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Leveraging business intelligence systems to enhance management control and business process performance in the public sector

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Abstract

Purpose – Recent research and policy reports indicate public sector organizations struggle to leverage information technology-based performance measurement systems and fail to effectively evaluate performance beyond financial metrics. This study aims to focus on organizational factors that influence the assimilation of business intelligence (BI) systems into integrated management control systems and the corollary impact on improving business process performance within public sector organizations.

Design/methodology/approach – The complete Australian client list was acquired from a leading BI vendor; and the authors surveyed all public sector organizations, receiving 226 individual responses representing 160 public sector organizations in Australia. Using latent construct measurement, structural equation modeling (SEM)-partial least squares is used to test the theoretical model.

Findings – When top management promotes knowledge creation among the organization's operational level employees and support their activities with strong BI infrastructure, the same knowledge and infrastructure capabilities that are critical to assimilation in private sector hold in the public sector. However, public sector organizations generally have difficulty retaining staff with expertise in new technologies and attracting new innovative staff that can leverage smart systems to effect major change in performance measurement. When top management effectively manages knowledge importation from external entities to counteract deficiencies, public sector organizations effectively assimilate BI knowledge into performance measurement yielding strong process performance.

Research limitations/implications – When top management promotes knowledge creation among the organization's operational level employees and support their activities with strong BI infrastructure, the same knowledge and infrastructure capabilities critical to assimilation in the private sector hold in the public sector. However, public sector organizations generally have difficulty retaining staff with expertise in new technologies and attracting new innovative staff that can leverage smart systems to effect major change in performance measurement. The research extends the theory behind organizational absorptive capacity by

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highlighting how knowledge importation can be used as an external source facilitating internal knowledge creation. This collaborative knowledge creation leads to affective assimilation of BI technologies and associated performance gains.

Practical implications – The results provide guidance to public sector organizations that struggle to measure and validate service outcomes under New Public Management regulations and mandates.

Originality/value – The results reveal that consistent with the philosophies behind New Public Management strategies, private sector measures for increasing organizational absorptive capacity can be applied in the public sector. However, knowledge importation appears to be a major catalyst in the public sector where the resources to retain skilled professionals with an ability to leverage contemporary technologies into service performance are often very limited. Top management team knowledge and skills are critical to effectively leveraging these internal and external knowledge creation mechanisms.

Keywords Performance management, Management control systems, New public management, Business intelligence, Business analytics, Integrated information systems, Business process performance, Public sector governance

Paper type Research paper

1. Introduction

Over the past two decades, public sector organizations worldwide have instituted significant reforms and introduced new information technology (IT)-enabled management control systems (MCS). These MCS seek to provide better information and program outcomes while improving government organizations' efficiencies and return on investments (Arnaboldi *et al.*, 2015; ter Bogt *et al.*, 2015; Australian National Audit Office (ANAO), 2018). Accordingly, public sector organizations invested heavily in strategic IT projects (Spekle and Verbeeten, 2014) and implemented new MCS intended to better capture the quality and efficiency of service delivery (Wiesel *et al.*, 2011). Yet, research has provided little insight into how and why MCS initiatives succeed or fail, and what role the cultural controls infused by top management play in these organizations (Hoque and Adams, 2011; Wiesel *et al.*, 2011; Spekle and Verbeeten, 2014; Kwarteng and Aveh, 2018).

Recent reports highlight that many public sector MCS innovations fail to meet performance objectives (Cinar *et al.*, 2019). Beginning in 2009, Australia required all organizations in the general government sector to report on service outcomes (Australian National Audit Office (ANAO), 2011, 2014, 2017). The Australian National Audit Office (ANAO) undertook a review of the progress for 89 government programs with 4 detailed reviews during 2010–2011. The results paint a clear picture of the difficulty such organizations encounter in implementing MCS that focus on service performance. Less than one-third had appropriate key performance indicators (KPIs) for assessing the effectiveness of performance (Australian National Audit Office (ANAO), 2011). The ANAO's 2018 report highlights the ongoing problems for public sector organizations implementing effective performance measurement and reporting systems. The Australian National Audit Office (ANAO) (2018) notes two major barriers that need to be overcome by public sector organizations: frameworks need to be designed that encompass the complete cycle of performance measurement and reporting, and organizations must establish internal and/or external "expertise to provide advice and guidance on performance measurement and reporting that is accompanied by sufficient executive support." These findings are consistent with global patterns observed over the past decade (Ross, 2011; King *et al.*, 2017).

This study focuses on business intelligence (BI) systems as one of the management innovation reforms used by public sector organizations to improve MCS and process performance. BI systems provide analytical and reporting capability widely viewed as critical to leveraging the wealth of data encapsulated in enterprise systems and providing full-scale MCS capability to an organization (Elbashir *et al.*, 2011; Peters *et al.*, 2016; Harlow, 2018) [1]. BI systems also come with *industry solutions* that tailor a subset of these reports that are unique to a specific industry or sector – including the public sector. The purpose of this study is to further our understanding of the dynamics that enable effective assimilation of BI systems in the public sector and to establish the relationship between assimilation and improved service performance.

In setting the theoretical frame for the study, we draw on the basic concepts underlying Modell's (2019) institutional performance theory on the challenges of implementing New Public Management (NPM) systems that moderately or radically alter the performance goals of an organization. We integrate these underlying concepts on the complexity demands with knowledge-focused theorizations of Elbashir *et al.* (2011) on organizational absorptive capacity. Given the strong focus on performance management reforms within the public sector over the past two decades, we integrate theoretical perspectives from private sector research as advocated by the NPM doctrine to assist in identifying the key organizational structures for successful assimilation of BI (Elbashir *et al.*, 2011). In the private sector, the research emphasizes the internally developed capability of the organization that is enhanced through the learning culture (i.e. absorptive capacity) surrounding strategic IT adoptions (Chatterjee *et al.*, 2002; Liang *et al.*, 2007; Elbashir *et al.*, 2011; Secundo *et al.*, 2017). Public sector organizations have increasingly invested in managerial reforms similar to those adopted by private sector organizations under the auspices of enhancing efficiency, increasing entrepreneurship and enabling performance-based benchmarking (Baird and Harrison, 2017; IBM, 2010, 2017; Wiesel *et al.*, 2011). The critical output must be a process performance improvement. For public sector organizations, delivery on service outcomes defines return on investment (Hoque and Adams, 2011; Ross, 2011; Baird and Harrison, 2017; Modell, 2019). This perspective is not misaligned with private-sector research where the benefits of IT investment are increasingly viewed as being derived from business processes (Elbashir *et al.*, 2008; Elbashir *et al.*, 2021).

To test the theoretical model, data were collected via survey from 226 individuals representing 160 Australian public sector organizations that all use the same BI software system. Results indicate that the top management teams' (TMTs) leveraging and diffusion of absorptive capacity to the operational levels is positively related to knowledge sharing among operational managers, the sophistication of the BI infrastructure and importation of external knowledge. These factors directly affect assimilation of BI which has a positive effect on business process performance.

This research has several implications for theory and practice. First, the results support theorizations that organizational structures that promote BI assimilation can be imported to the public sector, as the knowledge sharing culture created by the TMT is a major influence on assimilation. This effect occurs when strategic visions and directions are translated into institutional resources that enable BI assimilation. Second, the results also demonstrate that in the public sector, assimilation benefits from external knowledge importation from the private sector when effectively monitored and directed by top management. This external knowledge importation provides a means to compensate for the difficulty that public sector organizations oftentimes have in developing or hiring in-house expertise necessary to leverage top management's absorptive capacity and address evolving MCS needs. The research model adds to our insights regarding the effective organizational linking of intellectual capital with BI/analytics to enhance value. Third, the research goes beyond BI assimilation to show the effects on business process performance and to demonstrate the expanded managerial control capability that arises when the entire package of controls in the MCS is considered simultaneously (Malmi and Brown, 2008).

2. Background, theory and hypotheses

2.1 Performance management reforms

Despite steady decreases in funding and other resources, public sector organizations are generally facing much greater demand for their services. These trends place increasing pressure on senior management to enhance their performance management and cost controls (Australian National Audit Office (ANAO), 2018; Johansson and Siverbo, 2014; Modell, 2019). These are long-term trends; and, since the 1980s, most developed economies have demanded higher levels of performance reporting by their public sector organizations (Brignall and Modell, 2000; Baird and Harrison, 2017). In recent times, this has included a shift away from the traditional focus on reporting of financial inputs and a move toward a focus on achievement of outputs in comparison to expenditures on inputs, similar to that in the private sector (Hoque and Moll, 2008; Australian National Audit Office (ANAO), 2011, 2014, 2018; Baird and Harrison, 2017). While inherently more difficult in the public sector, effective performance management is critical to maintaining public confidence and achieving sustainable public financing (Ross, 2011; Northcutt and Taulapapa, 2012; Baird and Harrison, 2017).

This study focuses on performance management among public sector organizations in Australia – a country that has perhaps pushed NPM philosophies harder than any other country (Australian National Audit Office (ANAO), 2011, 2014, 2018; Baird and Harrison, 2017). Australia first introduced the Outcomes and Outputs Framework as part of the 1999–2000 federal budget process. This Framework charged governmental entities with the responsibility to specify intended outcomes and to report on actual performance. In follow-up, the ANAO regularly audits the application of the Framework by a sample of government entities. In its initial review, the ANAO concluded that "development of a comprehensive, relevant and informative regime of performance indicators, including cost-effective systems and processes to capture, monitor and report complete, accurate and relevant entity performance, continued to be challenging for many entities" (Australian National Audit Office (ANAO), 2011). This finding persists in ongoing audits (Australian National Audit Office (ANAO), 2018).

Beginning in 2009–2010, all Australian public sector entities were required to adhere to the reporting requirements of the Framework. Under this mandate, programs are the focus of government budgeting and reporting, and organizations are expected to provide tangible links between government funding, activities and actual outcomes. With this mandate came specific guidance on developing KPIs to be included in the entity's outcome reports. KPIs should provide both qualitative and quantitative measures of program performance (Australian National Audit Office (ANAO), 2011).

The Australian National Audit Office (ANAO) (2011) followed up the broader application mandate in 2010–2011 with an audit of 89 programs across 50 public sector entities, along with an in-depth review of 4 selected organizations. The audit was conducted to garner an understanding of how well the affected organizations were meeting the mandate. The results indicated that the vast majority of organizations were struggling to develop effective performance measurement systems. Less than one-third of the audited organizations had effectiveness KPIs that included clear targets while the majority of organizations' KPIs were largely descriptive and unmeasurable. Heavy reliance on qualitative effectiveness KPIs limited most organizations' ability to measure the results of program activities over time. Overall, 40% of the programs had non-specific KPIs, 45% had KPIs that were not measurable, 55% had KPIs that were not clearly achievable, 10% had KPIs that were not relevant, and 50% had KPIs that were not timed. The Australian National Audit Office (ANAO) (2011) concluded that the vast majority of public sector organizations are not meeting the performance measurement mandates of the Framework. This report, in part, led to the passage of the Public Governance Performance and Accountability Act of 2013 with the intent of enhancing the formalization of performance reporting requirements including an emphasis on non-financial performance indicators (Australian National Audit Office (ANAO), 2014). Subsequent review of organizations adoption of relevant KPIs resulted in essentially the same findings in the 2013–2014 fiscal year – Australian Government agencies continued to fail at high rates in the implementation of relevant KPIs for measuring service performance and accountability (Australian National Audit Office (ANAO), 2014). A detailed investigation of four organizations considered to be performing well was conducted during 2015 and 2016, yielding more evidence of on-going deficiencies in non-financial performance management (Australian National Audit Office (ANAO), 2017). In the audit for the fiscal year 2016–2017, the Australian National Audit Office (ANAO) (2018) summarized what it had learned and provided further guidance to organizations. They noted that key to viable performance measurement frameworks is the need to focus on frameworks that capture the full measurement and reporting cycle, and the need to have appropriate expertise available internally or externally to effectively implement and execute the frameworks – with management support key to success.

The results are not particularly surprising as the challenges are great for public sector organizations that are generally recognized as having low quality management control information in comparison to the private sector and are often faced with sifting through volumes of data that are frequently neither reliable nor timely (Ratia *et al.*, 2018). Additionally, *one size fits all* systems for implementing performance management are not applicable to the public sector where performance outcomes are very different across entities (Arnaboldi, *et al.*, 2015). Public sector organizations are commonly hampered by an inability to attain and/or retain skilled employees capable of leveraging MCS innovations (Cinar *et al.*, 2019; Ross, 2011; King *et al.*, 2017); and, with all of the pressures on public sector employees, motivation to focus on MCS innovations may also be lacking (Demircioglu and Audretsch, 2017). The lack of internal knowledge and key skill sets necessitates a willingness to import such expertise from the private sector to leverage key technologies that can facilitate key performance measurement system improvements. These deficiencies only further add complexity when organizations face the implementation of performance management systems that moderately or radically change organizational managerial control processes, as is the norm when implementing NPM directives (Marrone and Hazelton, 2019; Modell, 2019).

This study focuses on one specific technological advance that has been perceived to provide the capability for rapidly implementing a broad-based, integrated MCS (Peters *et al.*, 2016; Harlow, 2018; Peters *et al.*, 2018; Mahama *et al.*, 2021). The study serves the dual purpose of providing a theoretical basis for understanding how public sector organizations effectively assimilate BI into their business processes to achieve such performance improvements; and exploring whether public sector organizations can garner performance improvements from BI assimilation into their business processes. We also begin a discussion on whether technological solutions can be effectively leveraged in public sector organizations to overcome challenges in performance measurement capability to improve program effectiveness.

2.2 Theory and hypotheses

Our theorizations represent a blending of the knowledge creation (i.e. absorptive capacity) driven assimilation arguments put forth by Elbashir *et al.* (2011) with the expectation of greater challenges and limitation in internal knowledge capability outlined in Modell's (2019) institutional performance framework. The theoretical model remains top management driven, cultural controls-oriented model, focusing on a culture that enhances operational managers' knowledge sharing coupled with the necessary technical infrastructure to promote assimilation of BI (Elbashir *et al.*, 2011). However, we extend the model to address the challenges posited by Modell (2019) that suggest, for public sector organizations, internal knowledge may be insufficient to address moderate to radical changes in MCS that are inconsistent with their established understanding of MCS. Our theoretical model incorporates this need for the importation of external knowledge to help operational managers adjust to a substantially new vision for the goals and objectives of MCS – the type of change created with the advocacy of NPM-based objectives. The model, as shown in Figure 1, continues to adhere to Elbashir *et al.* (2011) theorizations of the necessity for TMT to guide both these internal and external knowledge creation sources.

This focus on the role of TMT addresses concerns in the MCS literature that little empirical attention has been paid to the role that top management plays in the design and use of control systems choice (Abernethy *et al.*, 2010; Lee *et al.*, 2014). As Abernethy *et al.* (2010) note, "the relevant question is not whether "TMT matter?", rather how it matters and how TMT influences the MCS." The focus here is on how TMT can address the need for managerial innovativeness and creation of an innovation culture to facilitate adoption of new IT innovations in the public sector while recognizing that public sector organizations face major impediments to acquiring and retaining such innovation and knowledge in the house (Cinar *et al.*, 2019; King, 2017; Secundo *et al.*, 2017).

This focus on managerial innovativeness is consistent with a growing body of MCS literature emphasizing the need to consider how management's focus on organizational culture can lead to the overall integration and success of MCS (Malmi and Brown, 2008; Kwarteng and Aveh, 2018). Malmi and Brown (2008) argue that cultural controls are necessary to instill a set of values, beliefs and social norms among an organization's members. Simons (1995) similarly notes that "value" (i.e. cultural) controls are the organizational definitions that TMT communicates formally and reinforces systemically in providing values, purpose and direction for an organization. Cultural controls are often viewed as even more critical in the public sector where the political and cultural environment can have multiple conflicting agendas and goals, and TMT must use their relationships with line managers to align efforts to support IT innovation (Chapman and Kihn, 2009; Abernethy *et al.*, 2010; Baird and Harrison, 2017; Harlow, 2018). Strong internal leadership can guide operational-level managers' actions in a manner that enables the realization of an organization's vision (Baird and Harrison, 2017).

Approaching cultural control from TMT's focus on an absorptive-capacity view highlights TMT's knowledge and TMT's ability to put that knowledge into practice.

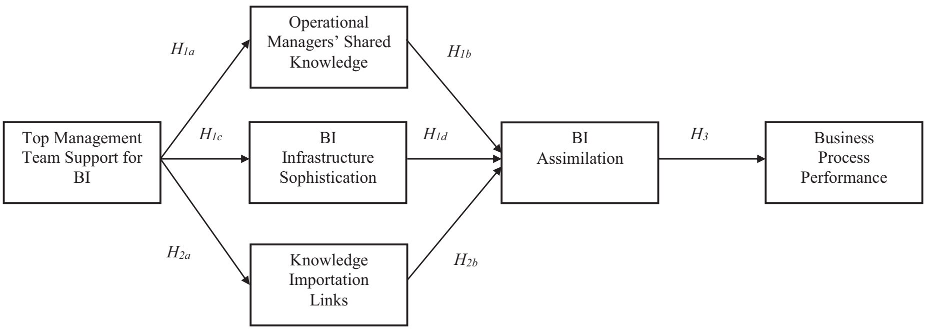


Figure 1.
BI assimilation and the business process performance effects

Elbashir *et al.* (2011) posit that absorptive capacity is a key determinant of TMT's ability to provide strong leadership and to foster increased levels of absorptive capacity across the organization – creating a learning and knowledge sharing organization that aggregates, defuses and leverages the necessary knowledge to execute strategic change. However, TMT's effect on the assimilation of BI is indirect, flowing through operational managers' absorptive capacity – the knowledge sharing ability that TMT fosters across the organization.

At the same time, the literature broadly accepts that the IT infrastructure also needs to be in place for BI systems to effectively support the utilization of BI capability. BI, in supporting management control, requires leveraging of complex business data (Quattrone and Hopper, 2005; Dechow and Mouritsen, 2005) that are integrated with broader entity-level data to form enterprise-wide databases (Granlund and Malmi, 2002). Hence, consistent with Elbashir *et al.* (2011) theoretical model, the underlying IT infrastructure that TMT has put in place is expected to be a key component of public sector organization's ability to assimilate BI. In the public sector, this presents challenges as IT adoption is often pushed by the political process (Arnaboldi *et al.*, 2015), but true assimilation of the technologies for strategic benefit rarely occurs and requires strong intervention from TMT (Iannacci, 2010). These relationships put forth in Elbashir *et al.* (2011) assimilation theory are hypothesized as follows:

H_1. TMT support for BI systems enhances operational managers' shared knowledge and the development of the necessary BI infrastructure and facilitates the assimilation of BI.

H_{1a}. TMT support for BI systems enhances operational managers' shared knowledge in public sector organizations.

H_{1b}. The operational managers' shared knowledge enhances the BI assimilation in public sector organizations.

H_{1c}. TMT support for BI systems enhances the BI infrastructure sophistication of public sector organizations.

H_{1d}. The BI infrastructure sophistication enhances BI assimilation in public sector organizations.

H_1 is consistent with the wide array of concerns that have been raised within the public sector innovation space (Arnaboldi *et al.*, 2015; Australian National Audit Office (ANAO), 2018; Cinar *et al.*, 2019; Demircioglu and Audretsch, 2017; Ross, 2011;) and the MCS literature (Chapman and Kihn, 2009; Abernethy *et al.*, 2010). Ross (2011) notes that fundamental to the achievement of effective performance measurement and management in the public sector is the intelligent application and adaptation of performance measurement tools to the specific circumstances of the organization. TMT leadership and commitment is key to guiding operational adoption, adaptation and integration of performance measurement into business processes.

While the internal institutional resources may be in place and properly aligned for successful adoption of an MCS innovation, such as BI, the IBM (King *et al.*, 2017) and Australian National Audit Office (ANAO) (2018) reports and research reviews on innovation in the public sector (Cinar *et al.*, 2019) highlight a critical barrier in the public sector – a shortage of IT and finance professionals who can lead successful assimilation of contemporary IT-driven MCS innovations. This shortage can occur from either the inability to retain internally developed experts or hire new experts (Cinar *et al.*, 2019). Identifying and remediating knowledge gaps are critical, as assimilation of BI is dependent on operational level managers understanding of the full potential for such systems (Secundo *et al.*, 2017). This requires operational level managers to somehow raise their IT and performance measurement literacy to a level conducive with effective deployment (Rikhardsson and Kræmmergaard, 2006). Thus, when the expertise is not available internally, TMT support also includes facilitating the acquisition and importation of the necessary knowledge from outside the organization (such as the use of consultants and customized training) (Purvis *et al.*, 2000; Hartnett *et al.*, 2012; Leiby, 2018).

The importation of knowledge is an important component of the knowledge creation mechanisms that TMT can use to address knowledge gaps at both the TMT and operational levels and is often a necessary component to support new strategies and enabling technologies (Elbashir *et al.*, 2011). These gaps become particularly critical when new strategies or enabling technologies cause fundamental change in organizational goals and objectives, altering the perceived reality of both TMT and operational managers (Modell, 2019).

Knowledge importation links refer to the external sources of knowledge that organizations draw on to overcome their knowledge barriers. These importation links are generally based on the creation of alliances with external entities including consultants and service firms for the purpose of learning and deploying technical knowledge and skills that are required for effective systems deployment (Purvis *et al.*, 2000). Prior studies suggest that organizations need to acquire knowledge from external sources to supplement their internal knowledge (lower their learning barriers) and effectively implement complex technologies (Purvis *et al.*, 2000; Hartnett *et al.*, 2012; Secundo *et al.*, 2017; Leiby, 2018). Drawing on absorptive capacity literature (Cohen and Levinthal, 1990), operational managers' shared knowledge and knowledge importation links will facilitate public sector organization's learning and help overcome the knowledge barriers by filling in the knowledge gaps that are required to assimilate BI. Thus, we hypothesize that public sector organizations' TMT that maintain and use external links to a greater extent will be able to overcome learning barriers associated with effective use of BI systems allowing these organizations to support an array of value chain activities and enhance process performance.

Knowledge importation is not without its own potential pit falls. Leiby (2018) finds that consultants alter the type of technologies they recommend to TMT based on TMT's knowledge and experience with related technologies. Thus, simply importing external knowledge is not a panacea on its own, but rather the effectiveness of knowledge importation is influenced by TMT's BI absorptive capacity and related ability to understand, manage and effectively leverage knowledge importation activities in a manner that best facilitates the organization's BI assimilation. This external component necessary for building an organization's absorptive capacity directly addresses the limitations in capability highlighted in Modell's (2019) institutional performance framework and highlights the importance of TMT's knowledge to effectively navigating the challenges. This leads to the second hypothesis as follows:

H_2. TMT support for BI systems enhances knowledge importation and facilitates assimilation of BI Systems.

H_{2a}. TMT support for BI systems enhances knowledge importation links in public sector organizations.

H_{2b}. The knowledge importation links enhances BI assimilation in public sector organizations.

Successful adoption is more than just acquisition and installation of software (Chapman and Kihn, 2009) and the MCS literature needs to investigate the variation in quality or depth of use of MCS following adoption, which we refer to in this study as BI assimilation (Davila and Foster, 2007; Elbashir *et al.*, 2011; Peters *et al.*, 2016; Peters *et al.*, 2018). BI assimilation refers to the level of use of BI systems by public sector organizations to support their various processes and activities that they go through while delivering services to stakeholders. Accordingly, we investigate variation in assimilation, which includes the scope, use and strategic integration of a system (Chatterjee *et al.*, 2002; Elbashir *et al.*, 2011).

While assimilation by definition is the use of BI systems to support business processes, the link between assimilation and business process performance is important. The Australian National Audit Office (ANAO) (2011) analysis highlights the mismatch between poorly constructed performance measures and the ability to achieve successful outcomes. Similarly, the chartered institute of management accountants report highlights the failures of too many public sector KPIs focused on inputs rather than outcomes or impact (Ross, 2011). The empirical questions remain. Do public sector organizations that assimilate BI into business processes have better process performance? Does BI provide better performance measurement capability through industry solutions designed to provide comprehensive packaged MCS capability? The assumption is that enhanced MCS will lead to better process performance and that this effect will hold in the public sector. For instance, through BI assimilation, public sector organizations will enable their MCS, which will, in turn, report on service delivery activities and processes. The information produced by BI systems can enable the public sector organization to segment their client/citizen base, identify their needs, deliver the services that match their needs and report on the input and output related to this service delivery process. The link between BI assimilation and performance has been inconsistent in the private sector, but research suggests that this link is strongest when BI is used to support the structuring of business unit coordination and integration to facilitate the performance of known tasks and activities (Peters *et al.*, 2018) – the primary goal in public sector organizations. This leads to the third hypothesis as follows:

H_3. BI assimilation enhances business process performance of public sector organizations.

On an overall basis, the theoretical model presented in Figure 1 establishes relationships from TMT provision and alignment of institutional resources to higher levels of BI assimilation and, in turn, higher levels of business process performance. The institutional resources of interest include both internally developed resources (operational level managers shared knowledge, BI infrastructure sophistication) and externally acquired resources that compensate for internal deficiencies (knowledge importation links).

3. Research design

3.1 Respondents

Data were gathered through a large survey targeting 982 senior and middle managers in 323 public sector organizations [2] in Australia [3]. All organizations had implemented the same BI software offered by a major international IT vendor. In the private sector, BI systems are one of the most critical enablers of MCS (Elbashir *et al.*, 2011; Peters *et al.*, 2016, 2018). The BI software used by the organizations in this study is recognized in the industry for being particularly focused on performance management data and was the dominant system used among public sector organizations in Australia. At implementation, the system provides pre-developed metrics that can be configured to connect to the underlying databases of most leading enterprise resource planning (ERP) vendors. These metrics provide access to over 200 different pre-built reports using more than 500 KPIs and analytics answering over 2,900 process critical questions. The metrics include a broad array of performance measures along with a multitude of scorecard analyses (Elbashir *et al.*, 2011). Focusing on organizations implementing the same BI software controls for potential variations in connectivity, configurability and functionality available from alternative BI systems [4].

Multiple respondents from each organization were solicited at different levels, including senior business and IT executives, middle managers and IT users. This strategy enables the collection of rich data and eliminates bias while ensuring accuracy (Huber and Power, 1985) [5]. A total of 226 responses were received from 160 organizations providing an organizational response rate of 49% [6].

Demographic information was collected on the 160 organizations as shown in Table 1 Panel A and includes information on the organizational sector, number of employees and annual revenues. The majority of the sample (64.37%) are represented by government agencies (e.g. city councils, state and federal government ministries), followed by health care (e.g. public hospitals) (14.37%) and education/research organizations (21.25%). The sample includes mostly large organizations with over 1,000 employees (76.25%) and annual revenue over US$100m (74.38%). Demographic information on the 226 informants is shown in Table 1, Panel B and includes age, gender, position title and experience. Most of the respondents were male (71.24%) middle aged (62.40% over age 40) and business executives (57.53%) with over 15 years of work experiences (51.33%).

3.2 Construct operationalization

Business process performance refers to operational efficiency and effectiveness of business processes that are attributable to the use of BI systems to support the organization's value chain activities. This focus is consistent with both private sector research on measuring the value of IT and the mandates to report on process performance efficiency and effectiveness under the Australian Public Governance Performance and Accountability Act of 2013. Business process performance is operationalized as a second-order construct using a scale adapted from Elbashir *et al.* (2008). The business process performance measures have three dimensions, process efficiency, partner relations and customer responsiveness, which are measured with reflective indicators. Measurement items for business process performance and measurement items for all constructs are shown in Table 2.

BI assimilation was developed by adapting Armstrong and Sambamurthy (1999)'s instrument. Building on Porter's value chain framework, Armstrong and Sambamurthy (1999) used a total of 14 items to measure IT assimilation, 6 items to capture IT assimilation into business activities and 8 items to measure IT assimilation in business strategies. Results from the exploratory factor analysis shows the 14 items loading on three factors of BI assimilation. These factors are referred to in this study as follows: *customer relations*, *business operations* and *marketing and sales*.

Knowledge importation links was measured using a scale adapted from Purvis *et al.* (2000), which capture two dimensions, *service acquisition* and *expertise acquisition*. Service acquisition refers to the use of the service of consultants and customized training and support of the vendor. Expertise acquisition refers to hiring employees with BI systems experiences/expertise and alliances with other organizations that possess BI experience.

Operational managers' shared knowledge refers to the understanding and appreciation among IT and line managers for the technologies and processes that affect their mutual performance. Shared knowledge was measured by five items that were adapted from Nelson and Cooprider (1996) which represent two types of measures, multiplicative and general. For

Demographic	Frequency	(%)
Panel A: Organizational information (n = 160)		
Number of employees		
Less than 50	5	3.13
50 to > 200	5	3.13
200 to > 500	12	7.50
500 to > 1,000	13	8.13
Above 1,000	122	76.25
Did not answer	3	1.87
Total	160	100.00
Estimated gross revenue		
Less than US$50m	30	18.75
US$50m to < US$100m	11	6.87
US$100m to < US$500m	40	25.00
US$500m to < US$1bn	16	10.00
US$1bn to < US$5bn	10	6.25
US$5bn to < US$10bn	14	8.75
US$10bn and above	16	10.00
Did not answer	23	14.38
Total	160	100.00
Sector		
Education/research	34	21.25
Government	103	64.37
Health care	23	14.37
Total	160	100.00
Panel B: individual information (n = 226)		
Gender		
Male	161	71.24
Female	65	28.76
Total	226	100.00
Age		
<25 years	1	0.44
25–30 years	14	6.19
31–40 years	70	30.97
41–50 years	90	39.82
51–60 years	43	19.05
61+ years	6	2.65
Did not answer	2	0.88
Total	226	100.00
Years of experience		
5 years to below 10 years	60	26.55
10 years to below 15 years	50	22.12
15 years to below 20 years	35	15.49
20 years to below 25 years	32	14.16
25 years to below 30 years	25	11.06
Above 30 years	20	8.85
Did not answer	4	1.77
Total	226	100.00
Job title		
Business Executives:		
Chief Financial Officer	1	0.44
Chief Operating Officer	4	1.77

(*continued*)

Table 1.
Demographic information

Demographic	Frequency	(%)
Chairman	3	1.33
Executive Vice President	13	5.76
Senior Vice President	28	12.39
Vice President	58	25.66
Others	23	10.18
Total Business Executives	130	57.53
IT Executives:		
Executive Vice President	1	0.44
Senior Vice President	9	3.98
Vice President	16	7.08
Director of Management Information Systems (MIS)	17	7.52
Chief Information Officer	16	7.08
Manager of MIS	17	7.52
Others	6	2.66
Total IT Executives	82	36.28
Did not specify the job title	14	6.19
Total	226	100.00

Table 1.

multiplicative or interaction measures, the informant was asked to assess separately the role of IS and line managers for each characteristic. For instance, Items 1 and 2 capture understanding while Items 3 and 4 capture appreciation. Using the conceptualization of fit interaction (Venkatraman, 1989; Nelson and Cooprider, 1996), we operationalize the two concepts of understanding and appreciation by multiplying the two relevant items for each of the concepts (i.e. item1*item2 and item3*item4). Using multiplicative measures provides stronger evidence of the validity of the measurement instrument than would be possible if only one type of measure (e.g. general) was used (Nelson and Cooprider, 1996). This is because the distribution of the final score of the measure depends on the extent to which the two indicators for a concept agree with each other. For general measures, the respondent was asked to evaluate the overall level of appreciation that line managers and IS managers have for each other's accomplishment (Item 5). This procedure results in three items used to capture shared knowledge (one general item and two items from the outcome of the multiplication).

BI infrastructure sophistication was measured as a second-order construct using a scale adapted from Armstrong and Sambamurthy (1999). The scale was refined by reviewing the IT literature and interviews with business managers and BI consultants. The aim of this refinement was to include additional items that capture specific IT infrastructure components necessary to support BI. The measures were further refined at two focus group meetings. The final measurement list includes six key components representing two categories of infrastructure: *BI Maturity*, which is the maturity of BI software that organizations use to generate managerial control metrics to support managerial processes; and *BI infrastructure,* which includes infrastructure components that are applied specifically to support BI applications (e.g. Extract, Transform, Load (ETL) tools, data warehouse, data marts and data mining tools) that organizations use to analyze big data and provide reports that BI software can draw on.

TMT support for BI was measured using an instrument adapted and extended from Chatterjee *et al.* (2002). TMT support was operationalized as a second-order construct with two dimensions as follows: TMT belief in BI as having potential value to the organization, and TMT participation in the management of BI by developing the relevant policies, goals

Table 2. Measurement items, item loading (weight), composite reliability, average variance (AVE)

Panel A: Reflective constructs	Loading	*t*-value
Business process performance		
Since it first implemented the BI Systems, the following business benefits have been achieved by my organization (Items are measured on a seven-point scale where 1 = Strongly Disagree, 4 = Neutral and 7 = Strongly Agree)		
Business processes performance – process efficiency: (composite reliability = 0.92, AVE = 0.75)		
PE1: Improved efficiency of internal processes	0.878	35.593***
PE2: Increase staff productivity	0.888	34.755***
PE3: Reduction in the cost of effective decision-making	0.837	22.130***
PE4: Reduced operational cost	0.853	32.818***
Business processes performance – partner relations: (composite reliability = 0.92, AVE = 0.69)		
PR1 Reduced inventory levels	0.787	20.633***
PR2: Reduction in the cost of transactions with business partners	0.857	30.591***
PR3: Improved coordination with business partners/suppliers	0.818	25.284***
PR4: Improved responsiveness to/from suppliers	0.880	38.038***
PR5: Increased inventory turnover	0.821	24.759***
Business processes performance – customer responsiveness: (composite reliability = 0.90, AVE = 0.75)		
CRS1: Reduced marketing costs	0.864	26.078***
CRS2: Reduced customer return handling costs	0.891	41.294***
CRS3: Reduced time-to-market products/services	0.845	22.250***
BI assimilation		
BI Systems have been used extensively in my organization to support the following business activities/strategies (Items are measured on a seven-point scale where 1 = Strongly Disagree, 4 = Neutral and 7 = Strongly Agree)		
BI assimilation – customer relation: (composite reliability = 0.92, AVE = 0.66)		
CRE1: Customer services (e.g. improving customer satisfaction)	0.802	22.965***
CRE2: Delivery of products/services	0.784	18.477***
CRE3: Enhancing customer relations	0.802	24.636***
CRE3: Enhancing existing products/services	0.833	25.724***
CRE4: Providing value-added goods/services to customers	0.849	33.336***
CRE5: Creating new products/services	0.796	23.809***
BI assimilation – business operations: (composite reliability = 0.88, AVE = 0.59)		
BO1: Supplier management (e.g. inbound logistics or purchasing).	0.749	16.610***
BO2: Manufacturing and/or efficiency performance	0.703	13.456***
BO3: Being a low-cost producer/provider	0.806	22.369***
BO4: Creating flexible manufacturing/operations processes	0.773	22.369***
BO5: Enhancing supplier relations	0.815	29.322***
BI assimilation – marketing and sales: (composite reliability = 0.88, AVE = 0.71)		
MS1: Marketing (e.g. targeting customers and tailoring offers)	0.845	26.544***
MS2: Sales (e.g. sales force automation, revenue management)	0.850	29.553***
MS3: Entering new markets	0.840	29.450***

(*continued*)

Panel A: Reflective constructs	Loading	*t*-value
Knowledge importation links:		
Please indicate the extent to which your organization used the following sources to implement BI System (Items are measured on a seven-point scale where 1 = Not At All, 4 = To Some Extent and 7 = To a Great Extent.)		
Service acquisition: (composite reliability = 0.82, AVE = 0.70)		
SA1: Consultants	0.829	23.955***
SA2: Customized training/support with BI technologies vendor	0.846	32.005***
Expertise acquisition: (composite reliability = 0.78, AVE = 0.63)		
EA1: Hired employees with BI systems experience/ expertise.	0.823	16.070***
EA2: Alliance with other organization(s)	0.770	16.070***
Operational managers' shared knowledge (composite reliability = 0.95, AVE = 0.87):		
Please characterize the working relationship that currently exists at the operational level of your organization between the IS and the line managers (Items are measured on a seven-point scale where 1 = Strongly Disagree, 4 = Neutral and 7 = Strongly Agree)		
SHARED1 2: Line managers (IS managers) understand the work environment (problems, tasks, roles, etc.) of the IS managers (line managers)	0.898	33.503***
SHARED3 4: Line managers (IS manager) appreciate the accomplishments of the IS managers (line managers)	0.961	90.871***
SHARED5: IS managers and line managers appreciate each other's accomplishments	0.937	76.338***
BI infrastructure (composite reliability = 0.87, AVE = 0.63)		
Please indicate the extent to which your organization has diffused the following information and communication technologies into its IT infrastructure (Items are measured on a seven-point scale where 1 = Not At All, 4 = To Some Extent and 7 = To a Great Extent.)		
BINF1: Data warehouse/data marts	0.871	37.369***
BINF2: ETL and/other tools to import and update the data warehouse/other specialized database	0.807	16.625***
BINF3: Analytical/reporting tools, such as data mining and OLAP tools	0.772	5.540***
BINF4: Technologies that enable electronic access to external data	0.703	10.132***
Top Management Team support for BI		
Please indicate the extent to which the Top Management Team believes that (for belief questions) or actively participates in (for participation questions). Items are measured on a seven-point scale where 1 = Not At All, 4 = To Some Extent, and 7 = To a Great Extent		
Belief in BI Systems (composite reliability = 0.96, AVE = 0.81)		
TMSB1: BI Systems have the potential to provide business benefits to the organization	0.949	98.788***
TMSB2: BI Systems create competitive advantages for the organization	0.830	20.464***
TMSB3: BI Systems are accessible to the relevant managers of the organization	0.896	37.786***
TMSB4: BI Systems are important to support business activities/strategies of the organization	0.944	67.678***
TMSB5: BI Systems are secure technologies to support the business activities/strategies of the organization	0.882	27.927***

(*continued*)

Table 2.

Panel A: Reflective constructs	Loading	*t*-value
Participation in management of BI Systems (composite reliability = 0.96, AVE = 0.88)		
TMSP1: Articulating the vision for organizational use of BI Systems	0.937	56..833***
TMSP2: Formulating the strategy for the organizational use of BI Systems	0.952	55.950***
TMSP3: Establishing goals and standards to monitor BI Systems projects	0.924	47.921***
Panel B: Formative constructs		
BI: BI Maturity		
BIM: BI has been used extensively in my organization to support managerial processes *(Measured on a scale of 1 to 7 where 1 = Not At All, 4 = To Some Extent and 7 = To a Great Extent)*	0.825	18.916***
YRS: Time (in years) since the adoption of the BI software	0.189	0.859
PANEL C: Control variable:		
Information systems integration		
Please indicate the extent to which your organization has diffused the following information and communication technologies into its IT infrastructure (Items are measured on a seven-point scale where 1 = Not At All, 4 = To Some Extent and 7 = To a Great Extent.)		
ERP: (composite reliability = 0.84, AVE = 0.64)		
ERP1: Mainframe/server systems	0.822	24.412***
ERP2: Database/ERP systems	0.779	20.538***
ERP3: The latest back end technology. . ..	0.799	17.723***
Generic IT: (composite reliability = 0.92, AVE = 0.79)		
GIT1: Internal computer network	0.885	29.329***
GIT2: IT architecture and standards . . .	0.890	33.251***
GIT3: Security and risk management policies. . .	0.897	30.782***

Table 2.

Notes: *$p < 0.05$ (one-tailed); **$p < 0.005$; ***$p < 0.001$

and standards. Five items were used to measure the belief dimension, while three items were used to measure the participation dimension of TMT support. The two scales proved highly reliable in prior studies (Chatterjee *et al.*, 2002; Elbashir *et al.*, 2011).

Organizational size and *information systems integration* are used as control variables. Organizational size has been used to proxy for the resource base of the organization. Larger organizations are well-prepared to support the development of high-quality IT infrastructure, and foster various learning activities to support BI users (Armstrong and Sambamurthy, 1999; Davila and Foster, 2005, 2007). Similar to prior research, the number of employees is used to proxy for firm size (Liang *et al.*, 2007). Information systems (IS) integration represents the base IT infrastructure for aggregating and managing organizational data that BI systems use. IS integration is captured as a second-order construct formed by two first-order constructs as follows: *enterprise systems infrastructure* which encompass enterprise systems applications, databases and servers; and *generic IT infrastructure* which encompass computing and network, IT standards and security and risk management policies.

4. Data analysis and results

We use partial least squares (PLS), a component-based SEM technique, to both validate the constructs and test the research model and hypotheses7. The bootstrapping approach was used to generate 1,000 random samples of observations from the original data set. The paths' coefficients were re-estimated using observations from each of these random samples. This approach computes the *t*-statistics and provides a valid estimate of the significance of paths coefficients (Chin, 1998b). The test of the measurement model includes examining the internal consistency and convergent and discriminant validity of the instrument items. All composite reliability scores for latent constructs reported in Table 2 are well above the recommended level of 0.70, thus indicating adequate reliability of the reflective item measures for each such construct (Nunnally, 1978). Item loadings together with the average variance extracted (AVE) were used to examine the convergent validity of the reflective constructs while items weights were used to examine the validity of the formative construct. Table 2 shows that all measurement items have significant loadings indicating significant contribution to the measured construct. Moreover, the AVE for all constructs exceeds 0.50, demonstrating convergent validity of the measurement items (Fornell and Larcker, 1981)8. The AVEs also indicate that each measured construct explains more than 0.50 of the variation in the observed variables.

Table 3 shows the values of the square root of the AVEs (on the diagonal) are all greater than the inter-construct correlations (below the diagonal). This demonstrates that the measures exhibit satisfactory discriminant validity9. An additional test of discriminant validity was conducted where each measurement item was assessed to ensure that it has a higher loading on its assigned factor than on any other factors (Chin, 1998b). As shown in Table 4, each measurement item loads higher on the appropriate construct than on any other construct. These results further support the adequacy of the discriminant validity of the measures used in this study.

As shown in Figure 1, the research model tests the influence of TMT support for BI on three operational level factors as follows: operational managers' shared knowledge, BI infrastructure sophistication and knowledge importation links (H_{1a}, H_{1c}, H_{2a}), the influence of these three factors on BI assimilation (H_{1b}, H_{1d}, H_{2b}) and the effect of assimilation on business process performance (*H3*). Table 5 and Figure 2 present the overall results of the PLS analysis. The statistical results provide substantial support for the overall theoretical model.

Consistent with expectations, the results in Table 5 and Figure 2 show significant relationships between TMT support for BI and operational managers' shared knowledge (0.324, $p < 0.001$), BI infrastructure sophistication (0.329, $p < 0.001$) and knowledge importation links (0.420, $p < 0.001$). These results support H_{1a}, H_{1c}, H_{2a}, and are consistent with the view that TMT is critical in public sector organizations to fostering a knowledge creation culture among operational managers, providing the necessary technical infrastructure to support innovations, and managing and leveraging knowledge importation links to supplement and enhance the knowledge available to the organization as MCS innovations are implemented.

Table 5 and Figure 2 show how the three operational-level institutional factors are associated with BI assimilation. Table 5 shows significant positive relationships between the three factors as follows: operational managers' shared knowledge (0.160, $p < 0.005$), BI infrastructure sophistication (0.242, $p < 0.001$) and knowledge importation links (0.143, $p < 0.05$) to BI assimilation. These results support H_{1b}, H_{1d}, H_{2b}, and provide strong support for the importance of creating the necessary operational level preparedness to effectively assimilate MCS innovations while at the same time recognizing the importance and value of knowledge importation in facilitating public sector organizations navigation of the complex innovation process. Taken together these results support H_1 and H_2. The explained variance (R^2) of BI assimilation is 28.3%.

Table 3. Square root of AVE[a] and inter-construct correlations[b] (n = 160)

Constructs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Process efficiency	*0.864*													
2. Partner relations	0.489	*0.811*												
3. Customer responsiveness	0.389	0.752	*0.867*											
4. Customer relations	0.628	0.493	0.506	*0.811*										
5. Business operations	0.480	0.717	0.593	0.564	*0.770*									
6. Marketing and sales	0.387	0.495	0.618	0.571	0.557	*0.845*								
7. BI infrastructure	0.314	0.097	0.032	0.302	0.129	0.056	*0.791*							
8. Shared knowledge	0.241	0.217	0.247	0.342	0.218	0.235	0.259	*0.932*						
9. Expertise acquisition	0.403	0.345	0.201	0.321	0.362	0.179	0.370	0.121	*0.796*					
10. Service acquisition	0.295	0.159	0.132	0.287	0.221	0.117	0.339	0.234	0.572	*0.837*				
11. TMT belief	0.395	0.288	0.228	0.341	0.329	0.288	0.259	0.307	0.352	0.416	*0.901*			
12. TMT participation	0.310	0.295	0.246	0.323	0.288	0.260	0.179	0.299	0.306	0.274	0.743	*0.938*		
13. ERP	0.165	0.141	0.106	0.224	0.197	0.079	0.593	0.286	0.286	0.242	0.168	0.158	*0.800*	
14. Generic IT	0.130	0.010	0.038	0.188	0.034	0.059	0.600	0.258	0.203	0.228	0.126	0.120	0.722	*0.890*

Notes: [a]Square root of AVE shown on the diagonal; [b]Inter-construct correlations are shown below the diagonal

Table 4. Items loadings and cross loadings – constructs measured using reflective items

Item	Supplier relations	Internal efficiency	Customer intelligence	Customer relations	Business operations	Marketing and Sales	Shared knowledge	Service acquisition	Expertise acquisition	BI infra-structure	TMT belief	TMT participate	ERP	Generic IT
PR1	*0.787*	0.376	0.705	0.360	0.602	0.487	0.156	0.142	0.255	0.039	0.209	0.174	0.097	−0.015
PR2	*0.857*	0.454	0.561	0.422	0.613	0.366	0.178	0.139	0.361	0.200	0.253	0.244	0.199	0.054
PPR3	*0.818*	0.477	0.558	0.470	0.566	0.404	0.170	0.137	0.288	0.115	0.251	0.292	0.132	0.051
PR4	*0.880*	0.417	0.598	0.435	0.634	0.411	0.222	0.172	0.293	0.047	0.294	0.313	0.067	−0.020
PR5	*0.821*	0.312	0.718	0.363	0.572	0.394	0.174	0.071	0.235	0.000	0.188	0.204	0.090	−0.030
PE1	0.403	*0.878*	0.343	0.600	0.409	0.348	0.260	0.258	0.364	0.258	0.361	0.310	0.128	0.089
PE2	0.395	*0.887*	0.324	0.601	0.409	0.313	0.246	0.274	0.351	0.216	0.341	0.242	0.165	0.099
PE3	0.379	*0.837*	0.307	0.488	0.352	0.341	0.203	0.250	0.321	0.344	0.365	0.280	0.142	0.163
PE4	0.507	*0.853*	0.368	0.481	0.481	0.337	0.126	0.237	0.355	0.274	0.302	0.240	0.136	0.102
CRS1	0.605	0.349	*0.864*	0.426	0.504	0.650	0.189	0.074	0.134	0.036	0.245	0.244	0.060	0.020
CRS2	0.699	0.320	*0.891*	0.413	0.526	0.455	0.185	0.127	0.212	−0.007	0.134	0.191	0.057	−0.010
CRS3	0.650	0.346	*0.845*	0.478	0.512	0.508	0.268	0.140	0.175	0.056	0.216	0.207	0.160	0.091
CRE1	0.405	0.480	0.427	*0.802*	0.384	0.462	0.363	0.254	0.209	0.272	0.302	0.277	0.239	0.194
CRE2	0.366	0.523	0.341	*0.784*	0.437	0.341	0.241	0.243	0.287	0.272	0.249	0.261	0.214	0.195
CRE3	0.428	0.529	0.467	*0.802*	0.505	0.555	0.291	0.297	0.291	0.228	0.338	0.282	0.238	0.222
CRE4	0.306	0.494	0.335	*0.833*	0.451	0.413	0.218	0.189	0.249	0.246	0.231	0.231	0.121	0.110
CRE5	0.452	0.521	0.453	*0.849*	0.493	0.448	0.258	0.235	0.264	0.218	0.266	0.228	0.148	0.112
CRE6	0.431	0.506	0.424	*0.796*	0.468	0.538	0.290	0.174	0.261	0.237	0.266	0.288	0.130	0.084
BO1	0.590	0.344	0.421	0.343	*0.749*	0.430	0.126	0.231	0.303	0.051	0.228	0.184	0.186	0.027
BO2	0.498	0.278	0.435	0.379	*0.703*	0.381	0.120	0.129	0.197	0.108	0.112	0.133	0.206	0.097
BO3	0.520	0.423	0.440	0.436	*0.806*	0.349	0.159	0.151	0.306	0.145	0.322	0.304	0.121	−0.014
BO4	0.496	0.403	0.494	0.455	*0.773*	0.447	0.170	0.125	0.234	0.117	0.275	0.225	0.093	0.006
BO5	0.649	0.390	0.491	0.538	*0.815*	0.524	0.248	0.209	0.342	0.077	0.308	0.248	0.164	0.023
MS1	0.330	0.295	0.483	0.511	0.410	*0.845*	0.186	0.028	0.094	0.043	0.161	0.203	0.057	0.072
MS2	0.493	0.347	0.546	0.388	0.505	*0.850*	0.206	0.145	0.130	0.022	0.248	0.174	0.086	0.040
MS3	0.426	0.337	0.534	0.545	0.493	*0.840*	0.203	0.118	0.223	0.076	0.311	0.278	0.057	0.039
SH1 2	0.211	0.194	0.258	0.277	0.202	0.232	*0.898*	0.189	0.092	0.209	0.270	0.293	0.258	0.252
SH3 4	0.181	0.233	0.215	0.342	0.193	0.207	*0.961*	0.214	0.093	0.223	0.283	0.266	0.237	0.197
SH5	0.213	0.244	0.218	0.336	0.215	0.219	*0.937*	0.250	0.151	0.291	0.304	0.276	0.303	0.271
SA1	0.136	0.248	0.091	0.249	0.183	0.071	0.093	*0.829*	0.443	0.215	0.368	0.251	0.192	0.153
SA2	0.130	0.245	0.128	0.232	0.186	0.124	0.295	*0.846*	0.514	0.349	0.329	0.210	0.212	0.227
EA1	0.254	0.381	0.178	0.268	0.311	0.172	0.066	0.486	*0.823*	0.373	0.320	0.267	0.257	0.224
EA2	0.298	0.255	0.141	0.243	0.264	0.110	0.130	0.423	*0.770*	0.208	0.237	0.218	0.196	0.092
BIINF1	0.073	0.288	0.020	0.286	0.116	0.079	0.211	0.337	0.358	*0.871*	0.274	0.217	0.471	0.506

(*continued*)

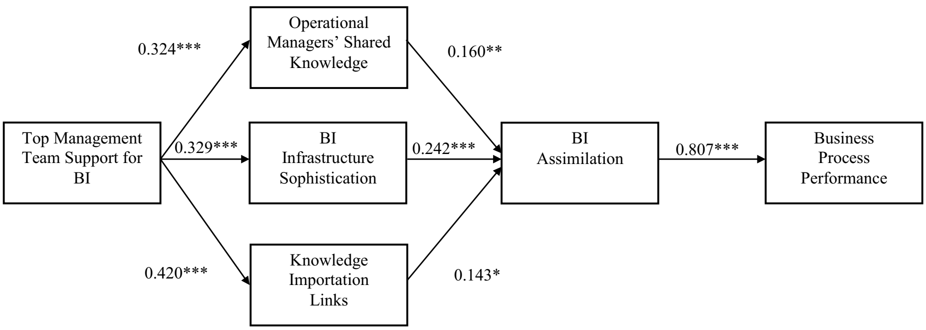
Table 4.

Item	Supplier relations	Internal efficiency	Customer intelligence	Customer relations	Business operations	Marketing and Sales	Shared knowledge	Service acquisition	Expertise acquisition	BI infra-structure	TMT belief	TMT participate	ERP	Generic IT
BINF2	0.029	0.252	−0.020	0.152	0.037	0.005	0.148	0.316	0.330	*0.807*	0.232	0.119	0.432	0.463
BINF3	0.069	0.246	0.030	0.203	0.076	0.028	0.187	0.181	0.204	*0.772*	0.198	0.088	0.455	0.435
BINF4	0.146	0.200	0.080	0.318	0.188	0.062	0.285	0.220	0.265	*0.703*	0.096	0.127	0.534	0.499
TMSB1	0.242	0.364	0.164	0.272	0.274	0.199	0.254	0.416	0.338	0.246	*0.949*	0.697	0.162	0.134
TMSB2	0.237	0.326	0.224	0.336	0.298	0.327	0.217	0.326	0.323	0.186	*0.830*	0.617	0.101	0.052
TMSB3	0.294	0.380	0.240	0.338	0.305	0.285	0.362	0.359	0.317	0.263	*0.896*	0.698	0.173	0.132
TMSB4	0.269	0.366	0.199	0.306	0.285	0.249	0.252	0.390	0.331	0.253	*0.944*	0.695	0.141	0.129
TMSB5	0.254	0.342	0.203	0.290	0.325	0.246	0.297	0.377	0.278	0.216	*0.882*	0.637	0.180	0.115
TMSP1	0.266	0.285	0.217	0.298	0.239	0.254	0.276	0.269	0.291	0.186	0.703	*0.937*	0.182	0.140
TMSP2	0.290	0.320	0.222	0.302	0.288	0.219	0.303	0.278	0.307	0.138	0.720	*0.952*	0.114	0.081
TMSP3	0.274	0.264	0.254	0.309	0.283	0.260	0.261	0.224	0.263	0.181	0.666	*0.924*	0.151	0.118
ERP1	0.001	−0.028	−0.058	0.065	0.053	−0.006	0.204	0.123	0.197	0.476	0.083	0.111	*0.822*	0.624
ERP2	0.243	0.241	0.207	0.235	0.333	0.158	0.130	0.192	0.263	0.402	0.173	0.102	*0.779*	0.425
ERP3	0.116	0.201	0.126	0.247	0.119	0.054	0.334	0.265	0.233	0.533	0.155	0.163	*0.799*	0.659
GIT1	−0.037	0.082	0.025	0.149	0.010	0.026	0.187	0.186	0.131	0.514	0.105	0.094	0.617	*0.885*
GIT2	0.053	0.186	0.065	0.205	0.039	0.073	0.229	0.220	0.232	0.597	0.110	0.107	0.641	*0.890*
GIT3	0.010	0.079	0.012	0.149	0.041	0.058	0.272	0.204	0.179	0.494	0.121	0.119	0.670	*0.897*

Tests	Path	Path coefficient	t-statistic
Hypotheses	TMT Support → Operational Managers' Shared Knowledge (*H1a*)	0.324	4.320***
	TMT Support → BI Infrastructure Sophistication (*H1b*)	0.329	4.916***
	TMT Support → Knowledge Importation Links (*H1c*)	0.420	6.294***
	Operational Managers' Shared knowledge → BI assimilation (*H2a*)	0.160	2.457**
	BI Infrastructure Sophistication→ BI assimilation (*H2b*)	0.242	3.177***
	Knowledge Importation Links → BI assimilation (*H2c*)	0.143	1.797*
	BI assimilation → Business Process Performance (*H3*)	0.807	27.109***
Control variables	IS Integration → BI assimilation	−0.054	0.757
	IS Integrations → Business Process Performance	−0.013	0.500
	Size → BI assimilation	−0.057	0.966
	Size (number of employees)→ Business Process Performance	0.073	1.717*

Notes: $*p < 0.05$ (one-tailed); $** p < 0.005$; $***p < 0.001$

Table 5.
Path coefficients: test of hypotheses and control variables



Notes: $*p < 0.05$ (one-tailed); $**p < 0.005$; $***p < 0.001$

Figure 2.
Path coefficients for BI assimilation and the business process performance effects

As theorized, the results reported in Table 5 and Figure 2 show that BI assimilation has a significant and positive association with business process performance (0.807, $p < 0.001$) and support H_3. The explained variance (R^2) of business process performance is 63.9%. The strong relationship between BI assimilation and business process performance reinforces the role of comprehensive MCS in facilitating business process effectiveness in public sector organizations.

With regard to the control variables, only organizational size has a significant effect and only on business process performance. This result is inconsistent with the findings reported in private sector studies where size consistently has a positive effect on the assimilation of technology solutions.

Post hoc analyses were conducted to test the significance of indirect relationships between TMT support for BI and BI assimilation via the three factors as follows: operational managers' shared knowledge, BI infrastructure sophistication and knowledge importation links (the three institutional factors theorized to mediate the relationship). To test the significance of the indirect effects, we use bootstrapping procedures suggested by Hayes (2009) as this method does not assume normally distributed data. We use the product of the PLS bootstrap resampling results for the path coefficients of the three indirect relationships that are expected to be mediated. We multiply these coefficients to approximate the sampling distribution for the indirect effects and generate a 99% confidence interval from this distribution (Hayes, 2009). The results, which are shown in Table 6, indicate that the above stated indirect relationships are all positive (coefficients are between 5% and 8%) and significant at the 0.05 level. These indirect effects further support the importance of TMT to creating an appropriate culture and environment to facilitate the effective assimilation of MCS innovations to support improved business process performance.

5. Discussion and conclusions

This study examined the institutional factors underlying public sector organizations' successful adoption and integration of BI systems to improve service performance. The underlying conceptual foundations of the study are based on Elbashir *et al.* (2011) theorizations on the role of internal knowledge creation activities that lead to better organizational absorptive capacity with a recognition in the literature that public sector organizations struggle to attract the talent necessary to achieve sufficient levels of knowledge within the organization. Modell's (2019) theorizations suggest this can be a major hindrance when the changes to MCS are moderate to even radical – typical of those driven by the global NPM movement in the public sector. Importation of external knowledge is theorized as an important attribute of successful BI assimilation in these circumstances.

The results support the theorizations put forth in this study. TMT support is a key driver in the development of institutional resources (i.e. operational managers' shared knowledge, BI infrastructure sophistication and knowledge importation links). These institutional factors similarly become important intermediaries in facilitating the translation of TMT support into effective assimilation of BI systems. These findings have important implications for understanding differences in the public sector versus private sector organizations in terms of recognizing the need to enhance internal knowledge sharing efforts with external knowledge acquisition/creation. While public sector TMT still needs to focus on creating the types of knowledge culture internally that can prepare and engage operational level managers in promoting MCS innovations, TMT also needs to effectively navigate the political and institutional constraints that can inhibit their ability to

Table 6.
Test of indirect relationships

Indirect effect	Mediated paths	Indirect path coefficient[a]	Bootstrap confidence interval (99%) Lower	Upper
TMT support to BI-assimilation	TMT Support → Operational Managers' Shared Knowledge → BI assimilation	0.0518**	−0.0080	0.1538
	TMT Support → BI-Infrastructure Sophistication → BI assimilation	0.0796***	0.0051	0.1897
	TMT Support → Knowledge Importation Link → BI assimilation	0.0600*	−0.0453	0.2104

Notes: [a]Path magnitude, * = <0.05, ** = <0.01 and *** = <0.001

acquire the resources necessary for the infrastructure to support MCS innovations such as BI. Further, TMT needs to be able to recognize where the organizational limitations exist in terms of knowledge and preparedness for proposed MCS innovations and import the appropriate external knowledge necessary to supplement and enhance internal knowledge sources in moving such innovations forward. Knowledge importation is shown in the study to be an effective solution to overcoming internal knowledge and skill limitations that are common among public sector organizations (King *et al.*, 2017; Australian National Audit Office (ANAO), 2018; Cinar *et al.*, 2019) to promote effective assimilation of BI in the support of business process performance.

The research in this study further contributes through its focus on the performance impact of BI systems at the business process level. Private sector research generally focuses on financial outcomes to assess performance, even though research is increasingly showing that the answer to the productivity paradox is assessment of performance gains as business process performance gains (Elbashir *et al.*, 2008, 2021). This is consistent with a recognition that a weakness at the public sector level is the failure to focus on the delivery of services as opposed to financial performance (Hoque and Adams, 2011; Arnaboldi *et al.*, 2015; Australian National Audit Office (ANAO), 2011, 2014, 2017, 2018). We find that enhanced assimilation of BI systems leads to improved business process performance among public sector organizations. The broad-based performance measurement and reporting capability of BI systems (Peters *et al.*, 2016) appear to provide the robust monitoring systems desired in an era of NPM mandates while facilitating the ultimate goal of improved business process performance that yields the service efficiencies and effectiveness that are demanded by the broad array of stakeholders.

At the same time, a focus on the business process level places the focus more on the social entrepreneurship at the local level and potentially highlights the knowledge sharing and knowledge acquisition/creation activities. This is consistent with our findings that the extent to which public sector organizations can build knowledge importation links and transfer external knowledge into the organization helps explain the variation in business process performance. On a theory level, this finding might initially appear to be contradictory to the resource-based view (RBV) of the firm that has been highly prominent in recent research discussions on the private sector. Knowledge importation links would not appear to fulfill some of the RBV conditions regarding strategic resources (e.g. rarity, inimitability, imperfect mobility) that provide competitive advantage. In part, this may be a function of competitive advantage not being a driving objective for public sector organizations – rather the focus is primarily on servicing the public interest and on the related goals of improved accountability, increased efficiency and enhanced effectiveness. This difference is reflected in our focus on business process performance and the results from our testing of the theoretical model.

The findings of this study should be considered in light of the inherent limitations. First, our data are limited to organizations using a specific BI system. While this allowed us to control for any noise from varying levels of capability (e.g. the BI system of interest in this study was recognized for its broad-based MCS capability and was the leading product adopted in the Australian public sector), the results may not necessarily be comparable to studies of other BI systems that are less capable. While the theoretical relationships would be fully expected to hold, there could be performance outcome differences at the business process level. Second, the study was limited to public sector organizations in Australia, a country that is recognized for its adoption of private sector practices in perhaps the most extensive application of NPM policies. Future studies may want to explore whether the relationships in this study hold as strongly in other countries that have adapted NPM policies in a more tempered fashion. Third, this study focuses on the assimilation of BI into business processes but does not focus on how specific capabilities provided by BI software are used by successful organizations to enhance specific MCS measures. Future research would be beneficial that takes a more in-depth look at a smaller set of organizations' use of BI software to achieve integrated MCS capability, to understand how MCS components interact as a package of controls.

Notes

1. For example, Davila and Foster (2007) specify 46 categories that encompass the range of MCS components used by companies. The extensive set of pre-built reports, such as scorecards, KPIs, performance measures and process metrics included in most BI systems provide support for all these categories.

2. Public sector organizations consist of those entities that are owned and operated by the government and aim to provide services to the public. Examples of public sector organizations used in the current study are public hospitals, public universities, water and public transport companies, city councils and government agencies, such as federal police, department of justice and department of housing. The funding for public services is usually raised through a variety of methods, including taxes, fees and financial transfers from other levels of government (e.g. from a federal or state government). Public sector organizations do not seek to generate a profit *per se*; however, the recent budget cuts by Australian federal and state governments have led public sector organizations to seek alternative sources.

3. The data for this project were part of a major data collection process. We obtained the complete Australia customer list for a major BI vendor, including all individual contacts associated with the adoption and implementation of the BI system. The vendor is not identified directly in accordance with the non-disclosure agreement signed at the initiation of the study and under the agreement all data was collected under a single use agreement covering the use of the customer list and with data collection being completed in 2006 as part of Mohamed Elbashir's (2006) thesis work. Beyond the thesis, the extensive data set has been used for a number of independent studies, including a focus on the relationship between business process performance and organizational performance (Elbashir *et al.*, 2008); the value of organizational absorptive capacity in the strategic use of BI (Elbashier *et al.*, 2011); the role of shared knowledge and BI assimilation on performance (Elbashir *et al.*, 2013); the identification of enablers for TMT support (Lee *et al.*, 2014); the examination of the duality of enterprise systems and BI software on business process performance (Elbashir *et al.*, 2021); and the current study which is the lone study focusing on public sector organizations. The data used in this study have not been used in any of the other studies.

4. Although public sector organizations surveyed in this study were under pressure to use IT-based performance measurement, the adoption of the BI-enabled performance measurement software was not mandatory and public sector organizations have some freedom to choose BI software from a limited number of vendors. However, the focal BI systems software was considered the most popular one for various reasons including the extensive set of pre-built reports, such as scorecards, KPIs and performance measures that can be customized to fit the public sector – all key mandates in the 2013 legislation.

5. The sample includes organizations for which the IT vendor had contact details of at least two managers; and organizations for which the contact person is a senior manager if the organization is small.

6. Two tests, inter-class correlation (ICC) coefficients and correlation between responses were conducted to test the consistency among multiple respondents from the same organizations. All the correlations are strong and significant. Moreover, ICC coefficients for all raters are above 0.70. These tests provide evidence of the consistency among the respondents which allows using the average from multiple respondents to represent the organization.

7. PLS is more appropriate than other SEM techniques such as covariance-based SEM such as AMOS and LISREL as the data used to test the model are multivariate non-normal. Moreover, the model contains a construct which is measured with formative indicators and the use of covariance-based SEM can result in an unidentified model (Kline, 2006). PLS was chosen, as it does not require the data to exhibit multivariate normal distribution (Chin *et al.*, 2003).
8. AVE measures the variance shared between a construct and the measurement items (Chin, 1998a).
9. For satisfactory discriminant validity, the AVE from the construct should be greater than the variance shared between the construct and other constructs in the research model (Chin, 1998a).

References

Abernethy, M., Bouwens, J. and van Lent, L. (2010), "Leadership and control system design", *Management Accounting Research*, Vol. 21 No. 1, pp. 2-16.

Armstrong, C. and Sambamurthy, V. (1999), "Information technology assimilation in firms: the influence of senior leadership and IT infrastructures", *Information Systems Research*, Vol. 10 No. 4, pp. 304-327.

Arnaboldi, M., Lapsley, I. and Steccolini, I. (2015), "Performance management in the public sector: the ultimate challenge", *Financial Accountability and Management*, Vol. 31 No. 1, pp. 1-22.

Australian National Audit Office (ANAO) (2011), *The Auditor-General Audit Report No. 5 2011-12 Performance: Development and Implementation of Key Performance Indicators to Support the Outcomes and Programs Framework*, Australian National Audit Office, Canberra.

Australian National Audit Office (ANAO) (2014), *Pilot Project to Audit Key Performance Indicators*, Australian National Audit Office, Canberra.

Australian National Audit Office (ANAO) (2017), *Implementation of the Annual Performance Statements Requirements 2015-16*, Australian National Audit Office, Canberra.

Australian National Audit Office (ANAO) (2018), *Implementation of the Annual Performance Statements Requirements 2016-17*, Australian National Audit Office, Canberra.

Baird, K. and Harrison, G. (2017), "The association between organizational culture and the use of management initiatives in the public sector", *Financial Accountability and Management*, Vol. 33 No. 3, pp. 311-329.

Brignall, S. and Modell, S. (2000), "An institutional perspective on performance measurement and management in the 'new public sector", *Management Accounting Research*, Vol. 11 No. 3, pp. 281-306.

Chapman, C. and Kihn, L.A. (2009), "Information systems integration, enabling control and performance", *Accounting Organizations and Society*, Vol. 34 No. 2, pp. 151-169.

Chatterjee, D., Grewal, R. and Sambamurthy, V. (2002), "Shaping up for e-commerce: institutional enablers of the organizational assimilation of web technologies", *MIS Quarterly*, Vol. 26 No. 2, pp. 65-89.

Chin, W. (1998a), "Issues and opinion on structural equation modeling", *MIS Quarterly*, Vol. 22, pp. 7-16.

Chin, W. (1998b), "The partial least squares approach for structural equation modeling", in: Marcoulides, G. (Ed.), *Modern Methods for Business Research*, Lawrence Erlbaum Associates, Mahwah, NJ, pp. 295-336.

Chin, W., Marcolin, B. and Newsted, P. (2003), "A partial least squares latent variable modeling approach for measuring interaction effects: results from a monte carlo simulation study and an electronic-mail/adoption study", *Information Systems Research*, Vol. 14 No. 2, pp. 189-217.

Cinar, E., Trott, P. and Simms, C. (2019), "A systematic review of barriers to public sector innovation process", *Public Management Review*, Vol. 21 No. 2, pp. 264-290.

Cohen, W. and Levinthal, D. (1990), "Absorptive capacity: a new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128-152.

Davila, A. and Foster, G. (2005), "Management accounting systems adoption decisions: evidence and performance implications from early-stage/startup companies", *The Accounting Review*, Vol. 80 No. 4, pp. 1039-1068.

Davila, A. and Foster, G. (2007), "Management control systems in early-stage startup companies", *The Accounting Review*, Vol. 82 No. 4, pp. 907-937.

Dechow, N. and Mouritsen, J. (2005), "Enterprise resource planning systems, management control and the quest for integration", *Accounting Organizations and Society*, Vol. 30 Nos 7/8, pp. 691-733.

Demircioglu, M. and Audretsch, D. (2017), "Conditions for innovation in public sector organizations", *Research Policy*, Vol. 46 No. 9, pp. 1681-1691.

Elbashir, M. (2006), *Strategic Information Systems and Organizational Performance: Testing an Integrated Model of Business Value Creation*, University of Melbourne, Parkville, VIC.

Elbashir, M., Collier, P. and Davern, M. (2008), "Measuring the effects of business intelligence systems: the relationship between business process and organizational performance", *International Journal of Accounting Information Systems*, Vol. 9 No. 3, pp. 135-153.

Elbashir, M., Collier, P. and Sutton, S. (2011), "The role of organizational absorptive capacity in strategic use of business intelligence to support integrated management control systems", *The Accounting Review*, Vol. 86 No. 1, pp. 155-184.

Elbashir, M., Sutton, S., Mahama, H. and Arnold, V. (2021), "Unravelling the integrated information systems and management control paradox: enhancing dynamic capability through business intelligence", *Accounting and Finance*, Vol. 61 NO. S1, pp. 1775-1814.

Elbashir, M., Collier, P., Sutton, S., Davern, M. and Leech, S. (2013), "Enhancing the business value of business intelligence: the role of shared knowledge and assimilation", *Journal of Information Systems*, Vol. 27 No. 2, pp. 87-105.

Fornell, C. and Larcker, F. (1981), "Evaluating structural equation models with unobservable variables and measurement errors", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50.

Granlund, M. and Malmi, T. (2002), "Moderate impact of ERPS on management accounting: a lag or permanent outcome?", *Management Accounting Research*, Vol. 13 No. 3, pp. 299-321.

Harlow, H. (2018), "Developing a knowledge management strategy for data analytics and intellectual capital", *Meditari Accountancy Research*, Vol. 26 No. 3, pp. 400-419.

Hartnett, E., Daniel, E. and Holti, R. (2012), "Client and consultant engagement in public sector is projects", *International Journal of Information Management*, Vol. 32 No. 4, pp. 307-317.

Hayes, A. (2009), "Beyond baron and kenny: statistical mediation analysis in the new millennium", *Communication Monographs*, Vol. 76 No. 4, pp. 408-420.

Hoque, Z. and Adams, C. (2011), "The rise and use of balanced scorecard measures in Australian government departments", *Financial Accountability and Management*, Vol. 27 No. 3, pp. 308-334.

Hoque, Z. and Moll, J. (2008), "Public sector reform: implications for accounting, accountability and performance of state-owned entities – an Australian perspective", *International Journal of Public Sector Management*, Vol. 14 No. 4, pp. 304-326.

Huber, G. and Power, D. (1985), "Retrospective reports of strategic-level managers: guidelines for increasing their accuracy", *Strategic Management Journal*, Vol. 6 No. 2, pp. 171-180.

Iannacci, F. (2010), "When is an information infrastructure? Investigating the emergence of public sector information infrastructures", *European Journal of Information Systems*, Vol. 19 No. 1, pp. 35-48.

IBM (2010), *Government Analytics: Set Goals, Drive Accountability, and Improve Outcomes*, IBM Corporation, Ottawa, Canada.

IBM (2017), *Move Forward into the Future with Cognos Analytics*, IBM Corporation, Armonk, New York, NY.

Johansson, T. and Siverbo, S. (2014), "The appropriateness of tight budget control in public sector organizations facing budget turbulence", *Management Accounting Research*, Vol. 25 No. 4, pp. 271-283.

King, M., Zaharchuk, D., Paydos, T. and Cabrera, M. (2017), *A Two-Front Battle: How Governments Can Prevail in the Face of the Global Skills Crisis*, IBM Institute for Business Value, Armonk, New York, NY.

Kline, R. (2006), "Reverse arrow dynamics. formative measurement and feedback loops", in: Hancock G. and Mueller, R. (Eds), *Structural Equation Modeling: A Second Course*, Information Age Publishing, Greenwich, CT, pp. 43-68.

Kwarteng, A. and Aveh, F. (2018), "Empirical examination of organizational culture on accounting information system and corporate performance: evidence from a developing country perspective", *Meditari Accountancy Research*, Vol. 26 No. 4, pp. 675-698.

Lee, J., Elbashir, M., Mahama, H. and Sutton, S. (2014), "Enablers of top management team support for integrated management control systems innovations", *International Journal of Accounting Information Systems*, Vol. 15 No. 1, pp. 1-25.

Leiby, J. (2018), "The role of consultants and management prestige in management control system adoption", *Accounting Organizations and Society*, Vol. 66, pp. 1-13.

Liang, H., Saraf, N., Hu, Q. and Xue, Y. (2007), "Assimilation of enterprise systems: the effect of institutional pressures and the mediating role of top management", *MIS Quarterly*, Vol. 31, pp. 59-87.

Mahama, H., Elbashir, M., Sutton, S. and Arnold, V. (2021), "Enabling ERM maturity through business intelligence analytics and management control systems: the case of public sector organizations", *Public Money and Management Journal*.

Malmi, T. and Brown, D. (2008), "Management control systems as a package–opportunities, challenges and research directions", *Management Accounting Research*, Vol. 19 No. 4, pp. 287-300.

Marrone, M. and Hazelton, J. (2019), "The disruptive and transformative potential of new technologies for accounting, accountants and accountability: a review of current literature and call for further research", *Meditari Accountancy Research*, Vol. 27 No. 5, pp. 677-694.

Modell, S. (2019), "Constructing institutional performance: a multi-level framing perspective on performance measurement and management", *Accounting and Business Research*, Vol. 49 No. 4, pp. 428-453.

Nelson, K. and Cooprider, J. (1996), "The contribution of shared knowledge to is group performance", *MIS Quarterly*, Vol. 20 No. 4, pp. 409-432.

Northcutt, T. and Taulapapa, T. (2012), "Using the balance scorecard to manage performance in the public sector: issues and challenges", *International Journal of Public Sector Management*, Vol. 25, pp. 166-191.

Nunnally, J. (1978), *Psychometric Theory*, McGraw-Hill Inc., New York, NY.

Peters, M., Wieder, B. and Sutton, S. (2018), "Organizational improvisation and the reduced usefulness of performance measurement BI functionalities", *International Journal of Accounting Information Systems*, Vol. 29, pp. 1-15.

Peters, M., Wieder, B., Sutton, S. and Wakefield, J. (2016), "Business intelligence systems use in performance measurement capabilities: implications for enhanced competitive advantage", *International Journal of Accounting Information Systems*, Vol. 21, pp. 1-17.

Purvis, R., Sambamurthy, V. and Zmud, R. (2000), "The development of knowledge embeddedness in CASE technologies within organizations", *IEEE Transactions on Engineering Management*, Vol. 47 No. 2, pp. 245-257.

Quattrone, P. and Hopper, T. (2005), “A ‘time-space odyssey’: management control systems in two multinational organizations”, *Accounting Organizations and Society*, Vol. 30 Nos 7/8, pp. 735-764.

Ratia, M., Myllarniemi, J. and Helander, N. (2018), “The new era of business intelligence: big data potential in the private health care value creation”, *Meditari Accountancy Research*, Vol. 26 No. 3, pp. 531-546.

Rikhardsson, P. and Kræmmergaard, P. (2006), “Identifying the impacts of enterprise system implementation and use: examples from Denmark”, *International Journal of Accounting Information Systems*, Vol. 7 No. 1, pp. 38-49.

Ross, L. (2011), *Public Sector Performance: A Global Perspective*, Chartered Institute of Management Accountants, London.

Secundo, G., Del Vecchio, P., Dumay, J. and Passiante, G. (2017), “Intellectual capital in the age of big data: establishing a research agenda”, *Journal of Intellectual Capital*, Vol. 18 No. 2, pp. 242-261.

Simons, R. (1995), *Levers of Control*, Harvard University Press, Boston.

Spekle, R. and Verbeeten, F. (2014), “The use of performance measurement systems in the public sector: effects on performance”, *Management Accounting Research*, Vol. 25 No. 2, pp. 131-146.

Ter Bogt, H., van Helden, G. and van der Kolk, B. (2015), “Challenging the NPM ideas about performance management: selectivity and differentiation in outcome-oriented performance budgeting”, *Financial Accountability and Management*, Vol. 31 No. 3, pp. 287-315.

Venkatraman, N. (1989), “The concept of fit in strategy research: toward verbal and statistical correspondence”, *The Academy of Management Review*, Vol. 14 No. 3, pp. 423-444.

Wiesel, F., Modell, S. and Moll, J. (2011), “Customer orientation and management control in the public sector: a garbage can analysis”, *European Accounting Review*, Vol. 20 No. 3, pp. 551-581.

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