Journal of Enterprise Information Management

# Tracing the effects of business intelligence on management controls and organisational performance

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Received 22 October 2024
Revised 11 February 2025
2 June 2025
31 January 2026
15 March 2026
Accepted 16 March 2026

## Abstract

**Purpose** – There is little consensus on how the link between business intelligence (BI) systems and organisational performance should be modelled or which performance outcomes are most relevant for assessing the business value of BI. This study draws on the "IT value" framework to develop a research model linking BI use to financial and non-financial performance outcomes through its impacts on the formal and informal management control systems of the organisation.

**Design/methodology/approach** – The method was quantitative in nature. Survey data were collected from a sample of 195 South African companies with structural equation modelling used to test the model's hypotheses.

**Findings** – Results indicate that extent of BI use has a positive significant influence on the effectiveness of both formal and informal management controls, along with positive significant effects on financial and non-financial performance outcomes of organisations.

**Research limitations/implications** – Self-administered surveys are subject to selection and response biases. Results may not be generalisable to all organisations. Data were cross-sectional, which limits causal inference. Longitudinal research designs would need to be employed in future studies.

**Originality/value** – The study contributes a novel explanation of BI value to organisations by demonstrating that BI systems can improve the effectiveness of formal and informal management controls. Control effectiveness measures are partial mediators linking BI use to financial and non-financial organisational performance outcomes. While BI use is strongest in bureaucratic control firms, clan organisations can benefit significantly from greater BI use. Moreover, we demonstrated that the value of BI should be considered from the balanced scorecard perspective of organisational performance.

**Keywords** Business intelligence, Management control, Organisational performance, South Africa, Information management, Financial performance, Non-financial performance

**Paper type** Research article

## Introduction

There is growing interest in the role of business intelligence (BI), analytics and artificial intelligence (AI) technologies in leveraging data to enable improvements in operational and decision-making processes (Akter *et al.*, 2016; Grover *et al.*, 2018; Zebec and Štemberger, 2024). BI platforms continue to be enhanced through cloud-based systems, real-time data analytics and convergence with AI technologies such as machine learning, natural language processing, conversational analytics and automated insights (Turi, 2020; Farmer, 2024; Salazar and Kunc, 2025). However, increasing investment in these emerging BI technologies is not always associated with greater business value. For example, a real estate company recently implemented new machine learning algorithms that failed to accurately forecast home



Journal of Enterprise Information Management
Emerald Publishing Limited
e-ISSN: 1758-7409
p-ISSN: 1741-0398
DOI 10.1108/JEIM-10-2024-0581

prices, leading to losses amounting to hundreds of millions of dollars (Metz, 2021). Furthermore, Gartner estimates that upwards of 70% of BI projects fail to deliver expected outcomes (Goodwin, 2011), highlighting that technological sophistication alone is insufficient for value creation.

These persistent failures indicate the growing need to examine the mechanisms through which BI influences organisational outcomes. Unsurprisingly, extant research remains concerned with how BI success can best be understood and measured (Ain *et al.*, 2025), and while much research has considered BI use at the individual level, few studies trace the effects of BI on the operational and decision processes that drive business value.

One promising area for such enquiry into the business value of BI is the role these systems play in management control (Rom and Rohde, 2006; Malmi and Brown, 2008; Elbashir *et al.*, 2011). Management controls are techniques and practices used by managers to ensure the behaviours and decisions of employees improve organisational performance and are consistent with organisational objectives and strategies (Simons, 1987; Malmi and Brown, 2008; Martin, 2020). For controls to be effective, significant effort is often expended in acquiring and analysing information on outcomes, such as deviations in performance, and on organisational member behaviours (Schermann *et al.*, 2012). Given their ability to integrate, analyse and visualise large volumes of organisational data, BI systems are theoretically well positioned to enhance both formal and informal management control processes. BI systems should be capable of providing the data collection, analysis, reporting, and results monitoring functionalities needed to enhance the sophistication of these management control processes (Arnold, 2018; Rikhardsson and Yigitbasioglu, 2018). Yet, studies suggest that the use of BI to enhance management control is not always satisfactory (Vukšić *et al.*, 2013). Management controls are often performed outside of BI systems on stand-alone systems and spreadsheet software (Rom and Rohde, 2006; Vakalfotis *et al.*, 2011). This disconnect raises important theoretical and practical questions regarding whether BI systems are effectively embedded within management control practices and whether such embedding is necessary for BI-driven value creation. It thus remains an open question as to whether, and to what extent, BI systems add business value to management control processes (Uppatumwichian, 2013; Appelbaum *et al.*, 2017). The relationships between organisational BI use, management control effectiveness and organisational performance outcomes have not yet been fully addressed (Peters *et al.*, 2016; Richards *et al.*, 2019; Bao *et al.*, 2023).

Building on this gap, our study offers three key contributions. First, it provides a theoretically grounded explanation of how BI adoption creates value through its influence on formal and informal management control systems. Second, it empirically examines both financial and non-financial performance outcomes, thereby extending prior studies that focus primarily on internal or short-term business process improvements. Third, it contributes contextual insight by testing these relationships in a developing country setting, where BI adoption is growing but empirical evidence remains limited.

We draw on the IT value model (Melville *et al.*, 2004) to develop a research model linking BI use to financial and non-financial performance outcomes through impacts on the formal and informal management control systems of the organisation. The IT value model is particularly appropriate for this study as it emphasises the transformation of IT resources into organisational capabilities and performance outcomes through complementary organisational processes. We test our model using a large sample survey of South African public and private sector organisations that are users of BI systems from SAP, Oracle, SAS and Microsoft, among others. The adoption of analytics technologies may be especially performance value creating in developing countries (Ansari and Ghasemaghaei, 2023), yet developing countries often lack the necessary technology infrastructures, skills and management processes needed to benefit from advanced technologies and despite an increased emphasis on data-driven decision making, the potential of BI for the South African market is yet to be fully realised (Allemann, 2023). The IT value model has not been sufficiently tested across all country and technology contexts (ZareRavasan and Krčál, 2021).

Our results thus contribute an improved explanation of the mechanisms through which BI systems influence organisational performance in a developing country setting. From a practical perspective, our results are also useful to organisations seeking relevant use cases for BI and other analytics technologies. Our research findings will help support organisations to better justify their investments in BI and to manage these systems for benefits realisation, including for enhanced management control practices.

This study is guided by the following research questions:

*RQ1.* How does the use of business intelligence systems influence the effectiveness of formal and informal management control systems within organisations?

*RQ2.* To what extent do formal and informal management control systems mediate the relationship between business intelligence use and organisational performance outcomes?

*RQ3.* How does BI-enabled management control affect both financial and non-financial organisational performance in a developing country context?

The next section of the article provides a review of the literature on BI and management control. Next, we outline the theoretical background and develop the study's research model and hypotheses. Thereafter, we describe the research methods before presenting empirical findings and implications of results for research and practice.

## Background literature

BI systems remain complex undertakings and often fail to deliver intended benefits (Yeoh and Popovič, 2016). Past studies have therefore focused on deriving a set of BI success measures (Ain *et al.*, 2025), and demonstrating a link between BI use and organisational level outcomes (O'Brien and Kok, 2006; Williams and Williams, 2007; Ain *et al.*, 2019; Narayanan and Boyce, 2019). However, there is little consensus on how the link between BI and performance should be modelled at the organisational level, and which performance outcomes are most relevant for assessing the value of BI (Işık *et al.*, 2013; Owusu, 2017; Hou, 2016; Popovič *et al.*, 2019; Ashrafi *et al.*, 2019). This lack of precision persists because prior research largely examines BI adoption at the individual or functional level, paying limited attention to the organisational processes through which BI create value. In public sector environments, research shows that BI initiatives frequently fall short of anticipated outcomes because managers make limited use of analytics tools, with very low uptake observed in government institutions; this under-utilisation undermines strategic decision-making and reduces the potential impact on efficiency and service delivery when BI is not integrated into routine managerial practice (Mansell and Ruhode, 2019). Further, barriers such as inadequate training, poor system quality and weak governance structures are commonly cited as inhibitors of effective BI adoption in public sector organisations, which contribute to sub-optimal use and failure to realise value from BI projects (Mansell and Ruhode, 2019; Nzimakwe, 2021).

One stream of research has emphasised the need for BI to be effectively embedded within various business processes to realise performance gains (Lönnqvist and Pirttimäki, 2006; Elbashir *et al.*, 2008; Elbashir and Williams, 2007; Božič and Dimovski, 2020; Aydiner *et al.*, 2019; Gauzelin and Bentz, 2017). For example, Popovič *et al.* (2019) studied 181 SMEs and found that BI adoption improves performance through its effects on functions such as marketing and sales, internal operations, and procurement. Aydiner *et al.* (2019) similarly found that business process performance linked BI adoption to financial performance, as did Elbashir *et al.* (2022) in the Australian context. More recently, Zebec and Štemberger (2024) also found that business process capabilities mediate the contribution of analytics to business value. These studies highlighted the process-driven nature of BI value but concentrated mainly on operational and financial outcomes, leaving

the role of management control largely unexplored. Despite these advances, most of the analytics and BI literature has not given attention to the use of BI in the management accounting and control context, even though these functions are central to organisational planning, monitoring and performance evaluation. This has obscured understanding of BI value, which is surprising given that management control activities are information-intensive and can benefit significantly from enterprise information systems, such as ERP (Rom and Rohde, 2006; Chapman and Kihn, 2009; Kallunki *et al.*, 2011). Some evidence suggests that BI can further enhance these controls by providing timely, integrated and actionable insights (Rikhardsson and Yigitbasioglu, 2018; Santos *et al.*, 2025). For example, Kallunki *et al.* (2011) demonstrated that ERP systems can improve non-financial performance; their study aggregated all non-financial outcomes and obscuring how customer satisfaction, internal business process improvements, or learning and development are individually affected. This aggregation limits understanding of how IT-enabled management controls generate value across specific organisational dimensions, leaving a gap in linking IT adoption to nuanced non-financial performance. Without BI, management control systems may lack timely and reliable information needed for real-time decision-making and strategic responsiveness (Nespeca and Chiucchi, 2018; Fähndrich, 2022). Our study explicitly differentiates non-financial performance into these distinct dimensions, allowing a more nuanced analysis of BI-enabled management control. Table 1 provides examples for the use of BI to implement both formal and informal management controls.

Relatively few empirical studies have, however, been carried out on BI links to management controls and performance. Richards *et al.* (2019) surveyed 337 companies and concluded that BI improved the effectiveness of planning and measurement controls. However, that study did not consider implications of BI for other formal or informal controls or organisational outcomes. Elbashir *et al.* (2021) found that BI-enabled management controls were associated with business process performance. However, their study did not differentiate between informal and formal controls and did not examine other performance measures such as customer outcomes. Peters *et al.* (2016) found that greater quality of BI functionality improved the performance measurement capabilities of firms, but they did not explore other types of management controls. Most recently, Martins *et al.* (2025) explored the early stages of BI implementation in a multinational engineering group and found that integrating BI and reporting can impact on management control and overall organisational performance, yet their study did not explore a larger sample of firms.

Taken together, there are several existing research gaps. While some studies support a positive relationship between BI and performance, there remains a greater need for research to investigate the mechanisms of the BI value creation process (Oesterreich *et al.*, 2022). Past studies confirm that BI is often adopted to deliver the analytical and reporting capabilities needed for management control activities. Yet, too few studies consider BI value through its contribution to the effectiveness of management controls (Richards *et al.*, 2019; Elbashir *et al.*, 2022). The importance of formal and informal management control processes in the BI value creation process thus needs further consideration. Past studies have also tended to focus mostly on intermediate process performance and have not consistently linked BI to a balanced scorecard of financial and non-financial performance outcomes. In addition, because evidence is lacking on the mechanisms through which BI improves organisational outcomes, the literature has not adequately identified the most valuable use cases for emerging analytics and BI solutions. Finally, most studies on BI value consider developed country contexts; there is less empirical evidence of the value of analytics and BI to performance outcomes in developing country settings. Developing countries are expected to observe high growth in analytics and BI adoption, yet there is limited literature to guide their effective use of these technologies to achieve financial and non-financial performance.

**Table 1.** Use cases for BI in management controls

| Example of control | Explanation of control | Use cases for BI |
|---|---|---|
| *Formal controls:* focus on measured performance, the activities that produce desired results and monitor against performance standards (Cravens *et al.*, 2004) | | |
| Planning | A management control for creating goal congruence (Malmi and Brown, 2008) | Analyse existing data to predict future trends and ensure efficient resource allocation to achieve planning goals (Hart and Snaddon, 2014) |
| Budgeting | Used to hold employees accountable for achieving financial goals (Felício *et al.*, 2021) | Dashboard displays that visualise actual performance against budget (Granlund, 2011; Elbashir *et al.*, 2021) |
| Cost analysis | Weighing costs, such as operational expenses, production costs and overheads, against profits to reduce unnecessary expenses (Langfield-Smith, 1997) | Aid organisations in understanding cost drivers, optimise spending and improve cost controlling (Rikhardsson and Yigitbasioglu, 2018; Felício *et al.*, 2021) |
| Activity based costing (ABC) | Provide accurate and detailed understanding of cost structures to apportion overhead to products (Hart and Snaddon, 2014) | Data analysis and visualisation to improve cost allocation and insight of detailed activities for better decision making (Rikhardsson and Yigitbasioglu, 2018) |
| Performance monitoring | Track progress towards multiple key performance indicators (Richards *et al.*, 2019) | Monitor areas such as process performance and customer service outcomes against quantified standards (Gauzelin and Bentz, 2017; CIMA, 2008) |
| Internal auditing | Provide assurance on compliance and alignment of practices with regulations and strategic objectives and evaluate operational effectiveness (Joshi and Marthandan, 2020) | Analyses large volumes of data, identify trends and anomalies that may indicate areas of concerns or opportunities for improvement (Joshi and Marthandan, 2020) |
| *Informal controls:* focus on culture, values, beliefs and social norms that influence and regulate employee actions and behaviours to achieve desired outcomes (Malmi and Brown, 2008) | | |
| Open channels of communication | A management control for promoting culture of sharing information and collaboration (Peters *et al.*, 2016) | Create a transparent environment where performance information is accessible and supported by real-time data (Peters *et al.*, 2016) |
| Interaction and consensus seeking | Encourages teamwork and aligns individual actions with organisational objectives (Malmi *et al.*, 2020) | Monitoring performance that aligns all employees to work towards a common goal (Chapman and Kihn, 2009) |
| Employee adaptation | helping employees adapt to organisational norms and expectations (Carenys, 2012) | analyse efficacy of employee training by providing feedback on performance (Elbashir *et al.*, 2021) |
| Clan culture | Creating an environment where employees share common values and beliefs (Malmi *et al.*, 2020) | Providing information to all employees that will encourage a culture of performance and the motivation to implement the strategy of the organisation (Chapman and Kihn, 2009) |

**Source(s):** Authors' own work

Our study addresses these gaps by examining how BI adoption influences formal and informal management controls and, consequently, both financial and non-financial outcomes. By distinguishing non-financial performance into customer satisfaction, internal process improvements, and learning and development, we provide a nuanced understanding of BI value creation that informs theory and offers practical guidance for managers in developing country contexts. Next, we present the theoretical foundation and research model.

## Theoretical underpinning and research model

The theoretical underpinning for our study is Melville *et al.*'s (2004) theory of IT Business Value and Trieu's (2017) framework for BI value. Drawing on the resource-based view of the firm and earlier work on IT value (Soh and Markus, 1995), Melville *et al.* outline a process theory on IT value creation. Specifically, IT value occurs within an organisational context when an IT asset is used to enable business processes and capabilities, which are the main value-generating activities of the firm. Value is therefore evidenced in business process performance and subsequent organisational performance that results from IT assets complementing other organisational resources and capabilities. Organisations apply and utilise the capabilities of information technologies in their business activities in order for them to add value (Armstrong and Sambamurthy, 1999). Thus, IT is not considered inherently valuable on its own but generates value only via intermediate operational and/or managerial processes that interact with IT to attain performance impacts. Variations of this IT value creation process have been drawn on to empirically examine IT business value in contexts such as ERP (Ruivo *et al.*, 2020), CRM (Trainor *et al.*, 2014), KMS (Hung *et al.*, 2015) and in BI (Elbashir *et al.*, 2008; Božič and Dimovski, 2019; Richards *et al.*, 2019). Recently, Trieu (2017) conceptualised an integrated BI value creation process. It suggests BI value occurs when BI assets are effectively used by management to generate BI impacts that yield organisational performance.

Drawing on the above, we present our research model in Figure 1. The model depicts a BI value creation process where the extent of BI system use is hypothesised to influence organisational performance (H1 and H2) directly and through intermediate effects on the management controls of the organisation (H4 and H5). The extent of BI use represents an IT asset under the resource-based view of the firm (Bharadwaj, 2000), and is defined as BI system diffusion across organisational functions to support their activities and processes (Liang *et al.*, 2007).

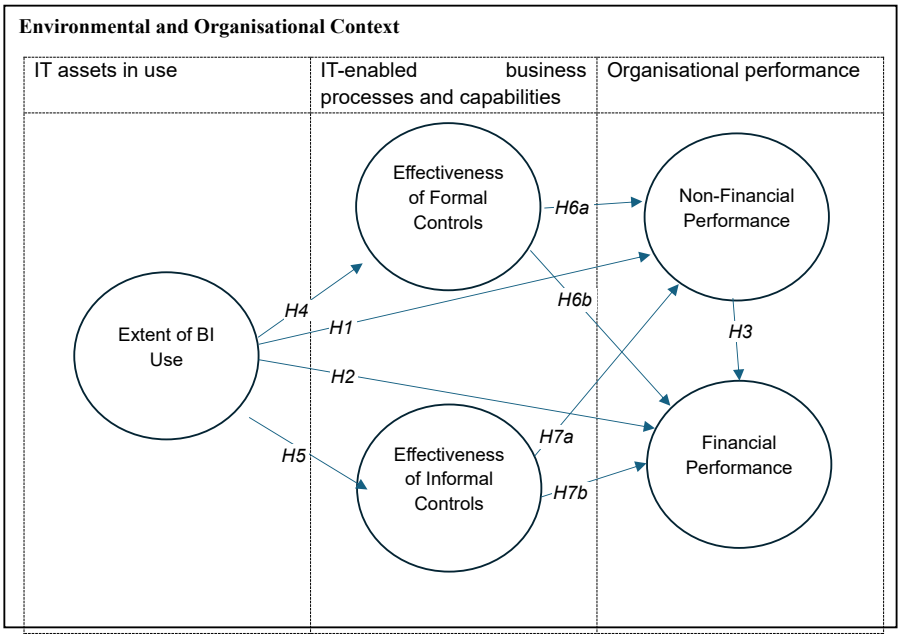


**Figure 1.** Research model. Source: Authors' own work

Management control effectiveness is an IT-enabled organisational capability under the resource-based view of the firm, responsible for translating IT assets into performance outcomes within the IT value creation process (Melville *et al.*, 2004). This is depicted by arrows H6a, H6b, H7a and H7b. Management controls include both the formal controls, such as budgeting, costing and performance monitoring, and the informal control processes that support organisations to achieve their strategic goals (Kallunki *et al.*, 2011). Organisational performance is a set of financial and non-financial performance indicators (Kaplan and Norton, 1992; Neely *et al.*, 2005; Božič and Dimovski, 2019). Non-financial performance covers areas such as customer service, business process improvement, and learning and development (Kaplan, 2009). Non-financial performance may also subsequently improve financial performance measures such as revenues and profitability (H3).

## Hypotheses development

### *Influence of BI on financial and non-financial performance*

BI systems are deployed to reduce the risks associated with executive judgement based on intuition and to improve the quality of those decision-making tasks important to organisational performance (Yiu *et al.*, 2021). BI has been associated with more timeous, accurate and responsive decision making (Appelbaum *et al.*, 2017; Jaklič *et al.*, 2018; Ain *et al.*, 2019), enhancing the absorptive capacity (Božič and Dimovski, 2020), sensing and seizing (Torres *et al.*, 2018) and the business process change capabilities of firms (Chen and Lin, 2021). BI systems have also been associated with improved explorative and exploitative innovation activities, which in turn enhance firm performance (Božič and Dimovski, 2019). Others have also found BI benefits performance through its impacts on organisational innovation and agility (Côrte-Real *et al.*, 2017; Ashrafi *et al.*, 2019). Better decision-making due to the data collection and analysis functionalities of BI prevents wasted organisational resources and missed opportunities. For example, providing real-time information to understand and respond to the behaviour of customers (Cox, 2010; Peters *et al.*, 2016; Aydiner *et al.*, 2019), improving customer service (Hadid and Al-Sayed, 2021), redirecting organisational resources to products and services yielding better returns (Lönnqvist and Pirttimäki, 2006; Popovič *et al.*, 2018), configuring business processes to cope with new ways of doing business (Olszak and Ziemba, 2012; Ain *et al.*, 2019), aligning processes with organisational objectives (Ramanathan *et al.*, 2017; Aydiner *et al.*, 2019) and identifying areas for employee development (Bronzo *et al.*, 2013).

The use of BI should thus translate to numerous intermediate non-financial performance outcomes such as customer satisfaction, organisational learning and internal process performance (Pirttimäki *et al.*, 2006; Elbashir *et al.*, 2008; Hou, 2016; Božič and Dimovski, 2019). Hence:

*H1*. The greater the extent of BI use, the greater will be the firm's non-financial performance

BI systems should also provide for improved financial performance (Popovič *et al.*, 2018; Elbashir *et al.*, 2021; Ain *et al.*, 2025). Past studies have associated BI with improving the capabilities that lead to market performance (Mikalef *et al.*, 2020; Kamel, 2023), along with increased turnover, cost reductions and better profit margins (O'Brien and Kok, 2006; Olszak and Ziemba, 2012; Aydiner *et al.*, 2019). It is also reasonable to expect that BI systems influence financial performance through improvements in non-financial performance (Hou, 2016). Specifically, internal business process improvements due to BI have been associated with improved financial performance (Elbashir *et al.*, 2008; Chen and Lin, 2021). Customer performance improvements due to faster and more accurate reporting translate to financial revenue growth and cost reductions (Gessner and Volonino, 2005). Improvements made in customer satisfaction also result in customer retention, cross-selling and repeat purchases that will have an impact on profitability (Kallunki *et al.*, 2011). Improvements to employee skills

and know-how help firms maintain capabilities important to achieving financial outcomes (Božič and Dimovski, 2019). Taken together, it can be hypothesised that:

*H2.* The greater the extent of BI use, the greater will be the firm's financial performance

*H3.* The greater the firm's non-financial performance, the greater will be the firm's financial performance

*Influence of BI on management controls*

BI reduces numerous barriers and improves the data collection, analysis and reporting required to establish strong management controls and strengthen the capacity of the control environment (Schermann *et al.*, 2012; Biswas and Akroyd, 2022; Elbashir *et al.*, 2022). First, BI reduces the costs and effort associated with large volume data collection and integration from across business processes and functions (Elbashir *et al.*, 2022). This improved access to data strengthens controls such as budgeting, cost controls and performance management (Grabski *et al.*, 2011). Firms without appropriate BI solutions risk low-quality data that is neither reliable nor timely, and which will constrain their management control systems (Uppatumwichian, 2013; Elbashir *et al.*, 2022). Second, BI improves control measurement and analysis by providing enhanced measurability of outcomes and better diagnostic tools to monitor if strategic objectives are being met (Malmi and Brown, 2008; Elbashir *et al.*, 2022; Sinarasri *et al.*, 2023). For example, BI systems embed forecasting tools, templates for budgeting, models for activity-based costing and scorecard tracking tools (Yiu *et al.*, 2021; Nespeca and Chiucchi, 2018). Third, BI improves reporting on control effectiveness and provides for continuous monitoring and timely access to meaningful reports through visualisation, drill-down and dashboard technologies, along with the opportunity for managers to interact with data and explore control information (Peters *et al.*, 2016; Schermann *et al.*, 2012; Yiu *et al.*, 2021). A major benefit of BI is the support it provides to identify performance deviations and their causes through interactive dashboard displays (Granlund, 2011).

BI also makes informal controls more effective. For example, visibility of information through BI may encourage employees to work towards achieving the target without any management influencing them to do so (Granlund, 2011; Martin, 2020; Felício *et al.*, 2021). Employees can be empowered through performance measurement tools that provide goals, targets, and feedback in a visual, simplified and easy-to-use manner (Fullerton *et al.*, 2013). This improves their ability to self-regulate and participate in informed interactions with managers (Long *et al.*, 2015). BI tools can also facilitate knowledge sharing and continual exchange between managers and employees for timely decisions and achievement of strategies (Bisbe and Otley, 2004; Peters *et al.*, 2016). BI can nurture a data-driven culture (Martins *et al.*, 2025), and when performance information is more readily available through BI, employees are more likely to develop a culture of performance and be more motivated to implement the strategy of the organisation (Chapman and Kihn, 2009; Elbashir *et al.*, 2021).

Therefore, it can be hypothesised that organisations with BI systems are expected to have more effective formal and informal controls than those in which BI systems are absent or less well diffused. Past studies confirm the positive influence of information systems and BI on control environments (Chapman and Kihn, 2009; Kallunki *et al.*, 2011; Vukšić *et al.*, 2013; Elbashir *et al.*, 2022). Hence:

*H4.* The greater the extent of BI use, the greater will be the effectiveness of formal management controls

*H5.* The greater the extent of BI use, the greater will be the effectiveness of informal management controls

*Influence of management controls on performance*

The outcomes of BI-enabled management control should subsequently reflect in the financial and non-financial performance of the firm. Weak management controls can lead to numerous undesired outcomes, including poor decision-making, financial losses, excessive costs, reputational damage and even organisational failure (Goebel and Weißenberger, 2017). On the other hand, more sophisticated controls should be performed, given their role in supporting the implementation of strategy and focusing organisational attention (Henri, 2006). Formal controls are particularly important to ensuring efficient work processes and maintaining the financial viability of an organisation (Goebel and Weißenberger, 2017). Management controls should result in quality and productivity improvements in key business areas, such as product reliability, customer service, product feedback and learning (Quattrone and Hopper, 2005; Liew, 2019). The effects of management controls on financial performance may thus be mediated by these benefits to operations (Felício *et al.*, 2021). Informal controls are also expected to translate to performance. They help employees identify more strongly with organisational goals and strategies, which is important for their commitment and contribution to achieving desired outcomes (Goebel and Weißenberger, 2017). They also orient employees towards the sorts of behaviours needed to create value for customers (Henri, 2006). Higher levels of both formal and informal controls are thus considered most effective (Cravens *et al.*, 2004). Taken together, effective management controls should translate into both financial and non-financial performance outcomes. Therefore:

*H6a.* The greater the effectiveness of formal management controls, the greater will be the firm's non-financial performance

*H6b.* The greater the effectiveness of formal management controls, the greater will be the firm's financial performance

*H7a.* The greater the effectiveness of informal management controls, the greater will be the firm's non-financial performance

*H7b.* The greater the effectiveness of informal management controls, the greater will be the firm's financial performance

*Organisational and environmental variables*

We control for the effects of numerous organisational and environmental factors that can influence information intensity, decision complexity and performance outcomes in a management control context. Melville *et al.* (2004) argued that numerous characteristics of the focal firm and the industry in which the firm operates can shape the deployment of IT resources and hence the IT business value. Therefore, we specifically consider organisational environment, structure, size, strategy and quality of the board (Ashrafi *et al.*, 2019; Elbashir *et al.*, 2021; Hadid and Al-Sayed, 2021). Organisational environment refers to the levels of dynamism and uncertainty in the sector in which the organisation operates. Strategy reflects the orientation of the organisation with respect to innovation, product/service differentiation and cost leadership. Structure is reflected in the organisation's hierarchy and decision authority. Size is reflected by revenue and the number of employees. A quality board monitors and holds executives accountable to stakeholders.

## Methods

*Measures*

The method was quantitative in nature. Each of the model's constructs was measured using multi-item scales. The detailed items are reflected in Table 3. Extent of BI system use was measured with multiple items on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) capturing the support provided by BI to several organisational functional areas, such as

financial management, supply chains and procurement, production and marketing, among others (Armstrong and Sambamurthy, 1999; Liang *et al.*, 2007). The measures capture the degree to which the technology has moved beyond initial or symbolic adoption and become more widespread and embedded into an organisation's primary and secondary value chain activities (Purvis *et al.*, 2001; Liang *et al.*, 2007). Our measure incorporates a common set of value chain activities that shape organisational outcomes and through which information gives firms a competitive advantage (Porter and Millar, 1985). These core organisational activities are also considered relevant to the design of management control and cost accounting systems (Hergert and Morris, 1989; Anderson, 2006). We did not include specialised functions, such as legal, that may be less common to pursuit of cost leadership or differentiation strategies (Porter and Millar, 1985). The choice of activities thus reasonably captures wide organisational diffusion of BI as a critical stage in post-adoption technology assimilation and from which value emerges (Purvis *et al.*, 2001). The construct was modelled as a formative (causal) construct because BI support across these different value chain functions defines the overall extent of BI use, rather than the items being interchangeable reflections of a single underlying latent variable. A 7-point scale was preferred for its ability to capture nuanced differences in respondents' perceptions, providing a detailed view of both the intensity and breadth of BI use across their organisation. A single formative composite score was calculated from the multiple items using a unit-weighted approach to reduce capitalisation on chance.

While multiple management controls are part of a control package, for practical reasons, we focused our measures on a few commonly considered controls (Bisbe and Otley, 2004; Kallunki *et al.*, 2011). The effectiveness of formal controls was modelled as a reflective construct, including six control items such as planning, budgeting, and cost analysis (Malmi and Brown, 2008; Chapman and Kihn, 2009; Kallunki *et al.*, 2011), each measured on a 7-point Likert scale (1 = much worse than expected to 7 = much better than expected). The effectiveness of informal controls was modelled as a reflective construct, measured as six items reflecting management–employee interactions and employee participation in decision making (Chenhall, 2003, 2006; Langfield-Smith, 1997). The informal control items were measured on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree). In line with other literature (Kallunki *et al.*, 2011), the reflective mode was used because a sophisticated management control system is observed as a set of interdependent rather than independent controls. Thus, we model formal and informal control systems based on the expectation that the indicators of a sophisticated-management control system covary, having the same antecedents and consequences as the reflective construct (Coltman *et al.*, 2008).

The non-financial performance measures were also measured as multiple items on a 7-point Likert scale (1 = much worse than expected to 7 = much better than expected). Internal business process performance was measured using five items reflecting the outcome of business process improvement, monitoring, efficiency, productivity and decision making (Elbashir *et al.*, 2008). Customer performance was measured using four items reflecting customer lead time, quality, performance and service (Elbashir *et al.*, 2008). While feedback, learning and development were measured using three items reflecting employee satisfaction, testing new ideas, training and product launch (Elbashir *et al.*, 2008). Financial performance was measured using five items reflecting respondent perceptions of whether the organisation had met its objectives with respect to profit, sales growth, return on investment, assets and cost savings (Kallunki *et al.*, 2011; Elbashir *et al.*, 2008) and were also measured on a 7-point Likert scale (1 = much worse than expected to 7 = much better than expected).

Items were also included to reflect organisation size, environment, structure, strategy and quality of the board (Ashrafi *et al.*, 2019; Martin, 2020).

To mitigate against self-administered survey bias, the questionnaire items were presented in neutral language so as not to lead respondents, and respondents were guaranteed full confidentiality and informed that only aggregate data would be reported (Podsakoff *et al.*, 2012). To improve content and face validity, a pre-test was conducted using ten BI system practitioners and academic experts. Thereafter, pilot testing was conducted using a

convenience sample of twenty executives. Recommendations were used to enhance the final instrument.

*Sample*

Data was collected from a sample of 360 public and private organisations in South Africa. BI systems have diffused fairly widely across both public and private sectors (CIMA, 2010). The Financial Mail (2016) ranking of the 200 largest leading companies in South Africa on total asset value was used as the sampling frame for the private sector, which included organisations from industries such as finance, manufacturing, and telecommunications. This list accounts for nearly 75% of Johannesburg Securities Exchange (JSE) listed companies and is thus representative of larger companies in South Africa. A further 196 public entities listed by the National Treasury in South Africa were included in the sampling frame (PFMA, 1999). These entities represent the total population of national public entities registered by the National Treasury in South Africa.

The key informant for each sampled organisation was a selected executive, such as the CFO equivalent, able to provide a relevant organisational perspective on BI use, management controls and performance (Ponterotto, 2005; Elbashir *et al.*, 2013). Executives are considered useful key informants given their responsibilities to drive organisational strategies and performance (Gong *et al.*, 2004). To test for non-response bias, we also used *t*-tests to compare data received from early respondents (first five days of survey) and late respondents (last five days of survey as proxies for non-respondents), and found no statistically significant differences.

A response rate of 50.23% was achieved with 199 organisations using BI systems completing the survey instrument. This relatively high response rate also reduced threats to the validity of conclusions arising from non-response bias. Only four responses were eliminated as they were missing some data items, resulting in a useable sample of 195 organisations providing sufficient data for meaningful statistical analysis. The demographic profile of these respondents is presented in Table 2. Respondents cover several industry sectors; they are mostly mature organisations, and 95% reported revenues above R500 million. SAP, Microsoft and SAGE BI solutions are the most popular solutions, with most organisations using BI for more than five years. Respondents will mostly be financial directors, CFOs and related executives.

## Results

*Measurement model testing*

An initial principal components analysis confirmed the dimensionality of the constructs. Table 3 presents the items with factor loadings. Items that did not load above 0.60 were dropped. For the formative construct, we report the VIF values and outer weights (Hair *et al.*, 2021). VIF values range from 2.304 to 2.584 and are below the commonly accepted collinearity threshold. Outer weights were positive and statistically significant (t-values ranging from 8.727 to 9.762; $p < 0.001$). We also ruled out common methods bias, using Harman's one-factor test, as the first factor in the analysis accounted for just 35% of the variance. Average variance extracted values supported convergent validity as all were above 0.50, and Cronbach's alpha values were above 0.70, thus confirming internal consistency reliability of the scales. We also confirmed Cronbach's alpha values were above the 0.70 cut-off across various subgroups representing private vs public, larger vs smaller organisations and higher vs lower formal control organisations. Therefore, we did not consider the diversity of the sample to have had an impact on the reliability of the scales. To confirm discriminant validity, we compared inter-construct correlations with the square root of AVE of each construct (Table 4). The square roots of AVE of each construct were larger than the inter-construct correlations, confirming that constructs share more variance with their own items than with other constructs in the model.

**Table 2.** Demographics

| Demographics | Category | Frequency | Percentage |
|---|---|---|---|
| Respondent job title | Chief Financial Officer | 42 | 21.5 |
| | Management Accountant | 23 | 11.8 |
| | Finance Director | 72 | 36.9 |
| | Managing Director | 20 | 10.3 |
| | Executive Director | 38 | 19.5 |
| Sector in which organisation operates | Manufacturing | 36 | 18.5 |
| | Utilities and energy | 12 | 6.2 |
| | Logistics | 17 | 8.7 |
| | Retail | 15 | 7.7 |
| | Telecommunications | 6 | 3.1 |
| | Pharmaceutical | 12 | 6.2 |
| | Public sector | 6 | 3.1 |
| | Service | 38 | 19.5 |
| | Finance | 34 | 17.4 |
| | Mining | 19 | 9.7 |
| Number of employees | 101–499 | 2 | 1.0 |
| | 500–999 | 10 | 5.1 |
| | 1,000–4,999 | 75 | 38.5 |
| | 5,000–9,999 | 66 | 33.8 |
| | >10,000 | 42 | 21.5 |
| Number of years company has been operational | <5 years | 2 | 1.0 |
| | 6–10 years | 24 | 12.3 |
| | 11–20 years | 24 | 12.4 |
| | 21–30 years | 15 | 7.7 |
| | >31 years | 130 | 66.7 |
| Number of years organisation has been using BI | <1 year | 14 | 7.2 |
| | 1–2 years | 16 | 8.2 |
| | 3–5 years | 45 | 23.1 |
| | 6–9 years | 67 | 34.4 |
| | >10 years | 53 | 27.2 |
| BI system in use | SAP business object | 52 | 26.7 |
| | Microsoft | 25 | 12.8 |
| | SAGE | 23 | 11.8 |
| | Clear Analytics (Excel based) | 19 | 9.7 |
| | Oracle | 16 | 8.2 |
| | Qlikeview | 15 | 7.7 |
| | SAS | 13 | 6.7 |
| | MicroStrategy | 12 | 6.2 |
| | Other incl. IBM Cognos, Sisense and Synergy | 20 | 10.3 |

**Source(s):** Self

A further confirmatory factor analysis test of the measurement model was undertaken using AMOS. The maximum-likelihood method was adopted. The ratio of the $\chi^2$/DF = 2 is acceptable and is less than the recommended value of 3 [GFI = 0.999; NFI = 0.998; CFI = 1; IFI = 1; RMSEA = 0.097; DF = 2; TLI = 0.865; RFI = 0.977] with the factor loadings between 0.690 and 0.922. We also considered more parsimonious factor structures and ran one-, two-, three- and four-factor CFA models. However, these exhibited poor fit with the low factor loadings. Taken together, results confirm the reliability, convergent and discriminant validity of the measured constructs, and hypothesis testing could proceed.

*Structural model and hypothesis testing*

The structural model was tested using AMOS with results reported in Table 5. As presented in Table 4, 13 out of 17 paths were directly supported by the model being tested.

**Table 3.** PCA results and item reliability

| Variables | Items | Factor loadings[a] | AVE[b] | Cronbach alpha[c] |
|---|---|---|---|---|
| Extent of BI Use (BI) | Our BI system is supporting financial management | 0.195 (0.824) | 0.800 | 0.968 |
| | Our BI system is supporting supply chains and procurement | 0.209 (0.851) | | |
| | Our BI system is supporting production/service management | 0.184 (0.826) | | |
| | Our BI system is supporting project management | 0.202 (0.825) | | |
| | Our BI system is supporting human resources | 0.220 (0.770) | | |
| | Our BI system is supporting sales | 0.189 (0.825) | | |
| | Our BI system is supporting marketing | 0.182 (0.786) | | |
| Effectiveness of Formal Controls (EFC) | Contribution of our cost control systems (such as variance analysis) to organisational performance outcomes | 0.823 | 0.820 | 0.902 |
| | Contribution of our strategic planning systems to organisational performance outcomes | 0.877 | | |
| | Contribution of our budget systems to organisational performance outcomes | 0.840 | | |
| | Contribution of our activity-based costing systems to organisational performance outcomes | 0.883 | | |
| | Contribution of our result monitoring systems to organisational performance outcomes | 0.844 | | |
| | Contribution of our internal auditing systems to organisational performance outcomes | 0.823 | | |
| Effectiveness of Informal Controls (EIC) | We are satisfied with how our employees can achieve consensus seeking without needing management intervention | 0.761 | 0.650 | 0.912 |
| | We are satisfied with how our employees can practice open channels of communication | 0.773 | | |
| | We are satisfied with how our employees can adapt to the local situation | 0.831 | | |
| | We are satisfied with how our corporate culture encourages informal signalling of potential problems | 0.849 | | |
| | We are satisfied with how our managers can develop new ideas even if they fall outside an individual area of responsibility | 0.818 | | |
| | We are satisfied with how our top-level managers can co-ordinate business activities across the organisation | 0.845 | | |
| Business Process Performance (BPP) | Business process performance has been | 0.920 | 0.840 | 0.939 |
| | Effectiveness of business process monitoring has been | 0.885 | | |
| | Business process continuous improvement has been | 0.889 | | |
| | Efficiency of internal processes has been | 0.820 | | |
| | Staff productivity has been | 0.883 | | |

(*continued*)

**Table 3.** Continued

| Variables | Items | Factor loadings[a] | AVE[b] | Cronbach alpha[c] |
|---|---|---|---|---|
| Customer Service Performance (CSP) | Customer satisfaction has been | 0.874 | 0.780 | 0.776 |
| | Response time to customers has been | 0.900 | | |
| | Customer retention has been | 0.839 | | |
| | Time to market for our products/services has been | 0.905 | | |
| Feedback, Learning and Development (FLD) | Employee satisfaction has been | 0.818 | 0.800 | 0.849 |
| | Employee training has been | 0.878 | | |
| | Number of new products/services launched has been | 0.839 | | |
| Financial Performance (FP) | The increase in operating income has been | 0.888 | 0.820 | 0.939 |
| | The improvement in sales growth rate has been | 0.922 | | |
| | The increase in return on investment has been | 0.839 | | |
| | The increase in return on assets has been | 0.899 | | |
| | Increase in gross profit has been | 0.860 | | |
| Quality of Board (QB) | Our board monitors organisational performance | 0.859 | 0.740 | 0.929 |
| | Our board accounts to stakeholders on organisational performance | 0.854 | | |
| | Our board holds executive management accountable | 0.870 | | |
| Organisation Environment (OE) | Changes in the external business environment make our products/services quickly obsolete | 0.706 | 0.510 | 0.961 |
| | Changes in the external business environment make our technologies quickly obsolete | 0.716 | | |
| | Changes in the external business environment make our competitive practices quickly obsolete | 0.762 | | |
| | The business environment is threatening the survival of our organisation | 0.690 | | |
| | Tough price competition is threatening the survival of our organisation | 0.704 | | |
| Organisation Strategy (ST) | Our organisation provides a variety of products or services | 0.904 | 0.770 | 0.969 |
| | Our organisation makes frequent changes to products/services that it offers | 0.862 | | |
| | Our organisation is a pioneer attempting to be first in introducing innovative products/services | 0.901 | | |
| | Pricing below competitors is a constant emphasis for us | 0.882 | | |
| | Continuing, overriding concern for lowest cost per unit is a constant emphasis for us | 0.893 | | |
| | Products or services in lower priced market segments is a constant emphasis for us | 0.835 | | |
| Organisation Structure (OS) | Our workers have the authority to correct problems when they occur | 0.768 | 0.570 | 0.926 |
| | Our work teams have control over their job | 0.745 | | |
| | Our supervisors or middle managers are supportive of the decisions made by our work teams | 0.770 | | |
| | We encourage workers to be creative in dealing with problems at work | 0.734 | | |

**Note(s):** Four formal control items and three informal controls items were dropped in the initial PCA analysis and are not reflected, [a]Standardised weights are reported for formative indicators (loadings in brackets) with all significant at $p < 0.001$, item VIF values ranged from 2.304 to 2.584, [b]AVE reported for all constructs, but has limited relevance for constructs modelled in the formative mode, [c]Cronbach's alpha test for composite reliability reported for all constructs, but has limited relevance for constructs modelled in the formative mode

**Source(s):** Self

**Table 4.** Matrix of composite scores and square root of AVE

| | Mean (S.D.) | BI | QB | OE | ST | OS | BPP | CSP | FLD | FP | EFC | EIC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BI | 5.8 (1.2) | *0.892* | | | | | | | | | | |
| QB | 4.7 (1.7) | 0.404** | *0.861* | | | | | | | | | |
| OE | 5.3 (1.5) | 0.664** | 0.403** | *0.716* | | | | | | | | |
| ST | 4.6 (1.9) | 0.423** | 0.382** | 0.480** | *0.880* | | | | | | | |
| OS | 5.0 (1.4) | 0.614** | 0.295** | 0.600** | 0.381** | *0.754* | | | | | | |
| BPP | 4.2 (1.9) | 0.358** | 0.296** | 0.454** | 0.309** | 0.406** | *0.915* | | | | | |
| CSP | 4.5 (1.5) | 0.332** | 0.070 | 0.292** | 0.146* | 0.140 | 0.064 | *0.885* | | | | |
| FLD | 4.6 (1.7) | 0.376** | 0.365** | 0.386** | 0.268** | 0.429** | 0.382** | 0.114 | *0.891* | | | |
| FP | 4.4 (1.9) | 0.322** | 0.221** | 0.435** | 0.314** | 0.220** | 0.218** | 0.380** | 0.136 | *0.904* | | |
| EFC | 4.7 (1.6) | 0.488** | 0.281** | 0.510** | 0.114 | 0.512** | 0.315** | 0.034 | 0.390** | 0.136 | *0.905* | |
| EIC | 5.0 (1.3) | 0.299** | 0.241** | 0.354** | 0.109 | 0.337** | 0.268** | 0.095 | 0.302** | 0.069 | 0.302** | *0.804* |

**Note(s):** **. "Correlation is significant at the 0.01 level (two-tailed)"
*. "Correlation is significant at the 0.05 level (two-tailed)"
**Source(s):** Self

**Table 5.** Results of hypothesised model (direct effects)

| Hypothesis | Path | Estimate | S.E. | C.R. | *p* | Supported |
|---|---|---|---|---|---|---|
| H1 | BI→CSP | 0.500 | 0.095 | 5.244 | *** | Yes |
| | BI→BPP | 0.360 | 0.115 | 3.129 | 0.002 | Yes |
| | BI→FLD | 0.296 | 0.104 | 2.851 | 0.004 | Yes |
| H2 | BI→FP | 0.257 | 0.118 | 2.172 | 0.03 | Yes |
| H3 | CSP→FP | 0.374 | 0.081 | 4.63 | *** | Yes |
| | BPP→FP | 0.142 | 0.069 | 2.06 | 0.039 | Yes |
| | FLD→FP | −0.013 | 0.076 | −0.17 | 0.865 | No |
| H4 | BI→EFC | 0.616 | 0.079 | 7.792 | *** | Yes |
| H5 | BI→EIC | 0.308 | 0.071 | 4.362 | *** | Yes |
| H6a | EFC→CSP | 0.168 | 0.076 | 2.223 | 0.026 | Yes |
| | EFC→BPP | 0.185 | 0.091 | 2.021 | 0.043 | Yes |
| | EFC→FLD | 0.264 | 0.082 | 3.204 | 0.001 | Yes |
| H6b | EFC→FP | 0.014 | 0.089 | 0.16 | 0.873 | No |
| H7a | EIC→CSP | 0.030 | 0.085 | 0.35 | 0.726 | No |
| | EIC→BPP | 0.222 | 0.102 | 2.165 | 0.03 | Yes |
| | EIC→FLD | 0.229 | 0.092 | 2.481 | 0.013 | Yes |
| H7b | EIC→FP | −0.077 | 0.098 | −0.784 | 0.433 | No |
| Control 1 | OE→BPP | 0.342 | 0.115 | 2.966 | 0.003 | Yes |
| Control 2 | OE→CSP | 0.207 | 0.092 | 2.263 | 0.024 | Yes |
| Control 3 | ST→BPP | 0.144 | 0.075 | 1.936 | 0.053 | Yes |
| Control 4 | OS→FLD | 0.266 | 0.094 | 2.834 | 0.005 | Yes |
| Control 5 | QB→FLD | 0.222 | 0.07 | 3.158 | 0.002 | Yes |
| Control 6 | ST→FP | 0.195 | 0.068 | 2.848 | 0.004 | Yes |

**Note(s):** BI = Extent of BI use; CSP= Customer service performance; BBP=Business process performance; FLD= Feedback, Learning and development; FP=Financial performance; EIC = Effectiveness of informal controls; EFC = Effectiveness of formal controls; OE=Organisational environment; ST= Strategy; OS=Organisational structure; QB = Quality of the board

**Source(s):** Self

H1 was supported as the extent of BI use was found to have positive significance effects on the non-financial outcomes of customer performance ($p < 0.001$), internal business process performance ($p < 0.01$) and organisational feedback and learning ($p < 0.01$). Furthermore, the adoption of BI systems was found to have a significant positive effect on financial performance ($p < 0.05$). Therefore, H2 was also supported. The adoption of BI systems has a significant positive influence on the effectiveness of both formal management controls ($p < 0.001$) and informal management controls ($p < 0.001$). Thus, H4 and H5 were supported. The adoption of BI systems thus plays a critical role in improving formal and informal controls. In turn, formal controls have a positive and significant influence on customer performance ($p < 0.05$), business process performance ($p < 0.05$) and feedback and learning performance ($p < 0.001$), supporting H6a. Informal controls have a positive and significant effect on business process performance ($p < 0.05$) and feedback and learning performance ($p < 0.05$), providing partial support to H7a. However, the sophistication of informal control had no significant influence on customer performance ($p > 0.05$) or directly on financial performance ($p > 0.05$). In addition, the sophistication of formal controls has no direct significant influence on financial performance ($p > 0.05$), leading to the rejection of H6b and H7b. This likely reflects that formal and informal controls influence financial performance indirectly through non-financial outcomes, such as customer satisfaction and operational efficiency, rather than having an immediate direct effect. The improvement in customer performance ($p < 0.001$) and business process performance ($p < 0.05$) has a positive and significant influence on the financial performance. However, organisational feedback and learning performance ($p > 0.05$) had no significant influence on financial performance. Thus, partially supporting H3, with customer performance and business process performing more

important to financial performance than feedback learning and development. This may be because feedback and learning primarily enhance employee skills, engagement and internal capabilities, which improve financial performance indirectly through better customer service and more efficient business processes, rather than producing an immediate direct effect. These results also suggest that the effectiveness of formal and informal management control partially mediates the effects of BI on performance outcomes.

Control variables pertaining to the quality of the board, organisational environment, strategy and organisational structure have significant effects on various financial or non-financial performance outcomes, as depicted in Table 5. Paths from control variables that were non-significant were dropped during the initial testing of the model to improve model fit.

The final model fit indicates a non-significant $\chi^2$ ($p = 0.762$) and $\chi^2$/DF = 2 is within the recommended range with good fit indices [GFI = 0.999; NFI = 0.998; CFI = 1; IFI = 1; RMSEA = 0.030; DF = 2; TLI = 1; RFI = 0.977]. Overall, the model explained 28.8% of the variance in effectiveness of formal control ($R^2 = 0.288$), 10.0% of the variance in sophistication of informal control ($R^2 = 0.100$), 25.1% of the variance in financial performance ($R^2 = 0.251$), 15.2% of the variance in customer performance ($R^2 = 0.152$), 19.4% of the variance in internal business process ($R^2 = 0.194$) and 22.2% of the variance in feedback and learning development ($R^2 = 0.222$).

We also analysed the extent of BI use and the bivariate correlations between BI use and performance outcomes in each of four control environments, based on a mean-split on the formal and informal control effectiveness measures. High control organisations score above the mean on both formal and informal controls. We use the label of "bureaucratic" organisations for those scoring high on formal controls but low on informal controls, and "clan" organisations for those scoring high on informal controls but low on formal controls. Low control organisations fell below the mean on both controls. Results (Table 6) indicate that the extent of BI use is highest within bureaucratic and high control organisations and lowest in clan and low control organisations. This suggests that BI is predominantly being considered a tool for complementing formal controls. Yet, the results also indicate that the performance

**Table 6.** Group comparisons

| | Pooled sample ($n = 195$) | High control environment ($n = 89$) | High formal control environment (bureaucratic) ($n = 40$) | High informal control environment (clan) ($n = 32$) | Low control environment ($n = 34$) |
|---|---|---|---|---|---|
| BI mean (std dev) | 5.83 (1.29) # F = 23.98 *** | 6.26 (0.61) | 6.36 (0.58) | 5.22 (1.73) | 4.63 (1.29) |
| CSP mean (std dev) | 4.53 (1.51) | 4.66 (1.53) | 4.46 (1.44) | 4.58 (1.54) | 4.25 (1.55) |
| BPP mean (std dev) | 4.21 (1.87) # F = 8.76 *** | 4.69 (1.76) | 4.48 (1.69) | 3.86 (1.92) | 2.94 (1.76) |
| FLD mean (std dev) | 4.56 (1.74) # F = 13.88 *** | 5.15 (1.41) | 4.90 (1.76) | 3.75 (1.76) | 3.36 (1.64) |
| FP mean (std dev) | 4.44 (1.78) # F = 3.20 * | 4.71 (1.65) | 4.51 (1.72) | 4.48 (1.82) | 3.62 (1.98) |
| BI - > CSP | 0.323 *** | −0.068 n/s | −0.155 n/s | 0.524 ** | 0.863 *** |
| BI - > BPP | 0.339 *** | −0.212 * | −0.041 n/s | 0.594 *** | 0.368 * |
| BI - > FLD | 0.366 *** | −0.141 n/s | −0.222 n/s | 0.502 ** | 0.403 ** |
| BI - > FP | 0.324 *** | 0.030 n/s | 0.140 n/s | 0.386 * | 0.485 ** |

**Note(s):** # statistically significant group differences
***$p < 0.001$ **$p < 0.01$ * $p < 0.05$ n/s non-significant

**Source(s):** Self

effects of BI use, as suggested by the Pearson correlations, can be highly beneficial for organisations with otherwise weak formal controls. BI adoption may vary across control types for several reasons. For example, organisations with strong formal controls may have greater absorptive capacity for BI adoption (Al-Eisawi *et al.*, 2021). In addition, studies have found management control and BI analytics adoption to be underpinned by common leadership styles (Nguyen *et al.*, 2017).

## Discussion and implications for theory

We drew on Melville *et al.*'s (2004) IT value model to provide a BI value model that links BI to financial and non-financial performance outcomes through its effects on management controls. We have thus made several contributions.

First, our results demonstrate that BI systems play an important direct and indirect role in strengthening the formal and informal management control processes that drive both financial and non-financial performance. Our work overcomes the limitations in past studies on BI and management control that did not consider both financial and non-financial performance outcomes (Elbashir *et al.*, 2011). Our findings also confirm that BI value must be considered in relation to multiple dimensions of non-financial performance, including operations, customer performance and feedback, learning and development (Hou, 2016). For instance, companies in the retail sector have found use cases for BI to improve how they address individual customer preferences. As an example, Amazon analyses customer purchasing patterns and browsing behaviour to recommend personalised products more effectively (Marr, 2016).

Second, we indicate that formal controls benefit from real-time information monitoring that BI can provide (Chapman and Kihn, 2009; Peters *et al.*, 2016). BI systems support the data collection, measurement, analysis and reporting needed to improve the sophistication of controls (Martin, 2020). For example, formal controls supported by BI help managers to avoid mistakes, prevent wastage and direct the resources in operational processes that are important to financial profitability (Chapman and Kihn, 2009; Hou, 2016). BI systems allow the monitoring of business processes and customer performance, giving management an opportunity to continuously improve their business processes and staff productivity, lead times, service levels, cost and quality (Hou, 2016; Aydiner *et al.*, 2019). For example, Walmart uses its analytics capacity to strengthen its controls by monitoring key sales metrics across stores to detect individual store stocking errors and avoid lost sales (Marr, 2019). While in the manufacturing sector, BI is being used to track key performance indicators such as quality rate, productivity, revenue per employee hour, manufacturing capacity level, returns rate and client satisfaction, among others (Bordeleau *et al.*, 2020). In addition, we found BI supports implementation of informal controls, such as by making information visible to all the employees within the organisation (Chapman, 2005; Granlund and Mouritsen, 2003; Liew, 2019), and motivating employees without requiring active management oversight to direct behaviours (Granlund, 2011; Quattrone and Hopper, 2005; Paré *et al.*, 2015). The value of BI is thus not restricted to organisations that rely on high formal controls. These findings suggest that BI and AI transform managerial roles from mere enforcers of procedures to analytical leaders who use real-time insights to monitor performance, anticipate problems and guide decisions. Digital systems allow managers to focus on strategic oversight and proactive problem-solving, extending their influence beyond routine operational control.

Third, our results confirm that BI-enabled formal and informal controls exert independent effects on various non-financial performance outcomes. Formal and informal controls should thus not be considered as substitutes but rather as complements (Kreutzer *et al.*, 2016). This suggests that the use of BI to improve the effectiveness of one set of controls does not prevent additional value being derived by using BI to enable other types of controls. Although our results did not show a strong relationship between informal controls and customer performance, it is likely that the relationship is moderated by the attributes and actual behaviours of individual customer-facing employees (Gauzelin and Bentz, 2017), which may

be subject to additional motivational and incentive-based factors. In addition, neither formal nor informal controls showed statistically significant effects on financial performance. Our results demonstrate that the effects of management controls on financial performance are mediated by non-financial performance outcomes. This can be explained by both the behaviourally grounded perspective on management control systems (Modell, 1996) and Simons (1994) levers of control framework. These perspectives view controls as maintaining and altering the desired patterns of human behaviour and processes that influence intermediary organisational outcomes, such as enhanced service consistency, which then translate to financial outcomes. Simons (1994) thus cautioned that the financial performance effects of controls cannot always be calibrated easily and that other dimensions of managerial effectiveness may be more appropriate for assessing their success. Taken together, this suggests that financial improvements may be achieved indirectly through control systems that influence the organisational behaviours that enhance the efficiency of resource allocation, monitor intermediate business processes and track customer satisfaction outcomes. Past studies have also found that management controls tend to have stronger direct effects on intermediary non-financial organisational outcomes than on financial performance (Kallunki *et al.*, 2011; Nielsen *et al.*, 2018). This confirms that controls are designed to support efficient monitoring and allocation of resources to the core internal operations and activities of firms (Chenhall, 2006; Peters *et al.*, 2016), which should reflect in multiple operational, customer service and employee-related improvements (Elbashir *et al.*, 2021). Although we did not find that our feedback learning and development construct directly influenced financial performance, there is an argument that some non-financial performance dimensions may be more proximal predictors of financial performance than others. For example, Gonzalez-Padron *et al.* (2010) proposed a causal ordering of balanced scorecard dimensions from feedback and learning to process performance to customer outcomes to financial performance. Such a causal ordering would explain our findings and is also consistent with planning tools such as strategy maps (Kaplan and Norton, 2000), and the theoretical propositions of the service profit chain (Heskett *et al.*, 1994), which theorises customer service outcomes as the more proximal predictor of financial performance. Thus, our findings suggest, in part, a more complex set of indirect relationships where feedback and learning occurs through improved information flows and allows for well-trained and supported employees to enhance employee engagement and internal service capabilities (Dhar, 2015; Zumrah, 2015), boosting customer satisfaction and loyalty for improved financial performance.

Fourth, our findings extend the work of Chapman (2005), Chapman and Kihn (2009) and Kallunki *et al.* (2011) into the BI context and contribute to the literature that recognises information systems play an important role in the formal and informal management controls important to organisational performance, and that theories on the business value of information systems should recognise management controls as a necessary intermediary variable linking systems to organisational performance. Prior work has found ERP systems important to management controls (e.g. Kallunki *et al.*, 2011). However, BI plays a distinct role in management control beyond ERP. While ERP systems help enforce management controls through process standardisation, adherence to business rules and transactional data integration, BI provides the information and insights needed to monitor performance and support decision makers to achieve organisational goals through data extraction, dashboards, visualisations and predictive analytics, among other BI outputs. BI thus plays a distinct role among enterprise systems for improving the sophistication of management controls.

Finally, we confirm the important role BI plays in the broader decision-making processes of organisations, with strong support found for BI's direct capability to influence business processes, customer service outcomes and feedback learning and development performance outside of the management control environment. This finding extends the work of others beyond an internal business process perspective (Elbashir *et al.*, 2008; Elbashir and Williams, 2007) to confirm that the value of BI should be considered from a balanced scorecard perspective (Hou, 2016; Owusu, 2017). Our findings complement those who argue that BI

contributes to the sensing and seizing (Torres *et al.*, 2018) and dynamic capabilities (Chen and Lin, 2021) needed to improve performance. We provide strong empirical evidence that the use of BI systems in functions such as marketing, financial management, supply chain and human resources can improve financial performance, such as cost reduction and increased revenues. Moreover, we indicate that BI has an additive effect on performance beyond factors such as organisational environment, strategy and structure. Taken together, these results clarify how BI creates organisational value by strengthening formal and informal management controls that improve non-financial outcomes and, through them, indirectly enhance financial performance. This advances IT value and management control theories by identifying digitally enabled controls as complementary mechanisms through which BI translates information into sustained organisational performance.

*Implications for practice*

Our study does not consider all the factors that may be important to successful and sustainable BI implementation, which may include managing employee resistance and achieving advanced use of BI system features (Mudau *et al.*, 2024). However, our results provide important impetus to organisations looking to enhance the value of BI in support of organisational performance. Specifically, our findings should motivate organisations to implement BI into their operations, controls and performance management systems so they can leverage real-time data analytics to make better decisions, boost operational efficiency and enhance customer satisfaction, leading to financial results. Organisations must initially identify the key performance indicators and metrics relevant to their formal and informal management control processes. Subsequent BI implementation steps will include the preparation of data and integration of underlying transactional data sources, the design and creation of various OLAP cubes, user interfaces and dashboards, along with the development of required query tools (Sherman, 2014). Organisations will also need to promote data-driven decision-making within their control functions and encourage the advanced use of BI tools needed to extract more value from data, facilitating proactive decision-making and enhancing the overall effectiveness of their management control systems (Noor *et al.*, 2019). Emerging BI technologies, particularly AI, are likely to also challenge the forms and practices of management control systems. For example, AI-enabled BI can shift predominantly deductive management control to inductive approaches that start with data to develop performance-explaining models through machine-learning (Sundström, 2024). Emerging BI tools will thus require organisations to consider how different deductive and inductive forms of analysis are coordinated, and how inductive data-driven analysis can best be incorporated into their traditional management control systems (Sundström, 2024). Training should be targeted and practical, focusing on building analytical competencies, interpreting dashboards and embedding BI into everyday decision-making (Mudau *et al.*, 2024). For low-maturity firms or public sector organisations, pilot projects integrating BI into specific processes (e.g. procurement, service delivery) can provide quick wins and gradually build organisational capability. Organisations will also need to strengthen their data governance and be mindful of data privacy, regulatory compliance and ethical aspects of BI use. AI bias, privacy and responsible predictive analytics use should be proactively addressed through internal guidelines, risk assessments, and oversight mechanisms.

Our findings also extend understanding of BI for public sector organisations that often lack the strong board oversight and accountability structures found in the private sector, which weakens the effectiveness of their management controls (Howard and Seth-Purdie, 2005). Our findings suggest that BI systems can help address these gaps by enhancing both formal control mechanisms, such as compliance monitoring, and informal controls that foster accountability. BI can thus support public sector organisations with control benefits more typical of private sector governance, leading to improved public sector performance. This positions BI not only as a technology but as a necessary enabler of improved governance and service delivery

(Nzimakwe, 2021). Managers can operationalise these findings by using BI to track actionable metrics, encourage data-informed decisions, improve efficiency, accountability and overall organisational performance. By combining gradual implementation, practical training, and attention to ethics and governance, organisations can ensure BI adoption is effective, sustainable and socially responsible.

## Conclusion and limitations

Some limitations of our study are noted. First, data were collected from a single key informant representing large South African organisations, and results may therefore not be generalisable to all organisations. There is growing convergence in the application of management control standards across developing and developed countries, which enhances the wider applicability of our findings. Yet, organisations in developing countries often face unique constraints in relation to resources and BI infrastructure and skills, which may influence their BI value process. Our results should thus be especially relevant in developing country contexts. Second, the data collected were cross-sectional, which limits our ability to establish temporal precedence and make causal claims. Although we considered relevant control variables, we are also not able to adequately control for all confounding explanations. Therefore, we rely on theoretical arguments within the IT value model framework in making causal inferences between the constructs of BI adoption, management control and performance. Longitudinal research designs, which can better establish temporal precedence in these relationships, would need to be employed in future studies. Future studies can also strengthen causal claims by testing the effectiveness of management controls pre- versus post-adoption of BI systems. Third, self-administered surveys are subject to selection and response biases, such as social desirability bias. We have attempted to mitigate against these biases through ensuring survey respondents' confidentiality and anonymity in our reporting, through questionnaire design, such as the use of neutral phrasing of items, and through tests of non-response bias and common methods bias. Our dataset also provides a limited opportunity for triangulation of financial performance data. However, we provide a strong additional focus on non-financial performance. Executive judgment and perceptions are considered good proxies for such measures and are also likely to be more proximal predictors of their decisions pertaining to technology adoption and use, and their choices on investment and resource allocation. Nonetheless, we explicitly acknowledge risks of perceptual performance measures and cross-sectional inference.

Finally, our study notes the convergence of BI with cloud and AI technologies. Further work may want to explicitly examine how other AI applications reshape management controls or decision-making. Future research should explore how continually emerging AI tools might also transform control processes, influence decision frameworks and interact with BI to drive organisational performance.

Notwithstanding these limitations, we have contributed much-needed evidence on how BI systems impact financial and non-financial performance. BI systems promote more effective management controls, which help translate investment in BI into improved financial and non-financial performance. BI systems should thus be implemented to support the formal and informal management controls needed to ensure business processes, customer satisfaction and feedback and learning performance. This balanced performance measurement approach may assist future researchers and organisations in measuring the benefits and success of BI systems and could be adapted for other system contexts.

We have also contributed to theory on IT value and demonstrated the relevance of the IT value model in theorising about BI's business value, and data-driven analytics technologies more broadly. The IT value model is a useful theoretical underpinning for tracing the effects of BI on financial and non-financial performance outcomes. We show that internal organisational and managerial processes are important mediating constructs in theories of IT value, serving as mechanisms through which technology adoption translates to firm performance. Future

researchers may wish to explore how BI and analytics impact different organisational functions, beyond management controls and improve the explanatory power of our model by incorporating additional determinants of management control effectiveness and firm performance. Future studies can also continue to explore the IT value generation process and how it might apply to other novel decision technology solutions, including AI, across various industry and country contexts.

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