the time and start being more predictive. Additionally, participants found scenario planning and predictive maintenance to be essential to optimise resources, reduce

downtime and foresee changes in the market. The work of Dubey et al. (2019) indicates that making use of predictive analytics enables resilience in organisations and identifies threats before they become bigger, aligning with the views of the participants. The findings also support Awan et al. (2021) recommendation that making decisions based on facts makes an organisation more competitive and responsive.

In the context of mining, what stands out is the emphasis on proactive intelligence being a means of safety and continuity, as opposed to a cost-optimisation tool. In essence, while literature often associate BDA with predictive ability in terms of competitive advantage and market profitability, participants highlight industry specific value BDA provides in addressing safety concerns, compliance and asset utilisation in mining operations (Chen et al., 2022; Mikalef et al., 2019). By demonstrating that lowering operational risk is one of the BDA gains in mining, this addition broadens the body of research which is frequently dominated by efficiency and profitability indicators.

6.2.4 Research Question 1: Discussion Summary

The purpose of research question 1 was to identify the critical success factors for integrating of BDA into the decision-making process to enhance strategic agility. The findings identified and contextualised the critical success criteria required for BDA integration in mining operations. According to the participants, the successful adoption of BDA is dependent on ongoing stakeholder engagement and communication. This strategic emphasis enhances and adds depth to existing literature on BDA implementation. The findings underscore ongoing interaction coupled with a focus on cultural factors is important especially within the socio-technical complexities of the mining industry.

The findings demonstrated that, in addition to technical capabilities, leadership interaction, trust in the data and proactive intelligence building are all critical to the success of BDA initiatives. This offers an opportunity for understanding the social and technical aspects of mining, factors that contribute to strategic agility.

Table 14: RQ1 Comparisons of findings with literature

Theme	Research Findings (Empirical Evidence)	Supporting Literature	Similarities/Contradictions
Leadership & Governance	BDA adoption is driven by leadership support and continuous stakeholder engagement.	Mikalef et al. (2020): Leadership commitment legitimises analytics initiatives and mobilises resources. Sarwar et al. (2025): BDAMC leadership and governance enable strategic agility.	Similarity: emphasise leadership and strategic alignment as critical drivers. Insight Added: Engagement across all levels, moving from top management focus only
Data Readiness	BDA success requires trust, data quality, accessibility of data Data must be verifiable to promote trust. Governance of data, robust infrastructure key to real time data use.	Rialti et al. (2020): quality of data and reliability Chen et al. (2022): Poor data quality undermines credibility Awan et al. (2021): BDAC drives the quality of decisions Richardson et al. (2021): ethical use of BDA in line with the POPA framework	Similarity: Data governance and data quality form the basis of data readiness.

Shift from reactive to proactive intelligence	The benefits are predictive maintenance and scenario planning.	Dubey et al. (2019): early detection facilitated by predictive analytics.	Similarity: BDA as a driver for proactive decision-making. Contribution: emphasis on proactive intelligence as an enabler of operational safety and resilience in mining.
	Shift from reactive to proactive risk management and strategy alignment.	Awan et al. (2021): BDA enables foresight and agility of the business.	
	A critical culture transformation to promote operational agility.	Chen et al. (2022): predictive insights enhanced decision quality.	

6.3 Research Question 2: Role of BDA in Strategising

Research Question 2: What is the role of BDA in the microprocesses of strategising?

The purpose of this research question was to determine how BDA play a role in the small-scale operations that make mining operations' strategising. Although earlier research by Dubey et al. (2019) and Mikalef et al. (2020) has demonstrated that BDA can enhance decision-making quality, organisational responsiveness, and company performance in manufacturing and supply chain, little empirical work has been done on its role in complex, safety-critical industries such as mining. Hence, Research Question 2 sought to probe ways in which BDA aids mining organisations and enables them to make informed decisions.

During the exploration of the research question, two major themes emerged from the empirical data: data accessibility, operational excellence and competitive edge.

In answering Research Question 2, the study found that by facilitating proactive decision-making, scenario planning, and real-time responsiveness, BDA significantly impacts the microprocesses involved in strategising. According to the participants, analytics provide practical insights that connect long-term strategic objectives with operational effectiveness. BDA was seen as a strategic enabler that enhances cross-departmental collaboration, risk management and foresight rather than functioning as a standalone technology. The study also revealed that developing personnel competencies and analytical literacy was needed to embed data-driven thinking in day-to-day activities. As it will be further discussed within the sections below, the literature confirms this.

6.3.1 Theme 4: Operational excellence and competitive edge

Operational excellence emerged as a key outcome of BDA as participants repeatedly mentioned. Participants described it as a means to gain a competitive advantage and a contributor to the improvement of operations. According to P8, analytics helps mining operations to focus on improving equipment availability and reducing breakdowns, costs and time spent on scheduled maintenance activities. Furthermore, P3 stated that BDA makes operations more predictive as opposed to reactive in managing analytics, which changes how managers view problems in production.

The empirical evidence suggests that BDAC enable firms to identify, accumulate and redeploy resources on a real-time basis to improve operational effectiveness and strategic agility (Mikalef et al., 2020). In the same way, Dubey et al. (2019) supported that predictive analytics lowers the downtime, providing an early warning signal, which enables the manager to act before the disruption takes place. According to Talaoui et al. (2023) and Wamba et al. (2020), the enhanced sensing, seizing and reconfiguration capacities can be attained through analytics. The work of Shamim et al. (2019) and Akter et al. (2016) also asserts that the capacity of an organisation to analyse information is important for agility and enables prompt information flows and scenario planning, which affects micro-management decisions. The study results show that mining operations could significantly benefit from enabled BDA operations which could provide stable and predictable operations, allowing mines to control operational

costs and create room for resource reallocation towards growth initiatives projects.

The competitive aspect of operational excellence was stressed by several respondents. According to P12, analytics has helped their business optimise performance and remain ahead of competitors on cost per ton, which is a critical competitive measure in mining. P7 added that monitoring performance in real time gives a competitive advantage over others who are not as technologically advanced. The results align with the findings of Muller et al. (2018), who report that data-driven businesses exhibit better competitive positioning and outperform their competitors by 5-6% on productivity and profitability.

In contrast with much of the literature available, these findings take a strategic view of important operational functions. According to Wamba et al. (2017), BDA is commonly used in marketing and finance. In contrast, mining gives more significance and priority to sustaining production and optimising asset use. As the findings imply, asset-intensive industries such as mining see operational excellence as a strategic end goal rather than merely an enabler of strategy. This research adds to the already vast body of knowledge.

6.3.2 Theme 5: Data accessibility

Another fundamental theme related to Research Question 2, was the understanding that BDA can only be beneficial if it is validated by timely, accurate and high-quality data. The research findings support Chen et al. (2022) study, warning that poor data quality affects the validity of the decision-making process and subsequently the adoption of analytics tools. In addition, P5 echoed this awareness with the statement that analytics use depends on organisational belief in the data, and that data must speak for itself. P15 stated that strong governance and validation procedures are required concerning whether the data is regularly reviewed and signed off. The study findings align with those of Rialti et al. (2019), underlying that the implementation of actionable insights involves data governance, quality assurance, and integration of data.

The findings revealed a focus on timeliness as a requirement for effective strategising. As P11 highlighted, managers are better equipped to identify trends

and take immediate action when data analysis is closer to the actual event. The results support findings by Awan et al. (2021), which found that regular data-driven decisions, improve organisational responsiveness and allow for real time adaptation to changes in the environment. Additionally, participants connected infrastructure dependability and data availability, particularly in challenging underground settings where network connectivity could be a challenge. The point was further elaborated by P17, who suggested that having reliable access points underground will improve data collection and help in more or less real-time decision-making. The importance of BDAC lies not only in quality but also in the availability of data. The discussions in section 6.2.2 underscore these points and support the participants' view. BDAC is a necessary condition but not a sufficient condition for development. The work of Dubey et al. (2019) also supports that the quality of the analytical output depends on the reliability and speed of the data pipeline. Furthermore, this study supports the study findings of data readiness and real-time access.

When it comes to building organisational capabilities, participants strongly emphasised the importance of improving organisational practices and workforce competencies in order to fully utilise BDA. According to Awan et al. (2021), a data-driven culture of organisational learning is an essential success element for boosting the quality of decision-making. In support of this study, P6 stressed the importance of training the workforce to not only cover the use of the BDA tools but also to interpret them, so that insights can be put into action rather than remain unused. At the same time, P10 contended that organisations should prioritise upskilling their workers to be able to use such tools. These findings corroborate those of Talaoui et al. (2023), which maintain that a critical factor in determining the success of digital transformation is the absorptive capacity, which is the ability to recognise, incorporate and apply new information. Mikalef et al. (2020) in their study contend that BDAC encompasses management and human skills that influence the degree to which analytics is used in decision-making, agreeing with the study findings.

Additionally, participants connected the capability-building to cultural transformation, highlighting the objective of integrating analytics into daily decision-making processes, which is consistent with the Resource-Based View

(RBV), which presents organisational knowledge and human abilities as rare, precious and unique resources that generate long-term competitive advantage (Braney, 2001). The findings suggest that in mining, workforce readiness is a major bottleneck, in contrast to literature from more digitally advanced industries where technology investment is usually given priority (Wamba et al., 2017). Hence, the investment into capability development, along with technology-developed investment, must be prioritised in the mining industry where manual processes are still prevalent and where digital literacy is relatively low, in order to realise the true value of analytical strategies.

The findings from the study provide a cultural dimension to the concept of data readiness. According to the participants, it is important that employees first trust the data before making decisions based on it. Trust-building strategies such as cross-functional validation, open sign-off procedures and data lineage documentation are an important part of encouraging adoption. The findings of this research go beyond the technical definition of data readiness in the literature, as it illustrates that data readiness is both a technical and cultural construct.

6.3.3 Research Question 2: Discussion Summary

The purpose of Research Question 2 was to explore the role of BDA in the microprocesses of strategising in mining organisations. The findings demonstrate how BDA aids mining organisations in connecting operational insights with strategic objectives by boosting productivity, providing timely access to high-quality data and building organisational capacity. Much of the existing research that links BDA to operational efficiency, responsiveness and competitive advantage is confirmed by the study (Awan et al., 2021; Dubey et al., 2019; Mikalef et al., 2020). Further to this, the study adds depth by emphasising trust, cultural adoption and capability building as equally important enablers in the mining context.

The mining-specific insights, especially connectivity, data trust and cultural preparedness, broaden understanding of how BDA can be integrated as a catalyst for strategic agility in complex and high-risk industries such as mining.

Table 15: RQ2 Comparison of findings with literature

Theme	Research Findings (Empirical Evidence)	Supporting Literature	Similarities/ Contradictions
<p>Operational Excellence and Competitive Edge</p>	<p>BDA enables cost management, efficiency of resource utilisation and maintenance planning.</p>	<p>Mikalef et al. (2020): BDAC promotes allocation of resources and enable firms to sense operational and market changes for efficiency gains. Dubey et al. (2019): Predictive analytics provides early-warning signals to prevent downtime. Müller et al. (2018): Companies become more competitive when they use data-driven insights, which drives productivity and profitability.</p>	<p>Similarity: BDA improves competitiveness and firm performance. Added insight: contextualises BDA as a production tool, extending its relevance to core operations.</p>
<p>Data Accessibility</p>	<p>Real-time data, access to data and data quality are critical. Trust in data and connection across systems is important. Connectivity can be a major barrier to adoption.</p>	<p>Rialti et al. (2019): actionable insights necessitate data governance and integration. Awan et al. (2021): data received timely support for agile decision-making. Dubey et al. (2019): The quality of the decision is influenced by reliability and speed of data.</p>	<p>Similarity: Data governance and timely data insights support existing literature. Added Insight: infrastructure challenges and data trust show culture plays a significant role in mining.</p>

		Richardson et al. (2021): Study supports data accessibility and accuracy	
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6.4 Research Question 3: Key Recommendations

Research Question 3: What are the key recommendations for integrating BDA into the decision-making process towards enhancing the strategic agility of mining operations?

Much of the current research on BDA adoption provides general recommendations for digital transformation (Mikalef et al., 2020; Rialti et al., 2019). However, there is a lack of recommendations specifically intended for asset-intensive, safety-critical sectors such as mining, where adoption risks need to be thoroughly mitigated. Research Question 3 aimed to determine practical recommendations that mining organisations could use to incorporate BDA into their decision-making processes in ways that enhance strategic agility.

The analysis of the empirical findings as summarized in section 5.7 and the discussion will be in accordance with the main theme identified and expanded in line with literature reviewed in Chapter 2. The People Centric Strategy theme, which was identified as an overarching theme for Research Question 3, is discussed in detail by incorporating the participants' viewpoints, contrasting and supporting the findings with the existing literature.

In answering research question 3, the study found that the key to successful BDA integration is a people-centric approach. Participants emphasised that communication, change management and people engagement are critical to the success of analytics initiatives than the technology itself. Overcoming resistance and building trust in data analytics were thought to require open communication, training and employee empowerment. A staggered implementation method was seen as an efficient way to grow BDA initiatives, starting with a pilot project that gives tangible gains. According to the findings, integrating leadership was also identified as a key success factor in order to maintain momentum across the

organisation. This was also supported by the literature, as evidenced in the discussions within the sections.

6.4.1 Theme 6: People-centric strategy

One of the main suggestions made by participants was that, in order to facilitate the adoption of BDA, a purposeful and people-centred change management strategy was required. According to P11, organisations should designate change champions who can lead teams through the transition and demonstrate the importance of analytics. P6 further supports this recommendation by suggesting that the rationale for change be tailored to each employee's job and that each employee understand the business objective so they can support adoption. The findings are in support of Alyahya et al. (2023) study, which suggests that effective digital transformation requires cultural change, which must be led by credible champions within the organisation. Additionally, backed by Mikalef et al. (2020), maintaining that creating a culture guided by data is just as crucial as increasing technical proficiency.

Awan et al. (2021) in their research, stress the necessity for organisations to develop BDAC since the technology itself is not the only source of BDA performance and agility. The organisation's overall capabilities also play a key role in the implementation. Aligning with this finding, participants placed a strong emphasis on training and skill development as part of the change strategy in addition to communication. Furthermore, P10 suggested that companies prioritise upskilling to ensure employees can understand and act on analytics insights. One of the key success factors for the adoption of BDA, is the process by which an organisation uses talent and technology to collect, store and analyse data for the purpose of producing insight (Mikalef et al., 2020). Therefore, findings suggest that developing the capabilities of your organisation through skills and talent development is key to the successful adoption of BDA in order for an organisation to realise its return on its investment.

Also of interest is participants recommending that to strengthen adoption, change management should incorporate rewards and recognition mechanisms. According to P8, celebrating quick wins was essential for maintaining motivation and exhibiting early advantages. This adds to the body of literature by

operationalising cultural change into tangible processes that are frequently overlooked in previous studies such as peer recognition, reward systems and storytelling. Therefore, the People-Centric Change Strategy theme, contributes to literature by converting abstracts such as cultural change into specific actional recommendations, communications tactics, implementation champions, training programs and incentives schemes. For mining organisations, a people-centric strategy is especially critical to gaining trust and establishing buy-in, as unionisation and employee resistance can impede the adoption of new technologies.

Nevertheless, structure is essential for human-centred change. The results highlight the need for an implementation and governance framework that supports the people strategy. It was seen as a necessity to have a systematic phased approach for BDA implementation that is supported by governance systems as shown by the findings in 5.7.2. The pilot-to-scale implementation will quantify as much data as possible based on the defined parameters, as explained by P7. It will also involve the real-time tracking of information to better understand success and improve roll-out. Mikalef et al (2020) study supports this argument by recommending incremental adoption of analytics to organisational learning and resistance reduction. P13 endorsed this strategy, stating that it was vital to have transparent governance and accountability frameworks to prevent projects drifting away from the objective and remaining consistent with the strategic objectives. This backs the claim of Rialti et al. (2019), which asserts that on account of uniform decision-making, BDA adoption needs structured data governance and cross-divisional integration. Chen et al. (2022) work highlighted the significance of organisational BDA capabilities as a moderating force to influence decision-making especially during the disruptive periods.

Wamba et al (2017), cited in Chapter 2, found that decision governance must enforce the incorporation of BDA capabilities into business processes for it to provide value. The empirical findings are consistent with the literature in this area. In defining governance roles, a cross-functional teams need clarity on whose job it is to ensure that developments are monitored, standards established and progress reviewed so that BDA insights are not left to technical

departments to use but are incorporated in strategy. Participants encourage a cautious, gradual rollout of new technologies instead of a rapid rollout, a contextual insight. P14 highlighted the operational risk associated with poorly planned implementation, noting that even a little downtime in mining may result in significant production losses. This opinion is at odds with some of the literature that pushes for swift adoption so that early adopter benefits may be realised. Nonetheless, the contrast is justified given that mining operations require careful risk management consideration and incremental adoption, as safety is the highest priority for operational sustainability.

Another essential aspect for people-centric transformation is stakeholder engagement and communication, which emerged as a social fabric connecting human and structural elements of BDA adoption. Continuous and inclusive interaction with stakeholders was the third recommendation. As participants alluded, engagement should take place continuously over the course of BDA initiatives, and not just once. As highlighted by P16, stakeholder engagement must be at all the time and in all phases, while P5 stressed the importance of creating alignment and trust at all organisational levels. Intermediate management and frontline worker stakeholders should also get involved, as these observations show executives cannot be the only stakeholders. The results of the study are in line with findings of Sarwar et al. (2025), which highlights the importance of BDAMC for agility, stakeholder alignment, and leadership influence on agility. The process of easier adoption happens when professionals overcome adoption resistance through better communication and building trust (Chen et al., 2022).

Emphasising middle management and inclusion of the frontline adds a further depth to the literature which often talks about top management support. According to the participants, engaging the non-technical employees in understanding BDA insights requires the use of dashboards that display progress, visual storytelling and feedback loops as detailed in section 3.7.5. The suggestions build on previous studies by turning the abstract requests for communication and alignment into actual procedures.

6.4.2 Research Question 3: Discussion Summary

The third research question looked at how BDA can be integrated into decision-making for enhancing strategic agility in mining organisations. The study results indicate that the implementation of people-centric strategies which include the use of champions, upskilling of people, and recognitions helps embed BDA. As a result, employees are equipped and ready to embrace BDA as part of their daily work routines. Also, the study suggested measured, phased roll-out backed by robust data governance and cross-functional accountability. With participants suggesting a phased-out deployment, in order to lower operational risk, establish alignment with organisational objectives and build BDA confidence prior to scaling.

Furthermore, the findings emphasised how crucial it is to involve stakeholders at all organisational levels in a consistent and inclusive manner. Trust, compliance and the successful implementation of BDA, were thought to depend on the sustained communication and involvement of all mining stakeholders across all levels.

Sarwar et al. (2025) noted that BDAMC which are shaped by leadership and governance, enable organisations to develop agility, which aligns with the participants focus on structured implementation and accountability. According to Awan et al. (2021), building both technical and human competencies is essential for BDA integration, which clearly supports the suggestion for training and people-centric adoption techniques by the research findings. Chen et al. (2022) further underlined the business strategic alignment and clear communication, reducing resistance and improving adoption rates, which is consistent with the participants' preference for inclusive and continuous ongoing stakeholder participation at all organisational levels.

These research findings support existing literature while expanding it through the contextualisation of recommendations for the mining industry. Crucially, the research findings indicate how the RBV and TOE frameworks interact. To achieve BDA driven agility, mining organisations need to align their technological, organisational and environmental settings (TOE) and utilise their distinctive organisational resources (RBV) (Braney, 2001; Nguyen et al., 2022).

The Research Question gives mining organisations a framework for BDA integration that is meaningful to them, as it takes into consideration the operational, safety and cultural constraints facing the industry. The people-centric strategy is about the human, structural and relational dimensions that together determine BDA adoption success in mining organisations.

Table 16: RQ3 Comparison of findings with literature

Theme	Research Findings (Empirical Evidence)	Supporting Literature (Chapter 2)	Similarities / Contradictions
People-centric strategy	Adoption to be driven by change champions. Celebrating small wins, upskilling and training drives data analytics culture and builds confidence.	Awan et al. (2021): BDAC shaped by both technology and talent. Sarwar et al. (2025): Leadership and governance enable agility. Chen et al. (2022): Communication reduces resistance and builds trust.	Similarity: supports readiness for business, leadership and communication as enablers. Extension: champions and recognition emerging as practical frameworks.
	Pilot to scale rollout advocated for risk management.	Rialti et al. (2019): Data governance and integration enable actionable insights. Chen et al. (2022): Business alignment is crucial for adoption. Abbasi et al. (2016): Advocated rapid deployment of decision support systems.	Similarity: Confirms governance and alignment as essential. Contradiction: gradual implementation preferred as opposed to rapid roll-out.
	Continuous engagement with executives, middle managers, and frontline staff is recommended.	Sarwar et al. (2025): BDAMC is shaped by leadership and stakeholder alignment.	Similarity: Strong alignment with the literature on communication

	Tools such as dashboards and feedback loops are seen as vital for adoption.	Chen et al. (2022): Resistance is lessened by communication, improving adoption. Mikalef et al. (2019): Organisational alignment enables BDAC.	and leadership engagement. Extension: Adds operational-level inclusion and practical engagement tools that are not extensively covered in the literature.
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6.5 Research Question 4: Approach for Integration

Research Question 4: What is an approach for the integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations?

As BDA encourages decisions based on data analysis and decreases bias, Mikalef et al. (2020) assert that creating a data-driven culture constitutes a major approach to its incorporation. The final research question, which is research question 4, sought to develop a systematic and practical solution for the integration of BDA into decision-making processes within the mining sector for strategic agility. The questions in prior research were to identify success factors (RQ1), understand the microprocesses of strategy (RQ2) and generate important recommendations (RQ3). The result of the Research Question 4 integrate these findings into a logical pathway.

According to the findings of Chapter 5, the themes underlying the findings converge on a single theme that is Pragmatic Approach supported by two sub-themes: leadership and fundamental steps, and structured and iterative rollout. The next section will address the research question as per the themes identified and will review the findings as per the literature review from Chapter 2. The study found, with respect to Research Question 4, that an organised, iterative and adaptable approach to using BDA within decision-making is needed. The strategy is based on leadership-driven vision setting, governance frameworks and policies. A phased method of implementation then takes place, backed by

continuous learning and development. According to the participants, analytics must be considered as an ongoing capability-building process which evolves over time with the organisation rather than a one-off exercise. This was also confirmed in the literature as discussed in the section to follow.

6.5.1 Theme 7: Pragmatic approach

As per the research findings, leadership is the anchor for BDA integration. According to participant P14, leaders must be decisive, starting from the top. P10 noted that BDA adoption should be driven by leadership and senior executives to provide credibility for the BDA initiative. The findings indicate that leadership commitment is not just a symbolic action. It is operationally important for aligning and acquiring resources, and using evidence-based steering at all levels of the organisation. P8 further reaffirmed this when comparing transactional and transformational leadership, suggesting only transformational leadership would be able to alter entrenched mining cultures. Mikalef et al. (2020) emphasise that BDAC is not merely a technical capability but also requires leadership and governance to translate data into strategic outcomes. Sarwar et al. (2025) also mention that BDAMC is one of the facilitators for agility as it brings together the integration of organisation, strategy and information systems. Participants stressed that leaders must have a clear strategic vision, consistent with the literature findings in Chapter 2, including that strategic alignment is necessary for BDA adoption success (Rialti et al., 2019).

The research findings broaden this discussion by placing leadership in a high-risk, compliance-driven environment like mining. In contrast to sectors where innovation is largely driven by leadership for competitiveness, leadership in the mining industry must balance the use of BDA, safety and regulatory requirements. By calling for top-down decisiveness, P14 is also recommending a step necessary to ensure that BDA implementation is consistent with union expectations and mine safety requirements. This subtlety, which has not yet been addressed in the existing literature, indicates a specific sectoral contribution, particularly that the mining leadership must provide operational safety and confidence. Furthermore, they must also promote BDA for strategic agility. The findings support existing literature on the crucial role of BDAMC and

governance by demonstrating that mining leadership must incorporate safety, legal, and cultural considerations in the first phase of BDA adoption.

The second dimension of the pragmatic approach suggests that the integration of BDA cannot be a transformational undertaking but a process based on incrementalism through potential small-scale testing and continual learning. Integration is viewed as successful when it adapts to organisational rules and decision-making frameworks (Talaoui et al 2023). It supports gradual change that is somewhere in between what is feasible and what is desirable. As stated by P10, “ we cannot go and implement new systems for the whole mine; we have to segment sections first and then go bigger”. P7 also supported the assertion by suggesting a gradual move from pilot to scale with metrics and real-time monitoring to deliver immediate gains. Meanwhile, P5 warned that rollouts which are not realistic are likely to fail, especially when they do not take the application context into account. The findings support the position of Abbasi et al. (2016) that iterations are necessary as well as for refining decision support systems before implementation. According to Awan et al. (2021), it is essential that BDA becomes part of organisational practices and does not continue as a separate project so it can achieve success.

When put together, the insights signify that gradual testing is required to allow dependability and eventual institutionalisation within decision-making frameworks to maintain value integration. However, some contrast occurs. Abbasi et al. (2016) mention that rapidly growing businesses can gain a competitive advantage through early adoption. However, the mining participants argued that a phased adoption is inevitable because of operational and safety issues. As P15 notes, integration must cut across all levels to avoid production interruptions. This difference shows that context matters. The mining context requires a slow, risk-controlled pace that prioritises operational continuity, while fast adoption may help companies with fast-moving consumer goods.

The TOE framework suggests that organisational and environmental factors impact the rate at which technologies are adopted, aligning with the structured and iterative approach (Nguyen et al., 2022). Al-Sai et al. (2020) and Ogbuke et al. (2022) state that enforcement of governance must go hand in hand with

phased action for sustainable change. To adopt agility practically in mining, incremental adoption is needed due to the environmental context, characterised by high safety risk, high capital investment and regulatory oversight. The paper reinterprets agility in mining as not the speed of adoption but the capacity to grow gradually further while protecting operational continuity.

To summarise, in the context of mining, the meaning of agility takes on a new meaning of growing steadily whilst maintaining operations rather than speed with which you adopt technology. The Pragmatic Approach takes operational conservatism and innovation into account while addressing the need for structural alignment, a visionary leader and a gradual rollout. Acquiring strategic agility through BDA necessitates strong leadership and structured implementation. Moreover, it should be based on a deep understanding of the industry's safety and regulatory requirements.

6.5.2 Research Question 4: Discussion Summary

The results and the literature suggest a three-stage strategy for answering Research Question 4, consisting of establishing the fundamental governance and leadership arrangements, conducting a structured and iterative rollout and embedding BDA into organisational culture for sustainability. The Resource-Based View (RBV) and Technology-Organization-Environment (TOE) approaches correspond with theoretical views on how resources and the environment influence the adoption outcomes. The findings of the mining exercise elucidate that agility should rather be interpreted as risk-managed adaptability than speed of adoption.

The findings reveal that leadership authority, incremental adoption and cultural transformation can be combined into one framework. In theory, it enhances understanding of how BDAC and BDAMC aid strategic agility in high-risk industries. It gives mining leaders a roadmap that balances ambition with caution so that BDA initiatives enhance safety, compliance, and trustworthiness while also improving competitiveness. The sector-specific approach that places general models in the reality of mining operations broadens the field of BDA integration.

Table 17: RQ4 Comparison of findings with literature

Theme	Research Findings (Empirical Evidence)	Supporting Literature	Similarities / Contradictions
<p>Pragmatic Approach</p>	<p>Leadership drive, decisiveness and vision underpin BDA. String top-down management drives legitimacy and culture.</p>	<p>Mikalef et al. (2020): BDAC needs leadership and governance, to turn analytics into results. Sarwar et al. (2025): Agility is enabled by leadership and stakeholder alignment. Rialti et al. (2019): adoption requires strategic alignment.</p>	<p>Similarity: Integration requires leadership. Extension: Mining-specific findings highlight safety, regulatory and union aspects rarely found in other literature.</p>
	<p>Pilot-to-scale approach supported for risk management, as opposed to fast roll-out.</p>	<p>Rialti et al. (2019): staggered implementation and governance reduce risk. Abbasi et al. (2016): supports rapid scaling for</p>	<p>Similarity: Stresses governance and alignment. Contradiction: Mining supported slow, gradual implementation, instead of</p>

		competitive advantage.	fast passed adoption.
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6.6 Summary of Discussion

Incorporating BDA into decision-making, as shown in the discussions, is beneficial for mining organisations and technology transformations in situating strategic agility. The study strongly indicates that success hinges on iterative implementation, people-centric culture, data credibility, and commitment to leadership. The research focused on four research questions and found that leadership and governance are essential for the BDA adoption. The participants emphasised that confidence in data quality should come before leadership support, contrary to the existing literature. In the mining sector, where safety and reliability are crucial, executives are only confident enough to invest in analytics by virtue of having data accuracy and system interoperability. This finding of data trust as a driver reinterprets existing adoption frameworks. However, existing adoption frameworks view trust as a by-product.

The research also showed that BDA has an active role in a strategy that is based on operations. In mining, the analytics begins at the ground level and works its way up, gaining operational insight, then helping with longer-term planning. New papers emerge which show how the strategic agility in complex and high-risk industries comes about through feedback loops and learning processes. This finding is in line with the dynamic capabilities perspective but goes on to also expand upon it.

According to the study findings, successful adoption of technology is about people and not about systems. Psychological safety, emotional trust, and change management were identified as essential elements for overcoming resistance. Personnel involvement in analytics initiatives will be ongoing as they believe in the overall objective and inclusiveness. This paper elaborates on existing theories of agility by suggesting that agility is a function of shared ownership and human involvement, along with IT competence, by embedding BDA with relational and emotional elements.

An orderly but flexible strategy for integration has been proposed by the study. Unlike continuous-maturity models proposed in the other studies, the participants diverged in proposing an iterative circular model to support continuity in inclusion improvement and development through stakeholder learning, governance alignment and phasing in features. Through this lens, the viewpoint of BDA shifts from a project with a limited duration to a dynamic organisational capability that tests and evolves through business strategy adjustments and other circumstances.

The findings of the study broadly agree with international studies on BDA and strategic agility; the context of the mining sector adds unique capacity depth and sequencing. It is operational insight that drives strategic direction, participants' engagement that strengthens adoption, constant adaptation that maintains agility, and data reliability that precedes leadership. The insights framed by this research augment the RBV and TOE frameworks by pinpointing the dimensions of trust, connection and adaptability as essential skills in mining organisations for the wider purpose of achieving data-driven strategic agility.

7. CHAPTER 7: RECOMMENDATIONS

7.1 Introduction

The objective of this chapter is to consolidate the research findings, contributions and insights derived from the study that sought to understand the integration of BDA into the decision-making processes to enhance the strategic agility of mining organisations. The study was motivated by the increasing complexity of the mining environment, its volatility and the growing demand for sustainability (Gruenhagen & Parker, 2020; Qi, 2020). As noted in Chapter One, the developing needs and advanced technology coupled with shifts in commodity markets are forcing mining firms to increase operational efficiency, environmental compliance, and safety performance. As a result, mining organisations are forced to transition from traditional decision-making processes to data-driven decision-making.

The study revealed that BDA can be used by mining organisations to develop dynamic capabilities that help them to respond to changes in operations, regulations and market conditions quickly and efficiently. Chapters 1 and 2 constructed the conceptual foundations using the Resource-Based View (RBV) and Technological Organisation Environment (TOE) frameworks (Barney, 2001; Nguyen et al., 2022).

Building on the data presented in Chapter 5, along with the analysis in Chapter 6, this chapter concludes the research by synthesising these data into an integrated narrative that connects practice, theory and evidence. It discusses what the study achieved with respect to its research questions, presents broad conclusions, and emphasises the study's importance for academics, practitioners, and policymakers. In addition, the chapter includes specific suggestions for various stakeholder groups. It suggests directions for further study to expand on the concepts of digital transformation and strategic agility in asset-intensive industries such as mining.

7.2 What has the research question answered

Four interconnected research topics were addressed in this study to identify the enablers, recommendations, mechanisms, and structured approaches for incorporating BDA into decision-making to improve strategic agility. With reference to the results and literature reviewed in the previous chapter, each research question (RQ) is discussed here.

7.2.1 Critical success factors needed to enable the successful integration of BDA into decision-making processes towards enhancing strategic agility in mining organisations.

The goal of this study was to comprehend the organisational, technological and leadership factors that help with successful BDA deployment. The findings revealed three key success factors, namely, governing and leadership; readiness of data; and shift from reactive intelligence to proactive intelligence. The above findings back the existing work of Mikalef et al. (2019) and Sarwar et al. (2025), who suggest that converting data resources to agility requires strategic leadership and BDA management capabilities (BDAMC)

As per the study's findings, the top indicator was leadership orchestration, which includes executive sponsorship, digital literacy, and openness in communication. Participants warned that, without management support, analytics initiatives lose credibility and are unlikely to gain traction across the organisation. Awan et al. (2021) recommend drawing on the cultural momentum created by leadership buy-in, which is required for integrating analytics into strategic decisions.

Data readiness, which includes Data Governance, Data Accessibility and Data Quality, was equally important. The participants pointed out that analytics cannot happen without a sound data ecosystem, and the foundation of agility is the ability to trust the data in terms of timeliness, integrity, and ethical use (Dubey et al., 2019). The results of the study suggest that the mining organisations must progress from reactive analytics towards predictive analytics to achieve proactive intelligence that allows foresight and scenario planning. In the period

of Industry 4.0, this supports the findings of Qi (2020) that predictive capability is critical for competitive mining operations.

Overall, Research Question 1 found that strong leadership governance, a high-quality data infrastructure, and a shift away from reactive decision-making and towards anticipatory decision-making are prerequisites for the successful integration of BDA in mining. The organisational “architecture of agility” is outlined by these success factors considered collectively.

7.2.2 The role of BDA in the microprocesses of strategising

Talaoui et al. (2023) in their study posit that BDA influences the microprocesses of strategising that are the everyday analytical and interpretative routines that managers use to perceive, understand and react to change. The findings suggest that BDA is essential for improving organisational learning, decision-making speed, and strategic sensing. According to participants, analytics applications reduce the feedback loops between information and action by providing real-time operational awareness, encompassing everything from production output and safety indicators to equipment performance.

Data-driven visibility empowers managers to appropriately respond to unpredictable situations and make timely changes. Managers are now capable of shifting their experience in decision-making to that of data. Mikalef et al. (2020) and Awan et al. (2020) literature review in Chapter 2 supports this finding, analytics improves decision quality and organisational agility, increasing knowledge flow across multiple levels. The participants in the study agreed to the study and revealed how analytics applications are useful for promoting accountability and transparency in the decision-making process. Moreover, these analytics applications help in effective collaboration between functions and collaborative problem-solving.

Additionally, BDA has been demonstrated to change the learning mechanism through drawing lessons from ongoing observation and post-decision analysis and incorporating them into future planning processes. This adaptive capability, which Sarwar et al. (2023) define as the result of developed BDA management systems, is consistent with this dynamic learning revealed by the study. As a

result, the research question affirms that analytics are not supplementary but rather essential to strategy. They serve as a cognitive framework that mining organisations use to understand complexity and make rapid, accurate adjustments.

7.2.3 Key recommendations for integrating BDA into decision-making towards enhancing strategic agility

According to empirical data, integration needs to be inclusive, systematic, and people-centred. Frequently mentioned as obstacles were unclear communication, lack of analytical literacy and resistance to change. Employees need to understand why analytics are important and how they improve efficiency, safety and environmental performance. This finding is consistent with research by Talaoui et al. (2023), which discovered that stakeholder inclusion and open communication lessen opposition during digital transformation.

Organisations should enhance capacity building and training initiatives to create a culture of curiosity and data confidence as part of existing workflow and professional development activities. Awan et al. highlighted that successful technology adoption is the most significant influence on human capital development. Along with the human factor, organised governance structures are required to coordinate efforts, standardise data processes, and track success. According to the study, with governance systems like analytics steering committees and data councils, an environment of confidence and cooperation is created. Supporting findings by Rialti et al. (2019), which acknowledge structural and process consistency in support of continuous agility.

Mining organisations operate in the complexity of communities, suppliers, OEM partners and regulatory bodies. BDA integration without stakeholder engagement, risk adoption failure, as highlighted by the study, the two cannot be done in isolation. Involving stakeholders in the analytical process promotes social legitimacy, ethical alignment and contextual understanding. According to these insights, integration is as much a social process as it is a technological one, and effective adoption brings relationships, organisations and individuals together behind a shared digital vision.

7.2.4 An approach for integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations

The final research question combined all prior findings into a practical integration methodology. The study recommends an approach that is progressive and iterative, that is founded on leadership, infused systematically and learned continuously. Each stage helps to improve organisational capability in addition to reducing the risks from a sudden technological change.

The leadership foundation phase aims to achieve manager commitment at all levels, governance establishment and vision articulation. According to empirical evidence, the leaders are responsible for effectively communicating the strategic weight of analytics and allocating resources accordingly. The above supports the assertions of Mikale et al. (2020) that the presence of a shared vision between leadership and BDA adoption ensures successful BDA adoption.

The implementation phase should pilot analytics in high-impact areas before scaling across operations. Examples include production forecasts and equipment health. In the view of the participants, progressive deployment would help in resolving technological issues at an early stage. It would also help in cultural acceptance and lesson retention. Sarwar et al. (2023) address adaptive maturity, in which organisations develop analytics capability by experimenting, gaining feedback, and adjusting their strategies, reflected in this stepwise learning.

Lastly, the implementation phase checks that analytics are part of standard operating procedures for continual strategy and performance management. To keep improving and to avoid technological stagnation, continuous reflection and evaluation are essential. BDA integration becomes a self-reinforcing process that enhances robustness and adaptation at different levels.

According to RQ4 findings, incorporating analytics is a process of transformation, not a mere addition, which necessitates an evolution in governance, learning framework, and leadership support.

7.3 Conclusion

Based on these observations, the study concludes that BDA is an enabler of agility when embedded through leadership, culture, and governance. Technology alone does not provide an advantage; instead, organisations gain a competitive edge when they build organisational and managerial capacity to convert data into immediate, well-informed action. BDA equips managers to transition from reactive management to proactive foresight in the mining industry, where operational risk, safety, and sustainability are critical. The road to integration, however, is complex and demands the interaction of data systems, leadership, governance and cultural transformation.

Empirical evidence indicates that leadership orchestration is the most important factor influencing adoption success. Also, people-centric change approaches encourage desired workforce acceptance while structured governance ensures that the analytic insights are credible and actionable. The components within the case study are capable of working simultaneously. This leads to the reproduction of a learning and adaptive organisation, one that can recognise the changes in the environment, interpret complex data and respond strategically.

By relating the RBV and TOE frameworks to reality, the findings support the theoretical positions in the literature reviewed in Chapter 2. In other words, the study bridges the gap between theory and practice by providing a credible model of how BDA leads to strategic agility in the mining sector.

7.4 Value of the Study

7.4.1 Strategic Takeaways

This study contributes to knowledge and managerial discourse by explaining that BDA integration is a comprehensive process of transformation involving people, technology, and leadership. This shows that people-centred, governance-ethics and leadership-driven BDA initiatives are more likely to generate measurable agility and performance improvements. Moreover, the findings of the study support those of Mikalef et al. (2020) and Sarwar et al. (2023) that analytical capabilities strengthen dynamic responses to uncertainty when consistently controlled.

As a result, the research offers an empirically supported blueprint for the integration of BDA into mining decision-making.

7.4.2 Recommendations for Business

The study's findings highlight the importance of institutionalising data governance in the management of mining organisations for cross-functional integration, accountability and transparency. Strategic executives should cultivate ongoing learning to encourage data literacy and analytics maturity across the organisation. Moreover, they should progressively implement BDA solutions, starting with pilot projects that yield quick wins to gain momentum and confidence. The observations are similar to Awan et al. (2021), who advocate a gradual approach to long-term integration. Thus, business leaders need to take a multifaceted approach to analytics adoption that encompasses capability development, governance, culture and leadership alignment.

The first prerequisite for mining companies is to embed the integration of analytics in Corporate Governance. All strategic planning forums must be data-driven in nature. Reliance on intuition or preconceived notions is further lessened when conversations incorporate analytics and an evidence-based culture supported by senior management. According to Rialti et al. (2019), with the help of analytics, the transparency of decision-making can be further enhanced.

Research results show that many managerial and operational workers are fearful of data analysis or do not know how analytics can add value to the company. This hampers adoption and strategic use. Mining companies can allow workers to engage in analytics-based problem-solving by developing a comprehensive training program covering data interpretation, dashboard use, and scenario modelling. The use of human resources allows turning digital infrastructure into a sustained advantage (Awan et al., 2022; Zhang et al., 2021). This highlights the need for mining organisations to purposefully invest in initiatives that enhance analytics literacy and capability.

The empirical findings of the study showed that an analytics project is not successful as a standalone project, the hindrance to success is often due to poor integration with other organisational divisions. Organisations should provide cross-functional data ecosystems to promote collaboration between safety, sustainability, finance, operations and more teams. The establishment of committees for digital transformation or data governance helps ensure that analytics results receive appropriate priority and communication within the organisation. Moreover, collaboration across functions reduces duplication of efforts and enhances the collective accountability for these outcomes.

Mining companies are also urged to form alliances with original equipment manufacturers (OEMs) and technology suppliers beyond contracts. Collaborations should aim at co-innovation, knowledge transfer and contextualising BDA to mining-specific circumstances. According to Popovic et al. (2018), the success rate for the integration of analytics can increase with cooperation between IT and business units. It is thus imperative that mining organisations and OEMs work together to co-create solutions that add functionality and improve internal analytical maturity.

In conclusion, mining companies must align their analytics strategies with performance metrics. These include metrics related to sustainability compliance, asset utilisation and safety performance. In doing so, analytics goes beyond enhancing operational dashboards to informing scenario modelling and strategic foresight, turning the firm into a predictive organisation.

7.4.3 Recommendations for OEMs

Mines should not only provide technology solutions but also support the mines by being strategic partners. This means that we will work closely with mining leadership to produce digital transformation roadmaps that align strategic and operational outcomes with analytics activities. Mining companies operate in an environment where their decision-making relies heavily on data. It is, therefore, necessary to build confidence through credibility and interoperability of data. To inspire confidence in analytics results, OEMs must provide open systems architectures, strong data governance and transparent validation procedures.

Moreover, OEMs should take a step-by-step approach in implementation, which focuses on people, communication, training and organisation. Companies that make the final product can help people accept it. They can help workers use data. They can work together on projects to help grow the product. Finally, OEMs should include ethical data practices and adaptive learning in their service models to encourage responsible data use and long-term customer development of capabilities. As a result of adopting these measures, OEMs can propel organisational change and technological growth by becoming innovative and adaptive drivers of the mining industry.

7.4.4 Contribution to theory

The study advances and contextualises existing models of strategic agility and BDAMC in the mining sector, theoretically. Although earlier studies by Mikalef et al. (2020) and Sarwar et al. (2023) have conceptualised how analytics resources improve organisations' performance through dynamic capabilities, empirical validation of these relationships in the mining sector has been limited. The study fills the gap by demonstrating how analytics-related techniques can alter strategy responsiveness in complex organisational environments when integrated into the systems of governance, leadership and culture.

The study shows that although analytics capabilities are useful on their own account because of technology, they draw their value from the uniqueness of the capabilities that combine the organisational and human capital resources that support the RBV. The themes of leadership and governance, data readiness, and people's strategy may become a resource for a competitive advantage for BDAMC development. According to the results, ethical data governance and leadership foresight are critical to turning analytics into learning systems for agile organisations, consistent with prior findings by Mikalef et al. (2020) and Sarwar et al. (2023).

In addition, the research broadened the scope of the TOE framework by paying attention to the context dimension of the firm and the way environmental pressure has impacted the adoption of analytics. It was confirmed that regulatory requirements and stakeholder expectations influence the scope and speed of integration of BDA. This enhanced understanding of TOE enables further

application within the mining industry by accentuating the importance of mitigating internal readiness and external demand alignment (Awan et al., 2021; Rialti et al., 2019).

To summarise, this study adds to the literature on people-centred digital transformation by showing how analytical capabilities can be developed by inclusive communication, shared learning and trust-based leadership (Talaoui et al., 2023). The findings therefore portrays leadership and culture as BDAMC social fabric. In summary, the research supports the utilisation of the RBV and TOE within the mining context and empirically links BDAMC to strategising micro-processes. These contributions provide a more nuanced and contextually informed perspective of how BDA establishes the framework for strategic agility of the organisation in complex industrial contexts such as mining.

7.4.5 What is known and not known

According to the study, BDA integration via leadership alignment, governance structure and people-centric culture improves decision quality, organisational learning and strategic agility. This illustrates that analytical capabilities require human discretion and trust to become meaningful. Data-driven insights will help shape the sensing and responding strategically. The findings provide support for the existing literature regarding the role of organisational preparedness and leadership intent towards the maximisation of the beneficial effects of analytics (Mikalef et al., 2020; Rialti et al., 2019; Sarwar et al., 2023).

One of the new learnings emerging from this study is the importance of people-centric transformation. Similarly, another finding that has emerged from this work is that effective integration of BDA is a learning process rather than a technological milestone. According to the study, analytics maturity improves with ongoing testing, dialogue, and collective learning that boost employee trust and organisational acceptance.

However, despite these insights, several gaps still exist. There is currently limited long-term data on how BDA implementation affects quantifiable performance objectives, including workforce transformation, productivity increases and sustainability results.

7.4.6 Recommendations for future studies

Building on this qualitative foundation, future studies could employ comparative or longitudinal designs to measure how BDA affects performance indicators, including innovation, productivity and sustainability. A deeper knowledge of how data informs judgement in high-risk contexts would result from more research into the human-analytics interface, including cognitive trust, ethical concerns and managerial sense making.

7.5 Recommendations

7.5.1 Recommendations for stakeholders

For mining business leaders, the study recommends establishing accountability and alignment through institutionalising analytics governance at the highest level of strategy formulation. Through regular training, communication and recognition of data-driven outcomes, managers should promote the adoption of analytics. Participatory forums and skill development programs that simplify data processes are essential for empowering employees.

The study also recommends that regulatory bodies, including the Department of Mineral Resources and Energy (DMRE), in accordance with POPIA, collaborate with industry by strengthening oversight by incorporating data governance into existing safety and compliance frameworks, such as the Mine Health and Safety Act (MHSA, 1996). This entails requiring mines and OEMs to maintain data in a manner that promotes industry collaboration and learning, while ensuring that the ethical use of operational and worker data is governed by mechanisms that protect the data and validate the reliability of analytics. Finally, it is recommended that OEMs and technology partners collaborate to co-design context-specific solutions that address data interoperability obstacles and seamlessly integrate with current mining infrastructure.

7.5.2 Recommendations for practical application

Mining organisations should adopt a three-stage integration approach, which will aid the transition from a fragmented digital initiative to data-driven systematic agility:

- Foundation phase: define the vision, leadership alignment, and establish governance
- Integration phase: invest in quality data, pilot analytics initiatives and develop analytical capabilities.
- The institutionalisation phase is when ongoing learning loops are established. Thus, analytics insights will then inform analytics strategy, innovation and sustainability decisions.

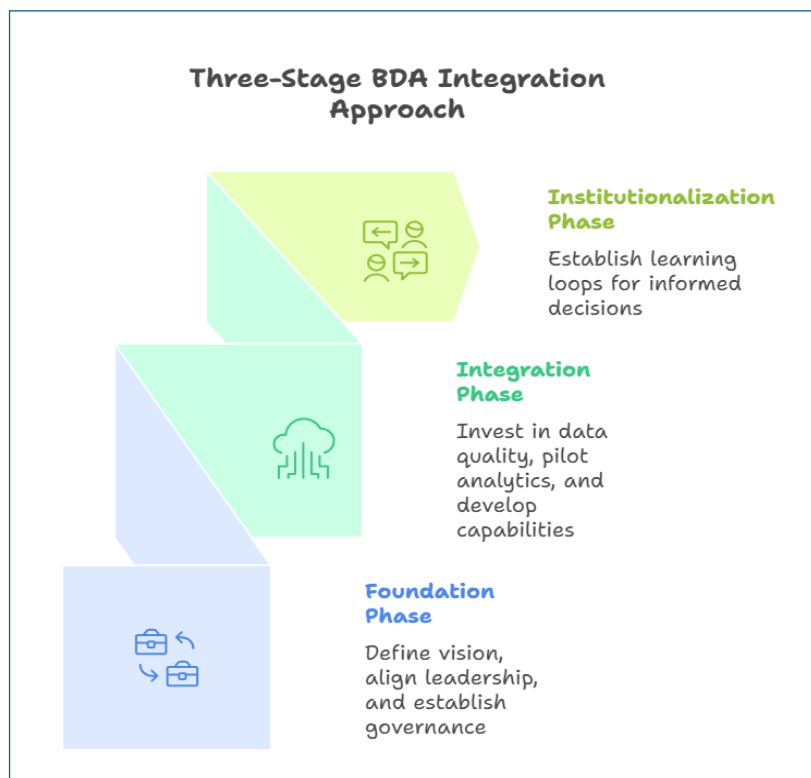


Figure 5: Three-stage approach to BDA integration

Source: Created by Author

7.6 Conclusion

The researchers have been afforded the benefit of knowledge relating to how BDA, along with leadership, governance, and culture, facilitates the strategic agility of mining organisations through this study. It connects the theoretical assertions of data communities with actual data practices by explaining how data becomes strategic only after it is transformed into shared organisational intelligence. The adaptive and concrete strategy of the research can be used by

mining business leaders to encourage rapid, evidence-based transformation by recognising success factors, mechanisms, and integration blueprints.

The empirical findings highlight that agility requires alignment of people, processes, and purpose, as technology alone cannot achieve it. In a sector that is ever looking for efficient, safer and more sustainable ways of working, this level of integration will enable mining companies to evolve from reactive to proactive, learning organisations. Mining competitiveness in the future will not depend on describing the past but on the ability to use data to influence the future.

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Appendix A: Consistency Matrix

Question	Sections in Literature Review	Data collection	Analysis Technique
RQ1(Critical success factors): What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?	Mikalef et al.,2019 Mikalef et al.,2021 Sarwar et al.,2025	Semi-structured Interview Questionnaire	Open-ended questions, Thematic analysis technique
RQ2(Role in strategising microprocesses): What is the role of big data analytics in the microprocesses of strategising?	Talaoui et al.,2023	Semi-structured Interview Questionnaire	Open-ended questions, Thematic analysis technique
RQ3(Key recommendations): What are key recommendations for integrating	Alyahaya et al.,2023 Chen et al.,2022 Talaoui et al.,2023 Xie et al., 2022	Semi-structured Interview Questionnaire	Open-ended questions, Thematic analysis technique

<p>BDA into the decision-making process towards enhancing the strategic agility of mining operations?</p>			
<p>RQ4(Approach for integration): What is an approach for the integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations?</p>	<p>Alyahaya et al.,2023 Awan et al.,2021 Xie et al., 2022</p>	<p>Semi-structured Interview Questionnaire</p>	<p>Open-ended questions, Thematic analysis technique</p>

Appendix B: Semi-Structured Interview Guide

I am currently a student at the University of Pretoria's Gordon Institute of Business Science and completing my research in partial fulfilment of an MBA.

My study has focus on integrating of BDA into the decision-making process towards enhancing the strategic agility of mining operations. Critical success factors for adoption will be considered.

You are invited to participate in this interview, which has 12 questions to answer, and will take 45-60 minutes. Your input is very valuable. Your participation is voluntary, and you may withdraw at any time, without penalties. Your anonymity will be maintained.

Questions

Critical Success factors

1. What are the critical success factors needed to enable the successful integration of big data analytics into the decision-making process towards enhancing strategic agility in mining organisations?
2. What are the factors that impede successful integration of BDA into decision-making?
3. How can integration of critical success factors adoption enable integration of BDA into decision-making?

Role of BDA?

4. What is the role of big data analytics in the microprocesses of strategizing?
5. Why is BDA key for enhancing strategic agility?
6. What are the benefits of BDA integration into decision-making for mining?

Recommendations

7. What are key recommendations for integrating BDA into the decision-making process towards enhancing the strategic agility of mining operations?
8. What are tactics that mining companies can use to integrate BDA into decision-making processes?
9. How can strategic agility be enhanced through BDA integration into decision-making?

Approach

10. What is an approach for the integration of BDA into the decision-making process towards enhancing the strategic agility of mining operations?
11. How are stakeholders included in this approach?
12. Does the approach allow consider change management?

For further details or information, please contact myself or my supervisor. Our details are provided below.

Researcher name: Jaqueline Raputsoe

Research Supervisor name: S Ramparsad

Email: 24072673@mygibs.co.za

Email: Sherin.ramparsad@gmail.com

Phone: 0766341454

Phone:

Date: _____

Appendix C: Participant Consent Form

Informed consent for interviews

I am conducting research on *Integrating Big Data Analytics (BDA) into the decision-making process to enhance strategic agility in mining operations in South Africa*. The interview is expected to last approximately forty-five (45) minutes and will aid in understanding how mining operations are leveraging BDA to inform their strategic and operational decisions, and how this impacts their ability to adapt quickly and effectively to dynamic conditions. The information provided during the interview will be kept strictly confidential.

Your participation is voluntary, and you can withdraw at any time without penalty. By signing this letter, you are indicating that you have given permission for:

- The interview to be recorded.
- Verbatim quotations from the interview may be used in the report, provided they are not identified with your name or that of your organisation.
- The data to be used as part of a report that will be publicly available once the examination process has been completed; and
- All data to be reported and stored without identifiers.

If you have any concerns, please contact my supervisor or me. Our details are provided below.

Researcher name: Jaqueline Raputsoe

Research Supervisor name: S Ramparsad

Email: 24072673@myqibs.co.za

Email: Sherin.ramparsad@gmail.com

Phone: 076 634 1454

Phone: 064 908 0043

Signature of participant: _____

Date: _____

Signature of researcher: _____

Date: _____

Appendix D: Interview Invitation

Dear Participant,

Thank you very much for your willingness to participate in my Gordon Institute of Science (GIBS) academic research topic, **Integrating Big Data Analytics (BDA) into the decision-making process to enhance strategic agility in mining operations.**

Your insights are invaluable to this research project, and I appreciate you taking the time to share your experiences.

Preparation:

There is no specific preparation required for the interview. However, the questions will be focused on the following themes:

1. The critical success factors for Big Data Analytics (BDA) integration.
2. The role of BDA in strategic agility within mining operations.
3. Approaches and recommendations for implementation.

Confidentiality:

We want to assure you that your participation in this research is completely confidential. All recordings and transcripts will be anonymised, and your name and company will not be associated with any of the data we collect.

Thank you again for your participation. Looking forward to speaking with you soon!

Regards

Jaqueline Raputsoe

Appendix E: Ethical Clearance

Gordon Institute of Business Science University of Pretoria	Ethical Clearance Approved
<p>Dear Jaqueline Raputsoe,</p> <p>Please be advised that your application for Ethical Clearance has been approved. You are therefore allowed to continue collecting your data. We wish you everything of the best for the rest of the project.</p> <p>Ethical Clearance Form</p> <p>Kind Regards</p>	
<p>This email has been sent from an unmonitored email account. If you have any comments or concerns, please contact the GIBS Research Admin team.</p>	

Appendix F: List of Codes

List of Codes			
1	Top management support	39	Enhanced agility
2	Leadership drive	40	Real-time decision-making
3	Executive literacy and communication	41	Faster problem-solving
4	Stakeholder Collaboration and Engagement	42	Market responsiveness
5	Stakeholder buy-in	43	Business resilience
6	Cross-functional collaboration	44	Opportunity identification
7	Collaborative vision	45	Operational to strategic linkage
8	Strategic Alignment	46	Business continuity insights
9	BDA as a Foundational Anchor	47	Informed expansion and market cycle analysis
10	Business-Value Alignment	48	Infrastructure and technology / Readiness
11	Trust in data	49	Connectivity Infrastructure
12	Data integration	50	Robust and scalable technological infrastructure
13	Data accessibility & interpretability	51	Real-time insights and scalable cloud platforms
14	Cross-functional data - Contextualization	52	Infrastructure for remote operations
15	Shared data interpretation	53	Tools as enablers
16	Data accuracy, integrity, management	54	Fit-for-purpose system design
17	Data Quality, Governance and Security	55	Talent and Skills / Upskilling
18	Ethical handling of data	56	Analytical Capability

19	Ethical sourcing of data	57	Data Accessibility and interpretability
20	Predictive maintenance	58	Modernising regulatory and qualification frameworks
21	Forecasting and predictive planning	59	Intensive and personalised change management
22	Scenario planning	60	Change management and communication integrated
23	Proactive culture	61	Paramount importance of change management
24	Navigating market volatility	62	Start small with pilots / new technologies
25	Optimising life-of-mine strategy	63	Use-Case Driven Approach
26	Informed decision-making	64	Focus on 'Burning Platforms'
27	Integrated decision-making	65	Realistic Roadmaps & Managed Expectations
28	Unbiased information	66	Continuous stakeholder involvement
29	Operational data insights	67	Co-creation and buy-in
30	Uncovering hidden strengths	68	Identifying stakeholder needs
31	Log-term information	69	Building data comfort through training and exposure
32	Analytics for business insights	70	Empowering change champions
33	Operational optimisation	71	Injecting diverse skills and Perspectives

34	Process optimisation	72	Skilled Workforce / Talent and Skills / Upskilling
35	Resource utilisation	73	Skills Gap & Democratization
36	Productivity	74	Coaching & Applied Learning
37	Identifying bottlenecks	75	Building Data Comfort through Training & Exposure
38	Value chain analysis	76	Ensure decisions are fact-based and transparent
List of Codes			
77	Top-down, transformational leadership	115	Data latency & timeliness
78	Data governance and management	116	Ethical sourcing of data
79	Modernising Regulatory & Qualification Frameworks	117	Strategic data selection
80	Pilot, phased implementation	118	Risk-averse culture and human validation
81	Holistic, phased approach	119	High trust environment for data sharing
82	Structured methodology with change management	120	Enabling and predictive analytics
83	Change management and integrated communication	121	Real-time, holistic value- chain adjustment
84	Realistic system integration	122	Navigating system ripple effect
85	Fit-for-purpose system design	123	Enabling option generation and contingency planning
86	Mine policies	124	Commodity market driven recommendations

87	Decision -making	125	Real-time decision-making and anticipation
88	Need for planning	126	Operation
89	Fact-based reporting	127	Dynamic operational and strategic adjustment
90	Need for reliable engineer	128	Fear and Cultural Resistance
91	Quality of programmes	129	Foundational Change Management
92	Attentive to information	130	A Multifaceted Cultural & Change Management Approach
93	Openness to communicate	131	A Formal, Holistic Change Management Framework
94	Analytics for business insights	132	Resistance to Change & Legacy Practices
95	Simplifying information	133	Employee anxiety about job security
96	Long-term information	134	Reassurance on job security
97	Operational data insights	135	Resistance & Pushback without Leadership Alignment
98	Ability to give raw data	136	Imperative of Change Management
99	Connectivity a prerequisite	137	Change Management & Support
100	Data integration into backbone systems	138	Stakeholder accountability in change management
101	Operational challenges in connectivity	139	Culture shift for BDA

102	Continuous monitoring	140	Coaching & Applied Learning
103	Predictive maintenance through algorithms	141	Competent Teams & Ongoing Training
104	Human factor in data utilisation	142	Skills Investment
105	Connectivity as a prerequisite	143	Skilled Workforce & Upskilling
106	Human factors in data utilisation	144	Employee training and upskilling
107	Predictive maintenance through algorithms	145	Training is, is incredibly vital
108	Data integration into backbone systems	146	Training & Upskilling
109	Operational challenges in connectivity	147	Continuous Training
110	Continuous monitoring	148	Empowering supervisors with data skills
111	Unbiased information	149	Value-Centric Change Management
112	Infrastructure and technology	150	Early & Continuous Stakeholder Involvement
113	Safety monitoring	151	Leadership Storytelling & Proven Use Cases
114	Infrastructure readiness	152	Audience-Tailored Communication Approach
List of Codes			
153	Realistic system integration	169	Early & Deep Stakeholder Engagement
154	Selecting & Empowering Change Champions	170	Incremental Progress Mindset
155	Lack of Clear Objectives & Communication	171	Realistic Roadmaps & Managed Expectations

156	Communication and awareness	172	Phased Pilot-to-Scale Implementation
157	Collaborative Vision & Stakeholder Buy-in	173	Start small with new technologies
158	Stakeholder involvement	174	Pilot projects before scaling
159	Supplier integration and buy-in	175	Continuous improvement and customisation
160	Engagement over Communication	176	Phased & Tailored Approach
161	Stakeholder inclusion	177	Pilot Projects
162	Stakeholder awareness and purpose clarity	178	Early Involvement
163	Leadership Buy-in & Data Culture	179	Tiered Implementation
164	Top-Down, Transformational Leadership	180	Pilot & Scale
165	Top-down strategic approach	181	Data Standardization & Governance
166	Start small with pilots	182	Feedback for system validation
167	Target low-hanging fruits	183	Predictive analytics for planning
168	Continuous iteration/customisation		