INSTITUTIONAL COMPETENCIES FOR BIG DATA ANALYTICS IN THE SOUTH AFRICAN FINANCIAL SECTOR

Moruti Dunstun Langa[1], Clive Smith[2]

Milpark Business School, SA
m.langa3@my.milpark.ac.za

Abstract

The South African financial sector faces challenges with big data analytics (BDA), including understanding its role, the risk of replacing managerial decision-making and identifying necessary institutional competencies (ICs). Globally, BDA is crucial for performance and competitive advantage, emphasising management's need to comprehend BDA and related ICs. Research with 10 senior management individuals highlighted five fundamental ICs for BDA implementation: leadership, business acumen, data science knowledge, new job roles and functional governance. The theoretical frameworks included resource-based theory, social cognitive theory and the diffusion of innovation theory. The findings stress the importance of enhanced leadership engagement, governance frameworks, business acumen and stronger data science roles alongside the development of new positions in BDA. Continuous development of suitable ICs is vital for improving organisational performance in the evolving BDA landscape.

Keywords

Big data analytics; Institutional competencies; Financial Sector South Africa, Generic qualitative research

JEL Classification

O33 - Technological Change: Choices and Consequences; Diffusion Processes (Innovation and Technology Management).

G21 - Banks: Banking; Other Depository Institutions; Micro Finance Institutions; Mortgages.

L86 - Information and Internet Services; Computer Software; Media.

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Introduction

The Financial Services South Africa (FSSA) is undergoing a significant transformation due to the proliferation of big data analytics (BDA), spurred by increased internet penetration and the emergence of tech-savvy consumers [1]. This evolution necessitates that financial institutions recalibrate their strategic frameworks to align with evolving consumer expectations and technological advancements.

While these organisations have robust operational competencies, it is imperative to cultivate specific institutional competencies (ICs) pertinent to BDA to enhance efficiency and elevate customer experiences [2].

The FSSA is a critical component of the South African economy, contributing meaningfully to the gross domestic product, employment and tax revenues [3]. The sector must actively embrace innovation and leverage contemporary tools such as BDA to sustain economic momentum. Despite the recognised potential of BDA to augment decision-making processes and improve organisational performance (OP), there remains a conspicuous dearth of comprehensive research delineating the ICs required for effective BDA implementation [4].

This investigation employs resource-based theory, social cognitive theory and the diffusion of innovation theory to elucidate essential ICs for BDA within the FSSA. The study navigates the South African financial landscape, with a population of approximately 63 million and encompassing 11,156 registered financial services providers (FSPs) categorised into four licensing types [5; 6]. While there has been a gradual increase in access to financial products, significant barriers to achieving financial inclusion remain, particularly for low-income households whose specific needs are often overlooked by conventional financial institutions. The Financial Sector Regulation Act of 2017 was instituted to enhance access to fair and affordable financial services, particularly for marginalised populations.

The advent of BDA offers substantial prospects for financial institutions to refine their service delivery and organisational effectiveness. Nevertheless, many institutions grapple with identifying the critical ICs for proficient BDA use, which is vital for bolstering competitive advantage and enriching customer experience [7].

Although South Africa's financial sector has acknowledged the substantial volume of big data generated through digitalisation, the potential of advanced technologies remains underexploited [8]. While BDA's significance in fraud detection is recognised, practical applications within the sector are limited. Financial institutions failing to invest in systems capable of complex analyses risk obsolescence [9]. Despite the theoretical frameworks available for BDA implementation, persistent challenges hinder effective decision-making and adaptability within a rapidly evolving marketplace.

Escalating productivity challenges, represented by considerable losses attributed to administrative inefficiencies, underscore the IC gap in BDA competencies [10]. This gap emphasises the necessity for organisations to integrate these ICs to enhance their competitive stature. Financial institutions must transform operational models and adopt data-driven decision-making practices that align with the exigencies of the modern marketplace to maintain relevance and ensure sustainability.

This discourse additionally addresses the formulation of research questions integral to guiding academic inquiry, highlighting several pivotal considerations. Research questions must be pertinent, well-defined, answerable, and articulated in straightforward language to facilitate comprehension [11]. The specific context of the phenomenon under investigation should inform question formulation, striving for a comprehensive and nuanced depiction of human interactions [12]. Theoretical frameworks that provide context and structure to the inquiry, such as resource-based theory, diffusion of innovation theory, and social cognitive theory, shape the research questions [13]. The interpretative research philosophy underpins this study, recognising the subjective nature of research and the importance of participant insights in understanding reality [14]. An extensive review of existing literature is crucial for identifying previous inquiries and gaps, informing the development of new research questions [15].

Literature review

Conceptual model

This section discusses the importance of a conceptual model in research, as outlined by Middleton (2019), which is a framework for identifying fundamental elements and hypothesising their relationships. The study focuses on two conceptual models relevant to BDA: The Data Warehousing Institute's (TDWI's) big data maturity model and the data capabilities model, which provide a comprehensive understanding of BDA within organisations. The TDWI's maturity model comprises five levels that help organisations assess their BDA capabilities, from basic analytics to advanced data-driven decision-making. Additionally, the data capabilities model lists 14 essential capabilities organisations should prioritise to enhance their BDA practices effectively. Understanding current BDA application levels is crucial for organisations to identify and cultivate relevant ICs.

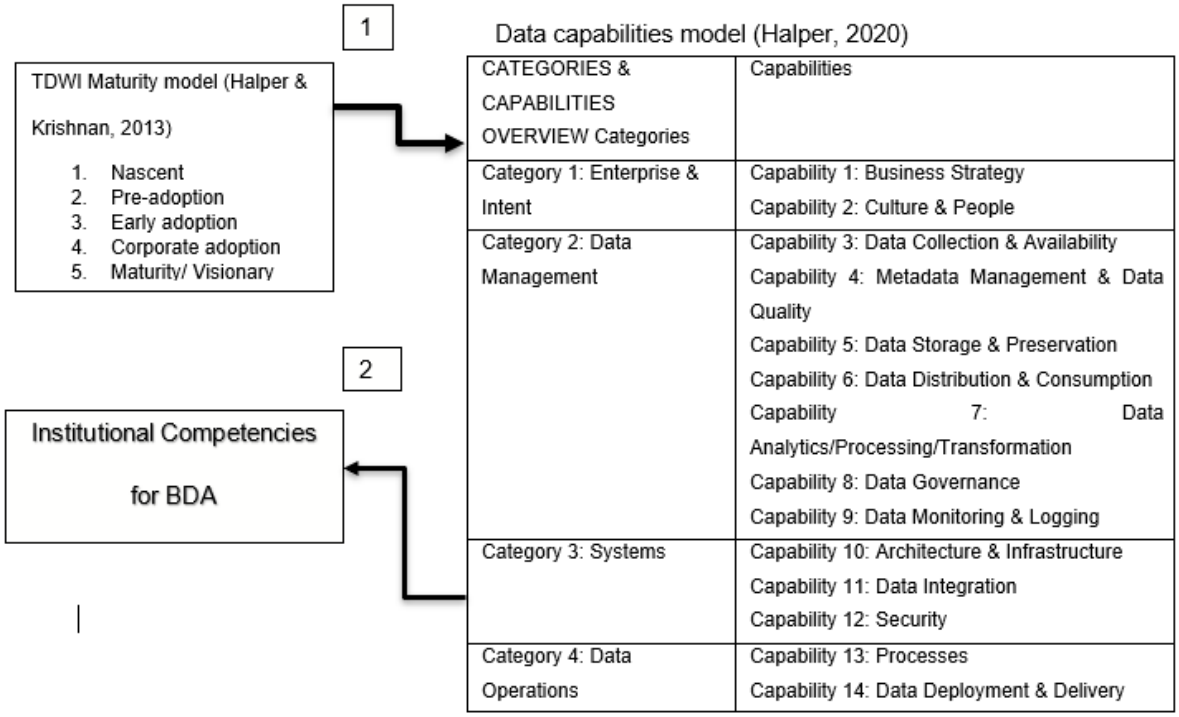

Figure 1: Conceptual model underpinning the study

Source: Author's own, adapted from Halper and Krishnan (2013) and Halper (2020)

ICs for BDA

The rise of BDA is transforming the financial sector, leading to a complex working environment that scrutinises current competencies [18]. Advanced technology tools, specifically artificial intelligence, are shaping new competencies for BDA [19]. Historically, the focus of organisational competencies has evolved from improving customer connections and streamlining processes [20] to emphasising strategy and effectiveness [21]. Coyne, Stephen and Patricia (1997) focus on insights and executive skills, whereas Eden and Fran (2000) highlight distinctive competencies as critical for differentiation. However, Coyne, Hall and Clifford (1997) revisited traditional competencies, stressing operational excellence and customer orientation.

The influence of technology has prompted a greater focus on competencies [23]. Fleury and Maria (2003) identify 22 core competencies for success. Wang and Yongheng (2004) highlight entrepreneurial and relational competencies as crucial, and Yang et al. (2006) emphasise the importance of HR

competencies. Entering the 21st century, the significance of data in organisations has grown, highlighting the competencies needed for effective data use [27]. Recent literature underscores the necessity for specialisation in competencies, particularly for BDA, indicating that general knowledge is no longer sufficient [28].

BDA capabilities

The literature highlights several capabilities related to BDA. One critical capability is BDA infrastructure, which comprises the technological tools and software that enable data scientists to optimise and manage system components [18]. Another crucial capability is BDA management, which describes top management's ability to establish routines that align with organisational objectives [19]. BDA personnel capability pertains to the proficiency of data scientists in effectively using their BDA skills [20]. Additionally, BDA coordination capability involves developing collaborative partnerships to share data and technology, enhancing the monitoring of environmental changes [21]. In general, BDA capability indicates a firm's ability to mobilise BDA resources to gain a competitive advantage [22].

The literature also emphasises data governance capability, an organisation's expertise in accessing and managing data from various sources [23]. Data integration and management capability involves collecting, integrating and storing data from diverse sources [24]. Research indicates that advanced analytics capabilities are essential for practical data analysis [25]. These capabilities can include techniques categorised as descriptive, predictive and prescriptive analytics. Another critical capability is data visualisation, which allows the visual presentation of information and facilitates intuitive decision-making [26].

Moreover, a data-driven culture reflects an organisation's attitude towards data-based decision-making, necessitating change management and cultural transformation. The literature highlights various challenges in analytics adoption, particularly due to cultural and managerial factors that can present significant barriers [27]. Lastly, collaboration between business and IT leaders is vital for BDA success because it emphasises integrating analytics into decision-making to maximise value creation [28].

Theoretical frameworks

This research is based on three multifaceted theories that help explain the ICs required for efficient BDA use: resource-based theory, diffusion of innovation theory and social cognitive theory. Resource-based theory articulates the mechanisms through which organisations secure competitive advantages by effectively integrating and using unique resources that are challenging to acquire. Reference [29] underscores the significance of resources in sustaining competitive viability, drawing attention to aspects such as "imperfect substitutability" and "imperfect imitability", which serve to limit competitive rivalry. As numerous scholars indicate, BDA is pivotal in decision-making and performance management, offering many advantages that enhance competitive positioning.

Empirical studies have established that identifying pertinent ICs is critical for effective BDA leveraging. Reference [30] asserts that resources that are rare and challenging to replicate are instrumental for enduring competitive advantages. Nonetheless, organisations must remain vigilant regarding the challenges associated with resource imitation and the consequences of cloud-based information sharing. This study focuses on the ICs vital for augmenting OP through BDA, accentuating the necessity for organisations to acknowledge and preserve these distinctive resources.

Social cognitive theory, formulated by Bandura in the 1970s, elucidates individual behaviour within a social context, concentrating on how knowledge and information are acquired. This theory comprises three fundamental elements: environmental impact, which posits that the external environment shapes cognitive processes, influencing how individuals perceive and respond to events and the

subsequent emotional and motivational effects; behavioural agency, where individuals are regarded as autonomous agents capable of impacting their social environments, cultivating competencies and self-beliefs that empower them to regulate their actions and motivations; and cognitive processes, which conceptualise thoughts as brain activities that facilitate problem-solving [31]. Individuals engage in metacognition, allowing them to reflect on their thoughts to assess and adjust their knowledge and strategies.

Research conducted by Dingelstad (2019) and subsequent analyses by Heather (2009) applied this theory to management, emphasising the function of managers as agents in acquiring organisational resources and their influence on behaviours and self-efficacy. The study also acknowledges inherent limitations within social cognitive theory, including the assumption that external environmental changes necessarily result in personal transformations and its insufficient consideration of biological and hormonal influences on behaviour.

The diffusion of innovation theory delineates how ideas and technologies disseminate within a population, focusing on the dynamics of communication among members of a social system. According to Kim, Bongsik and Ohbyung (2012), the essential components of this theory encompass innovation, communication barriers, temporal factors and social systems. Four critical elements influence BDA adoption: compatibility, complexity, trialability and observability. Compatibility pertains to the extent to which an innovation is congruent with existing values and needs, as a lack of compatibility can impede BDA adoption. Complexity relates to the perceived difficulty in comprehending and using an innovation, with heightened complexity adversely affecting adoption rates. Trialability reflects the degree to which an innovation can be evaluated on a limited basis, with increased trial opportunities facilitating quicker adoption. Observability denotes the visibility of an innovation's outcomes, encouraging adoption through role modelling and peer observation.

Rogers contends that innovations demonstrating advantages in these dimensions are adopted expeditiously [35]. The relationship between BDA and innovation highlights that successfully integrating BDA necessitates understanding these components. Prior studies have established connections between BDA and innovation, emphasising its role in fostering the ICs essential for effective BDA use. The theory has been referenced in previous literature regarding BDA, reaffirming its relevance in comprehending the impacts of technology.

Methodology

A research philosophy embodies the foundational assumptions regarding the knowledge and principles guiding the research process [50]. Prominent philosophical typologies within this domain include positivism, interpretivism, pragmatism, realism and critical paradigms [51]. The positivist approach posits an objective understanding of the social world, whereas interpretivism prioritises the subjective interpretation of meaning derived from participant interactions. Pragmatism is characterised by its focus on practical outcomes, whereas realism attempts to integrate subjective and objective viewpoints. In contrast, the critical paradigm perceives society as a site of conflict, where struggles against prevailing dominant structures are central [52].

This study adopts an interpretivist philosophical stance to elucidate participants' perceptions of BDA and the requisite competencies within organisations. This approach acknowledges that meaning is constructed through social interactions and that reality is understood as conceptual rather than purely objective [53]. The researcher's dual role as participant and observer is emphasised, highlighting the unavoidable biases that might influence the research process.

Three primary assumptions underpin the interpretivist framework: reality is constructed through individual perceptions, knowledge is best revealed through subjective methodologies, such as interviews, and participants maintain agency as information controllers [54]. This investigation aims to

comprehend social reality from the participants' perspectives, underscoring the inherently subjective nature of knowledge creation.

Generic qualitative research is situated within the qualitative research paradigm, emphasising a nuanced understanding of participants' unique experiences in specific contexts [55]. It stands apart from established methodologies, such as grounded theory, ethnography and phenomenology, because it does not conform to a prescribed set of philosophical assumptions [56]. Instead, it allows researchers to amalgamate various methodologies to enrich their inquiries. This approach is pertinent for examining participants' opinions and experiences on BDA and its implications for management practices. Researchers employing this methodology can adapt their strategies in response to emergent questions and perspectives, engaging creatively with the data.

Critics of generic qualitative research raise concerns regarding its lack of a formalised methodology and the potential for contradictions inherent in methodological pluralism [57]. Nonetheless, proponents argue that understanding multiple methodologies enhances researchers' capacity to justify their methodological choices and fosters a broader intellectual engagement with their work [58]. The approach accentuates the importance of continual comparison and a comprehensive understanding of various methodologies to address concerns about methodological inconsistencies.

Participants' profiles

This research focused on financial institutions, necessitating the selection of participants from these entities. Participants were chosen based on their registration as FSPs with the Financial Sector Conduct Authority and their positions as senior management overseeing BDA projects within their organisations. Due to the difficulties associated with recruiting individuals with the required BDA expertise, a snowball sampling method was used. Most participants boasted over a decade of experience in their roles and working with BDA initiatives. The decision to include 10 participants was grounded in the study's objectives, recruitment challenges, time constraints and the acceptance of a smaller sample size in qualitative research. Consequently, data were collected through triangulation, employing semi-structured interviews and organisational documents.

Analysis

This study followed Braun and Clarke's (2006) six-step framework. The first step, familiarisation with data, involves thoroughly reading transcripts and documents multiple times to gain a deep understanding of the material and making preliminary observations and notes. The second step, generating initial codes, focuses on organising the data into smaller, meaningful segments through inductive coding analysis, allowing themes to be generated organically rather than applying predetermined codes. The third step, search for themes, emphasises identifying themes that reveal significant patterns within the data and grouping the codes to reflect their relevance to these themes. The fourth step, reviewing themes, entails modifying and refining themes to ensure they are coherent and meaningful according to the original data while checking for overlaps and distinctiveness. The fifth step, defining themes, revolves around distilling the themes to their essence and understanding the interrelationships between the themes and the sub-themes. Finally, the sixth step, write-up, involves concluding the research with a report that effectively communicates the findings and insights derived from the data.

Results

The primary research question focused on the ICs necessary for effective BDA use in South Africa's financial sector. The findings indicate that leadership is vital to the success of BDA initiatives within this industry. Organisations should develop and foster a BDA-oriented culture while adopting visionary,

inclusive and courageous leadership styles. Additionally, the research revealed that task-focused leadership is crucial for the success of BDA projects. Leaders in BDA must engage continually with technology and align with the principles of the Fourth Industrial Revolution (4IR), necessitating that they are deeply familiar with and comfortable using technology. Organisations should strategically embed BDA in all areas of their operations to address contemporary challenges and enhance performance.

Effective governance that incorporates a supportive organisational culture for BDA and a robust information technology (IT) infrastructure is also essential for successful BDA implementation. The research emphasises the significance of using frameworks, such as the data management (DAMA) wheel, measurement and comprehensive data frameworks, to help banks organise the data they produce. It was found that fostering a learning culture where employees at every level are encouraged to pursue self-education improves operational performance. The study also noted that proficiency in programming languages, such as Python, Hadoop, SQL servers, Scala and R tools, contributes positively to BDA.

The findings indicate that business acumen is critical for leveraging BDA to address real-world issues. Employees must understand business to recognise BDA's potential in resolving organisational challenges. Although demonstrating BDA's value can be challenging, a successful investment can enhance customer satisfaction, improve market performance, and provide better career opportunities in machine learning, data science and data engineering. The research also determined that integrating BDA into business processes enhances decision-making, reveals trends and aids in customer retention, loyalty, revenue generation and risk management.

Data science emerged as a crucial competency for BDA because it allows IT personnel to use data for model building and insight generation. Data scientists apply mathematics, IT, machine learning, and pattern recognition to derive knowledge that informs business processes and decisions. Furthermore, the research underscores that data science concentrates on tracking, measuring and monitoring behavioural patterns. As an interdisciplinary function, data science analyses systems to derive insights from large datasets. The study highlights the necessity of computing tools that support data science, allowing for responsible forecasting and alerting organisations to unusual behaviour in systems.

Additionally, the research indicated that organisations must define job roles, such as chief data officer (CDO), data translator, data analyst and data engineer, to maximise the effectiveness of BDA. Individuals in these positions are tasked with data governance, infrastructure management, analysis and visualisation. Those appointed to these roles should also have advanced critical thinking, problem-solving, mathematics, software development and communication skills, which are essential for optimising BDA use. Organisations should provide training or partner with educational institutions to enable employees to develop these skills.

Conclusion

The primary research question focused on the essential competencies required for effective BDA use within the South African financial sector. The fundamental findings indicate the following: 1) On leadership: visionary, inclusive and task-oriented leadership is critical for the success of BDA initiatives. Leaders must be comfortable with technology and aligned with the principles of the 4IR. 2) On functional governance: a supportive organisational culture and a robust IT infrastructure are vital for BDA's success. Implementing frameworks such as the DAMA wheel helps structure data effectively. 3) On learning culture: encouraging a culture of continuous self-education among employees enhances operational performance. 4) On business acumen: a solid understanding of the business implications of BDA is essential for employees to effectively tackle real-world challenges and demonstrate the value of BDA. 5) On data science: this field is crucial in developing models and extracting insights from data.

Success in data science demands a blend of mathematics, IT, machine learning and pattern recognition skills. 6) On job roles: establishing positions, such as CDO, data translator, data analyst and data engineer, is necessary to optimise BDA use, emphasising critical thinking, problem-solving and communication skills. Organisations are encouraged to provide training or partner with educational institutions to nurture these essential skills among their employees.

Discussion

The discourse elucidates the pivotal role of leadership in advancing BDA implementation within South Africa's financial sector. Central to this discussion are several critical dimensions. Regarding leadership buy-in, effective BDA deployment necessitates not merely passive endorsement but active engagement and support from senior leadership. Such involvement is paramount in fostering an environment conducive to BDA's success. Regarding cultural and engagement dynamics, establishing a BDA-friendly organisational culture promoted by leadership is essential. Numerous studies corroborate that a supportive culture aligns with enhanced BDA outcomes, consequently impacting overall operational OP.

Regarding investment in BDA capabilities, leadership must commit to BDA by allocating resources and investments towards developing the necessary capabilities. This strategic investment is critical to harnessing BDA's full potential to enhance OP. Transformational and inclusive leadership approaches have emerged as the most conducive to BDA support. Such styles necessitate courage, vision and a collaborative spirit to navigate the complexities inherent in BDA initiatives. Regarding skills acquisition and development, cultivating pertinent leadership skills for BDA should originate from formal educational avenues and intentional organisational development programmes.

The significance of leadership support is underscored throughout, linking effective leadership to improved OP. Participant suggestions include establishing dedicated BDA departments and ensuring adequate financial resources to facilitate successful operations. Moreover, the necessity of employing skilled personnel proficient in BDA is highlighted because their expertise, coupled with robust leadership support, directly enhances OP. Active leader participation in BDA discussions is essential for fostering a collective vision among teams. Additionally, empowering senior-level executives with the requisite skills reinforces strategic alignment and support for BDA initiatives.

Feedback mechanisms, particularly 360-degree feedback systems, are valuable for enhancing the effectiveness of BDA teams, emphasising the importance of continuous engagement and communication. Furthermore, the data accentuates the importance of passionate leadership in successfully implementing BDA to enhance OP. Leaders who exhibit genuine enthusiasm for BDA can inspire innovation within their teams. Research indicates that a lack of such leadership can precipitate the failure of BDA initiatives. Leaders are urged to address tangible business challenges, identify correlations between these challenges and data-driven solutions, and communicate effectively to align short-term objectives with a long-term strategic vision.

Challenges in maximising BDA use often arise from scepticism regarding its capabilities and the proliferation of exaggerated claims. Thus, cultivating a sense of passion among leadership is essential for optimising BDA efforts and driving organisational success. In sectors such as finance in South Africa, passionate leaders are critical resources for enhancing OP through BDA initiatives. The discourse further explores the significance of organisational culture in facilitating BDA to bolster operational performance within South Africa's financial sector. Critical considerations include cultural support for BDA: effective support for BDA must be embedded within organisational norms and quotidian practices, particularly regarding data collection and processing; and employee interpretation and behaviour: the perceptions and interpretations of employees regarding their colleagues' behaviours

are crucial in cultivating a supportive culture, necessitating attention to language, mindsets and attitudes towards BDA.

Regarding promotion and education for BDA, organisations are encouraged to foster an analytics-oriented lexicon and acknowledge the instrumental role of BDA in enhancing operational efficiency, positively influencing organisational attitudes towards BDA. Regarding data-driven decision-making paradigms, a BDA-oriented culture significantly impacts decision-making processes, reflecting a discernible trend towards data-driven methodologies within large organisations. Establishing a learning culture dedicated to BDA is vital for enhancing organisational learning and performance because organisations embodying such a culture demonstrate superior operational efficacy. Lastly, the data emphasises the necessity of a robust IT infrastructure to enable effective BDA operations. Essential components include a reliable and secure network, efficient operating systems and adequate server storage capabilities to accommodate large data volumes. Technologies such as Hadoop are critical in addressing the storage demands associated with big data.

Furthermore, big data processing, including tasks related to data cleansing and batch processing, requires advanced infrastructures, whereas stream processing technologies, exemplified by Spark Streaming, are paramount for real-time data analytics. Skilled IT personnel, including developers, engineers and business analysts, are essential for sustaining BDA operations. Ongoing assessment of the efficiency and effectiveness of these technological systems is indispensable to ensure successful BDA implementation and use.

The discourse among participants underscored the critical role of frameworks in organisational settings in optimising BDA use. Participants specifically examined three frameworks. The DAMA wheel provides established best practices and metrics for data management, enhancing BDA by integrating various components into core business functions. Participants highlighted that the successful implementation of this framework is contingent upon the active involvement of top management. A measurement framework was articulated as essential for assessing and enhancing BDA performance. This framework mandates collaboration among stakeholders to effectively evaluate the value of BDA, which subsequently supports improved performance through clear alignment with organisational objectives.

Big data frameworks for banks are particularly valuable in the banking sector, enabling institutions to derive insights into client behaviour and detect potentially fraudulent activities, enhancing operational efficacy. Establishing a framework that aligns with organisational needs is vital for successfully applying BDA in this context. Furthermore, the financial sector is increasingly transitioning towards cloud-based storage solutions to manage extensive datasets more effectively. Data lakes are gaining traction for storing unstructured data, with cloud storage preferred for its scalability, security and online accessibility for authorised users, which contribute positively to BDA operations. Conversely, while on-premises storage solutions, including in-house servers, are perceived as more secure for sensitive data, they often entail high maintenance costs and lack flexibility. Colocation data centres emerge as a viable off-premises solution, providing secure environments that allow organisations to adapt storage needs cost-effectively while facilitating technological integration. Notably, despite perceiving hard disk drives as outdated, they remain a cost-effective option for startups, albeit with inherent risks of data loss and limited capacity. Organisations are encouraged to assess their storage options to ensure they align with their BDA objectives.

Big data processing necessitates specialised tools for interpreting vast amounts of unstructured information. Python is frequently identified as the tool of choice due to its user-friendliness, readability and extensive libraries, such as Pyspark and Pandas, which enhance insight extraction. Hadoop, a Java-based framework, benefits data processing by distributing tasks across computing clusters and offers competitive advantages when integrated with expansive storage technologies. SQL servers present an

alternative for extracting and managing large datasets, providing essential tools for data preparation. Additionally, Scala and Apache Spark are recognised for their superior efficiency in handling large datasets and conducting analytics. The R-programming language also holds value in data management and statistical analysis, particularly for its visualisation capabilities, contributing to its popularity within the BDA community. Selecting the appropriate processing tool is critical for optimising BDA outcomes and enhancing OP.

Moreover, the data emphasises the significance of business acumen in successfully implementing BDA within organisations. Fundamental considerations include the following:

i. Integrating BDA and business acumen (the true value of BDA is realised when it is internalised and aligned with business objectives to address real-world challenges);
ii. The role of leadership (leaders equipped with business acumen are better positioned to navigate complex issues across various domains, including IT, human resource management and marketing).
iii. The importance of innovation (adopting automation and innovative practices is essential for optimising processes and enhancing overall performance);
iv. Curiosity and strategy (business acumen nurtures curiosity, which is instrumental in developing effective business strategies that help organisations identify pertinent problems amenable to BDA solutions).
v. Understanding processes (a sound knowledge of business processes and interdepartmental dynamics augments the value of BDA and its acceptance within the organisation);
vi. Organisational awareness (conducting workshops and fostering a comprehensive understanding of BDA's objectives are crucial for leveraging its potential and instilling confidence among stakeholders).
vii. and BDA literacy (a foundational understanding of BDA across all employee levels is necessary for recognising its inherent value, cultivating a culture of adoption predicated on intrinsic motivation rather than external mandates).

The discourse further elucidates the indispensable role of data scientists in interpreting datasets to construct predictive models and derive actionable insights for businesses. Participants accentuated that data scientists must adeptly identify patterns within BDA and effectively communicate their findings to decision-makers, optimising BDA use. These professionals draw upon competencies from various domains, including mathematics, IT and machine learning, to extract knowledge that enhances business processes and strategic decision-making. Unfortunately, data scientists' responsibilities are often misconstrued, leading to unrealistic expectations regarding their capacity to resolve every organisational challenge. Organisations must understand the potential and limitations of this role to empower data scientists effectively. Additionally, data scientists engage closely with leadership teams to synchronise BDA insights with organisational goals, significantly contributing to strategic decision-making and competitive advantage. Thus, successful data scientists must have exceptional communication skills to articulate their findings and inspire stakeholders to adopt data-driven strategies.

The data discusses the interdisciplinary nature of data science, which involves analysing processes and big data to derive insights for businesses. Participants highlighted the close relationship between data science and BDA technology, emphasising the need for effective computing tools. Data science primarily aims to enhance organisational competitiveness and strategy through data insights, focusing on product performance and problem-solving. Furthermore, participants advocated incorporating software engineering practices to ensure reliable and repeatable project processes, emphasising the importance of understanding system programming. Root-cause analysis was identified as crucial for

addressing performance issues, and a comprehensive understanding of systems and infrastructure is necessary for providing meaningful insights. Data science is also vital in forecasting through machine learning capabilities, leveraging algorithms to analyse large datasets and improve predictive modelling. Additionally, it supports the design and prototyping of software products, allowing organisations to assess resource allocation before full system development.

The data discusses the importance of various roles in leveraging BDA for organisational success. Participants believe a CDO is essential for BDA success, emphasising their role in establishing data governance and data platforms and promoting strategic data analytics. The CDO is vital for implementing BDA and improving OP. Big data translators bridge the gap between technical teams and business stakeholders, translating complex analytics into actionable insights for decision-makers. They help identify business opportunities and add value to data insights. Data analysts are critical to BDA; they transform raw data into valuable insights and create visual representations, such as charts and dashboards. They communicate findings to stakeholders and collaborate with departments to support data-driven decision-making. Data engineers design and manage infrastructure for data processing and analysis. They ensure the smooth operation and integration of data systems, facilitating the functionality needed for BDA. Data visualisation involves presenting data in an understandable format through complex representations, such as heat maps. Effective data visualisation enhances decision-making by making insights readily accessible.

Participants identified several essential skills needed for emerging BDA job roles, including critical thinking, problem-solving, mathematical aptitude, software development and effective communication. These skills are crucial for optimising BDA and enhancing OP. Critical thinking fosters an environment of inquiry and innovation, whereas curiosity and scepticism are vital for questioning data and uncovering insights. Basic mathematical skills are necessary for analysing data and making informed decisions. Problem-solving involves defining issues, analysing data and communicating findings effectively, emphasising the importance of attention to detail and collaboration. The solution-focused approach, which emphasises co-creating practical solutions, was supported as a framework for new BDA roles. Organisations should assess candidates for their solution-driven mindsets and provide training for existing employees to enhance these skills. Finally, effectively communicating insights ensures shared understanding and use across the organisation.

Linking theories to themes

Three pertinent theories were examined concerning management perceptions of the intellectual ICs essential for BDA within the South African financial sector: resource-based theory [29], social cognitive theory [34], and diffusion of innovation theory [33]. Resource-based theory highlights the significance of leveraging valuable and unique resources to gain a competitive advantage. This study emphasises the importance of effectively acquiring ICs for successful BDA implementation, underlining the crucial role of management and the need for a reflective learning process. Although participants did not prioritise innovations or unique ICs, there was a clear focus on achieving actionable results.

Social cognitive theory illustrates that the participants' environments significantly shape their information competencies related to BDA. They demonstrated self-agency and a commitment to peer learning, highlighting the importance of collective understanding and continuous learning in effectively navigating the complexities of BDA. Rogers' diffusion of innovation theory categorises adopters into groups; it identified that most participants were early adopters of BDA. Critical factors influencing their adoption included compatibility with company values, low complexity, prior experimentation with BDA and interest in peer learning. The study highlights crucial elements for enhancing BDA adoption and success in organisations.

Limitations and future research

The study presents several limitations impacting the applicability of its findings. Notable concerns include issues of generalisability stemming from a generic qualitative methodology, which might not fully capture broader experiences due to the small sample size. Additionally, geographic constraints are significant; focusing on specific locations restricts the understanding of practices across various regions and financial institutions. Although the study identifies the ICs necessary for BDA, future research should investigate the implementation of these ICs to evaluate their value and influence on OP better.

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