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## An Integrated Model of Business Intelligence & Analytics Capabilities and Organizational Performance

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## Abstract:

Organizations can leverage business intelligence and analytics (BI&A) to transform themselves through a holistic integration process. Contrary to this proposition, many organizations implement BI&A without aligning or integrating it with organizational strategies. Some implement BI&A in a very ad hoc manner without any plans to leverage it. From a research point of view, we lack an integrated framework that can inform both academics and practitioners about adroit applications with business intelligence and analytics capabilities in organizations. We examine what significant BI&A capabilities organizations need to create value from BI&A. We conceptualize second-order constructs that affect the BI&A value-creation process: innovation infrastructure capability, customer process capability, business-to-business (B2B) process capability, and integration capability. We propose that these higher-order BI&A capabilities influence organizational performance through BI&A effectiveness's the mediation effect. We developed a questionnaire instrument and collected data from 154 firms in India. Partial least squares analysis provides broad support for our hypotheses. Our contributions include identifying and empirically assessing key BI&A capabilities that directly impact how effectively an organization implements BI&A.

**Keywords:** Business Intelligence, Analytics, Capabilities, BI&A Capabilities, India, Organizational Performance.

* All authors contributed equally and are co-first authors.

# 1 Introduction

Business intelligence and analytics (BI&A) broadly refers to using advanced data processing, analysis, management, and intelligence applications to obtain meaningful information to help an enterprise make decisions (Chen, Chiang, & Storey, 2012). Over the last decade, the BI&A area has grown tremendously, and emerging global trends in big data analytics and newer applications such as deep learning, artificial, and cognitive intelligence have driven further growth. Press (2017) has predicted that BI&A, along with big data and analytics, to reach a market size of more than US$200 billion by 2020 with more than a 10 percent annual growth rate. Accordingly, to realize BI&A's potential, firms have begun to increase investments in corresponding hardware, software, services, and data scientists (e.g., hiring, training, and continuing to educate them) (Azvine, Cui, Nauck, & Majeed, 2006). Creating a data culture in organizations requires that they understand, nurture, align, and cultivate a data-analytics based value chain and operational processes, which includes people skills. Broadly, we can define all these elements to create and manage BI&A activities as a firm's "business intelligence analytics capability" (Popovič, Hackney, Coelho, & Jaklič, 2012; Seddon, Constantinidis, Tamm, & Dod, 2017).

While some firms have realized value from their investments in BI&A, many struggle to determine how to strategically leverage from these investments or remain at the "tip of the iceberg" when it comes to analytics applications in business or innovation activities across firms and industries (Ransbotham & Kiron, 2017; Ransbotham, Kiron, & Prentice, 2016). Reports that highlight more than 70 percent of BI&A initiatives fail due to a lack of communication between IT and business users about specific business analytical tools (Elliott & Objects, 2008; Goodwin, 2011). Even major companies have failed to integrate business and analytics; for example, Apple's failure to use BI&A effectively in optimizing its manufacturing line led it to have to delay shipping its products to it's retailers (Spence, 2016), and KFC closed branches because it failed to properly manage supply chain-relevant information with analytics (O'Marah, 2018) (see Table A3 in Appendix for some failed cases that organizations could have avoided if they properly impelemented analytics). In particular, organizations have faced challenges in using BI&A in a manner that aligns with their business strategies and value-chain activities (Elbashir, Collier, Sutton, Davern, & Leech, 2013). The many failures suggest that organizations may find effectively initiating, implementing, and leveraging BI&A a challenging task that often involves integrating a set of distinctly different capabilities that range from information infrastructure to analytical mindsets. Thus, we need to identify capabilities that can make BI&A effective.

The unified term BI&A encompasses data processing and analytical applications, technologies, systems, business-centric techniques, practices, and methodologies that transform large amounts of data from disparate sources into meaningful information to help an enterprise better understand business and support timely decision making (Chen et al., 2012; Ramakrishnan, Jones, & Sidorova, 2012). In addition, BI&A involves analytical techniques in applications that require advanced and unique data storage, management, analysis, and visualization technologies. Given this wide definition, one needs to explicate BI&A capabilities in a simple yet holistic manner. In addition, for firms to more effectively improve their BI&A implementations, managers should understand what capabilities they need to develop while considering an integrated perspective of BI&A capabilities. However, from a capability perspective, nuances in how BI&A impacts organizational performance remain a gap in the existing literature. For instance, BI&A helps organizations better understand their operations, processes, and strategies (Lönnqvist & Pirttimäki, 2006), which helps them to improve their organizational performance. Likewise, BI&A can help organizations attain a single consistent view of business information that they need to make strategic decisions and efficiently manage business processes (Watson, Fuller, & Ariyachandra, 2004).

Though existing research has established that BI&A capabilities improve firms' performance, we lack knowledge about the causal pathways through which these effects manifest and how organizations leverage BI&A to achieve their goals. In this paper, we develop an integrated view of BI&A capabilities. Specifically, we address the following research questions (RQ):

**RQ1:** How do BI&A capabilities influence BI&A's organizational effectiveness?

**RQ2:** How do BI&A capabilities and BI&A's effectiveness influence organizational performance?

To address these questions, consistent with recent research that conceptualizes capabilities in the context of specific IT (Kathuria, Mann, Khuntia, Saldanha, & Kauffmanm 2018a), we draw on two interrelated concepts: the capability hierarchy perspective (Winter, 2003) and the operand operant resource

perspective (Madhavaram & Hunt, 2008), to develop a theoretical model of the hierarchical relationships between BI&A capabilities, BI&A effectiveness, and organizational performance. We conceptualize four BI&A capabilities that relate to four categories. First, BI&A innovation infrastructure capability comprises the foundational ability to mobilize and deploy BI&A functionalities to support innovation in an organization through infrastructure, culture, and technological improvements. Second, BI&A customer process capability enables BI&A to accommodate customer-centric activities, such as customer needs, service requirements, and information. Third, BI&A B2B process capability refers to using BI&A to engage new B2B partners and improve coordination with existing B2B partners. Finally, BI&A integration capability refers to how the organization builds and integrates such capability and develops ways to acquire and convert business intelligence towards organizational improvement. We posit that firms need to effectively deploy and leverage these four BI&A capabilities that reflect the two levels of resources (namely, operant resources and operand resources) to influence BI&A effectiveness. We define BI&A effectiveness as a firm's using BI&A to help orient its ability to integrate, build, and reconfigure its internal and external competencies to address rapidly changing environments and using business intelligence as a tool or artifact to achieve process-level integrative capabilities (Table 1 summarizes construct definitions, which we detail in the following sections). Based on these theoretical arguments, we propose a research model (see Figure 1) to highlight how the four BI&A capabilities influence organizational performance. We adopt a hierarchical and integrated view of B&A capabilities because BI&A comprises both technological and organizational components and, thus, organizations need to develop, coordinate, and integrate BI&A capabilities at different levels such that they provide business-wide solutions and generate value for stakeholders (Winter, 2003). This integrated perspective can enhance the degree to which scholars and practitioners understand the impact that BI&A has on an organization's performance and, thus, help organizations evaluate and identify BI&A capabilities.

**Table 1. Construct Definitions**

| Construct | Definition |
|---|---|
| BI&A technology | The degree to which an organization implements BI&A technology |
| BI&A culture | The norms by which an organization uses BI&A for decision making |
| BI&A governance | The degree to which an organization defines BI&A-related rules, policies, procedures, processes, and report patterns |
| BI&A customer orientation | The way an organization orients BI&A to meets its customer needs and serve them |
| BI&A customer application | The way an organization uses BI&A to absorb customer-related intelligence |
| BI&A B2B orientation | The way an organization orients BI&A to address supply chain-related needs |
| BI&A B2B engagement | The way an organization uses BI&A to engage new B2B partners and improve coordination with existing B2B partners |
| BI&A B2B compatibility | The degree to which BI&A has contributed towards process coordination and operational capability improvement through increased compatibility |
| BI&A acquisition | The degree to which an organization uses BI&A to procure and share intelligence |
| BI&A conversion | The degree to which an organization uses BI&A to make the intelligence gathered useful |
| BI&A effectiveness | The degree to which BI&A has contributed to making an organization effective in different dimensions to meet market/innovation/coordination volatile demands |
| Organizational performance | The degree to which organizational performance has improved |
| BI&A innovation infrastructure capability | The ability to mobilize and deploy BI functionalities to support innovation in an organization through infrastructure, culture and technological improvements |
| BI&A customer process capability | The capability that enables BI&A to accommodate customer-centric activities |
| BI&A B2B process capability | BI&A's ability to penetrate an organization's business processes |
| BI&A integration capability | The ability to mobilize and deploy BI functionalities to acquire and integrate business intelligence in an organization's systems |

## 2    Prior Literature

BI&A's effectiveness lies in its ability to support decision making in an organization and provide decision makers with timely and relevant information (Massa & Testa, 2005; Ramakrishnan et al., 2012). Organizations develop BI&A capabilities to deal with the data that internal and external sources produce and leverage it to improve performance (Işık, Jones, & Sidorova, 2013). Prior work on BI&A has examined the relationship between BI&A, competitive advantage, and performance. For example, Peters, Wieder, Sutton, and Wakefield (2016) suggested that BI improves management control systems and, thereby, augments performance measurement capabilities, which, in turn, provides a firm with a competitive advantage.

Similarly, studies have indicated that BI&A helps organizations by improving their supply chain performance (Trkman, McCormack, De Oliveira, & Ladeira, 2010). Further, BI&A provides value to an organization via the organization's creating and using a BI platform and BI tools and end users' using such tools. Organizations typically implement BI&A to help them analyze data and support decision making. Accordingly, BI&A can effectively help an organization improve its performance. However, exploring how different BI&A capabilities may help an organization increase its performance remains a gap in the literature that we address in this study.

We draw on prior work on IT capabilities and BI&A capabilities to propose that BI&A capabilities help an organization integrate, build, and reconfigure its internal and external competencies to address rapidly changing environments. IT capability helps organizations gain a competitive advantage through applying a combination of non-substitutable, scarce, difficult-to-imitate, and economically valuable resources (Barney, 1991)). Building on the resource-based view (RBV) (Barney, 1991), Bharadwaj (2000) defined IT capability as a firms' "ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities" (p. 171). Early studies on IT capabilities viewed IT capabilities in single dimension in terms of either technological capabilities (Sabherwal & Kirs, 1994) or managerial capabilities (Sambamurthy & Zmud, 1997); however, studies on IT capabilities have since evolved to comprise three dimensions: technological, human, and organizational (Kim, Shin, Kim, & Lee, 2011). The technological dimension refers to the configuration and structure of all the technological elements in a firm such as hardware, software, networking and telecommunications, and different applications. The human dimension refers to the knowledge and skills of IT workers who manage and leverage IT to achieve a competitive advantage for an organization. Finally, the organizational dimension refers to the organizational resources and the IT/business partnership that can provide a competitive advantage (Bhatt & Grover, 2005).

Recent work in this research stream has demonstrated that firms vary widely in developing unique IT-based resources and capabilities. However, this work widely acknowledges that an organization needs more than IT infrastructure to succeed. Though IT infrastructure constitutes a foundation and precursor for an organization to create value, prior studies indicate that IT capabilities have an impact when they leverage an organization's underlying IT resources, data assets, skills, and knowledge (Kathuria et al., 2018a).

Along a similar line, prior work on BI&A capabilities has focused on BI&A's technical and organizational aspects. For example, Sukumaran and Sureka (2006) examined BI&A capability as BI&A's ability to manage quantitative and qualitative data. Similarly, researchers have viewed BI&A capability as a tool that organizations can use to manage their internal and external data (Işık et al., 2013). In the same way, Tremblay, Fuller, Berndt, and Studnicki (2007) noted that BI&A tools' capabilities, such as online analytical processing, helps individuals to bettter perform their data-manipulation tasks. From an organizational perspective, researchers have examined BI&A capability as BI&A's ability to provide support for decision making under uncertain conditions (Gebauer & Schober, 2006; Işık et al., 2013). However, one can justify BI&A more as a capability than as an operational capability. Following prior work and the RBV perspective, we conceptualize that BI&A capability overall constitutes a hierarchy of different operational capabilities and also provides a second layer or integrative capability in an organization. Thus, an organization can demonstrate BI&A capability through three types of capabilities: 1) capabilities that integrate BI&A in the organization, 2) capabilities that align BI&A towards innovation, and 3) capabilities that use BI&A to improve customer-centric and business partner-centric processes.

## 3    Theoretical Model and Hypothesis

Our theoretical model draws on two interrelated concepts that build on each other. The capability hierarchy perspective suggests that firms possess a hierarchy of capabilities. Lower-order capabilities refer to competencies that provide basic functional capabilities. Higher-order capabilities extend lower-order capabilities and form the basis for higher firm performance (Winter, 2003). The operand operant resource perspective also suggests that firms possess a hierarchy of resources. Operand resources are physical in nature, whereas operant resources are intangible and invisible, such as knowledge, and act on the operand resources and leverage them to create value. Operant resources form a hierarchy that comprises basic, composite, and interconnected operand resources (Madhavaram & Hunt, 2008). These two theoretical perspectives complement and concur with each other; hence, we use them as the theoretical edifice of our research model.

We fundamentally argue that BI&A comprises four key components: 1) BI&A innovation infrastructure capability (which speaks to BI&A capability's technical aspect, 2) BI&A customer process capability and 3) BI&A B2B process capability (which speak to BI&A capability's techno-organizational aspect), and 4) BI&A integration capability (which speaks to BI&A capability's organizational aspect). We conceptualize these four components as higher-order capabilities that comprise lower-order capabilities. We conceptualize the lower-order capabilities as the first level of BI&A resources and, hence, as basic operant resources. Hence, we conceptualize the higher-order capabilities as the second level of BI&A resources and, hence, as composite or interconnected operant resources. These four higher-order capabilities lead to firm performance via improved BI&A effectiveness. Note that similar to much prior literature, we build on the RBV. The four BI&A capabilities are rare, non-imitable, immobile, and valuable operational processes and stable resource configurations. Thus, our conceptualization differs from other recent work that proposes the dynamic capabilities perspective to explain the role of BI&A in improving organizational performance (Torres, Sidorova, & Jones, 2018; Wamba et al., 2017).
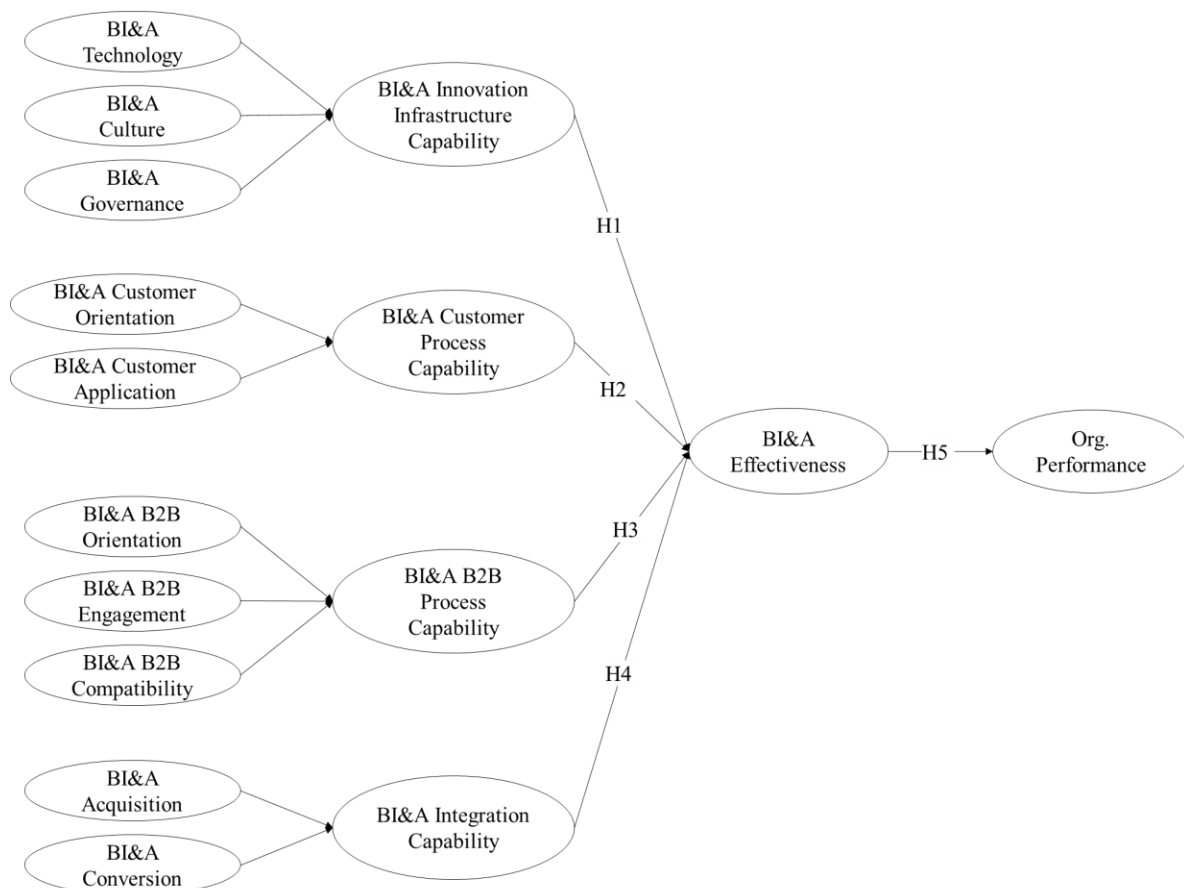


**Figure 1. Proposed Research Model**

## 3.1 BI&A Innovation Infrastructure Capability, Effectiveness, and Organizational Performance

We describe BI&A innovation infrastructure capability as an organization's ability to marshal and use BI&A's functionalities to sustain innovation. Organizations can sustain innovations either through technological, cultural, and infrastructure improvements. For example, organizations need the proper infrastructure and the right data-collection strategy for BI&A to support BI&A technology.

Further, organizations require appropriate organizational governance that can facilitate sharing and collaboration to leverage BI&A technology. Culture also plays a vital role in helping employees in an organization share and leverage information that BI&A generates. Thus, BI&A innovation infrastructure capability plays a crucial role in supporting decision making in any organization.

We conceptualize BI&A innovation infrastructure capability as a second-order capability that comprises technological, governance, and cultural elements (see Figure 2) and, thus, as a composite operant resource (Madhavaram & Hunt, 2008). First, BI&A technology capability refers to an organization's technological readiness to adopt BI&A. The technology element includes business intelligence, collaboration, distributed learning, discovery, mapping, opportunity recognition, generation and aspects related to data/analytics security and privacy. The governance element of BI&A innovation infrastructure refers to two further granular elements: modular organizational design and technological architecture. Thus, in general, design elements and architecture relate to the functions and innovations relevant to BI&A. BI&A cultural capability facilitates a firm's ability to manage data, knowledge, and intelligence. It espouses interaction between individuals and groups as a basis for creating new ideas and innovation. Since the three capabilities that constitute BI&A innovation infrastructure capability result from individual employees' applying their skills and knowledge to BI&A (an operant resource), they constitute basic operant resources (Madhavaram & Hunt, 2008).

Technological, governance, and cultural elements associated with BI&A innovation infrastructure capability provide abilities to firms that that help them manage data, knowledge, and intelligence through embedded routines and processes. Organizations deal with a large amount of structured and unstructured data (Delen & Demirkan, 2013). Technology plays an important role in the structural elements that firms need to capture, store, and analyze this data. A firm can link various communication systems and information systems to integrate a previously fragmented flow of data and information. These linkages can eradicate hurdles to communication between different business units and enable collaboration among them.

Further, BI&A technology capability can endow firms with the ability to create information and knowledge regarding their external fiscal environment and their competition (Gold, Malhotra, & Segars, 2001). Effectively using BI&A technology capability can help firms deal with competitive and institutional pressures that they face in an industry (Ramakrishnan et al., 2012). Further, properly using such technology can create new possibilities for firms to achieve innovation in improved processes, product delivery, or services.

While BI&A technology capability provides the foundation, BI&A governance capability establishes an organizational framework and readiness to accommodate and leverage it. Structure and governance refer to the distribution of tasks, coordination, the flow of information, and decision-making rights in an organization (Ang & Inkpen, 2008). Further, a rigid structure and governance may unintentionally inhibit an organization's business units from sharing information and knowledge (Gold et al., 2001) rather than enable communication and collaboration. Therefore, to leverage BI&A technology, a firm needs to have BI&A governance capability in place that encourages staff to share and exchange information and intelligence. Firms need to promote collective intelligence rather than individualistic acumen. They need to help internal business units share and transfer intelligence. Such firms will have a good position to use BI&A effectively for anticipating market opportunities and responding to market demands. They will also be able to adapt to volatile market changes and identify new business opportunities.

Finally, BI&A culture capability espouses interactions between individuals and groups as a basis for creating new ideas and innovation. Thus, a more interactive and collaborative culture is a precursor for converting the data or fact-based tacit information into more explicit intelligence and moving it from an individual to an organizational level. Employees in such a culture can develop an ability to self-organize their knowledge and practices to facilitate solutions to new or existing problems. Such a BI&A culture will

influence BI&A effectiveness by empowering employees to become responsive to market demands and deal with unpredictable industry/market changes.

We propose that BI&A innovation infrastructure capability represents a formative second-order capability for three reasons. First, BI&A technology capability, BI&A governance capability, and BI&A culture capability constitute and uniquely contribute to BI&A innovation infrastructure capability. Second, an increase in one does not result in an increase in the others. Third, the three capabilities are distinct and complementary. Thus, BI&A technology capability, BI&A governance capability, and BI&A culture capability represent BI&A innovation infrastructure capability's underlying first-order formative capabilities. To establish the value proposition of BI&A innovation infrastructure capability, we suggest that a firm can foster innovation using its technological, governance, and cultural elements. The technological element determines how data and information travel throughout the organization and how senior to middle managers capture and share the intelligence regarding product and process. Thus, senior to middle managers can use BI&A tools to retrieve and act on intelligence about products and processes in the organization and, thus, enhance how effectively senior to middle managers use BI&A. The governance element allows different business units to seamlessly exchange data and information and, thus, improve BI&A's effectiveness. Further, having a culture that facilitates interaction between individuals and groups to exchange information and intelligence that BI&A captures to come up with new innovative ideas can help firms better identify new business opportunities, adapt to volatile markets, and become responsive to market demands. Therefore, we hypothesize:

**H1:** BI&A innovation infrastructure capability has a positive influence on BI&A effectiveness.

### 3.2 BI&A Customer Process Capability, Effectiveness, and Organizational Performance

BI&A customer process capability refers to the capability that enables BI&A to improve customer-centric activities such as helping employees solve customer issues, improve customer retention, and also take advantage of the knowledge acquired from customers to compete in the market. For a firm to do well in a competitive business environment, it needs use BI&A to understand and communicate with customers (Watson, 2010), which involves understanding customers' needs and serving them, improving customer satisfaction, and, thereby, improving customer loyalty. Customers play an important role in creating value for any organization (Agarwal & Selen, 2009). Harrah's entertainment exemplifies a firm that has used BI&A to create a loyal customer base and become the leader in the gaming industry. In particular, the company used BI&A to gather data from various touchpoints and integrate them and, based on that, create promotional offerings to their loyal customers (Watson, 2009). In effect, the company captured consumer-oriented information and used it to develop a plan to improve customer loyalty. Thus, BI&A customer process capability involves the ability to absorb customer-oriented information/intelligence and convert it into an actionable plan.

Therefore, we conceptualize BI&A customer process capability as comprising two dimensions and, thereby, as a composite operant resource (Madhavaram & Hunt, 2008). The first dimension reflects the process to absorb customer-oriented information/intelligence using BI&A (BI&A customer application capability) and the second dimension uses this intelligence/information to meet customers' needs and improve customer loyalty (BI&A customer orientation capability) (see Figure 2). BI&A customer application capability involves using BI&A to analyze intelligence gained from customer-handling experiences. Further, this capability also helps organizations learn from customer-handling mistakes. Firms can leverage this BI&A capability to understand customers' psyche. They can gain insight into customers' needs and their purchasing behavior and, thereby, identify new business opportunities. They can also use this capability to improve their BI&A effectiveness in anticipating market opportunities and become more responsive to market demands. BI&A customer orientation capability, on the other hand, helps organizations to use the intelligence gained from handling customers to improve customer loyalty and customer satisfaction. This capability helps an organization collect and distribute customer intelligence so that it can take effective action to meet customers' needs (Allred, Fawcett, Wallin, & Magnan, 2011). Firms can use BI&A customer orientation capability to gather customer intelligence and identify and provide innovative services based on customers' needs. Firms can effectively use BI&A to identify loyal customers and provide them with promotional offers. Further, by leveraging BI&A customer orientation capability, organizations can take advantage of the knowledge they acquire from customers and use BI&A effectively to help solve problems associated with new customers. Since BI&A customer application capability and BI&A customer orientation capability result from individual employees' applying their skills and knowledge

to BI&A (an operant resource), we conceptualize them as basic operant resources (Madhavaram & Hunt, 2008).

We propose that BI&A customer process capability represents a formative second-order capability for three reasons. First, BI&A customer application capability and BI&A customer orientation capability constitute and uniquely contribute to BI&A customer process capability. Second, an increase in one does not necessarily lead to increase the other. Third, the two capabilities are distinct and complementary. Thus, BI&A customer application capability and BI&A customer orientation capability represent BI&A customer process capability's first-order formative capabilities. By tapping into these BI&A capabilities, an organization may more effectively respond to market demands and innovatively meet business and customer demands. Therefore, we hypothesize:

**H2:** BI&A customer process capability has a positive influence on BI&A effectiveness.

### 3.3 BI&A B2B Process Capability, Effectiveness, and Organizational Performance

BI&A B2B process capability refers to the extent to which BI&A has penetrated a firm's business processes. This capability includes BI&A functionalities that can sustain B2B-centric activities. Business processes in a firm help orient its activities to create value. Prior research indicates that IT creates value for an organization by its direct impact on the business process (Elbashir, Collier, & Davern, 2008; Ray, Muhanna, & Barney, 2005). We logically extend such findings by arguing that BI&A's effectiveness lies in its ability to create value by influencing the business process in organizations.

A process generally has many activities that various individuals across an organization perform. A simple process may target only a small functional unit in an organization. On the other hand, an end-to-end process can span different departments and different business partners. BI&A should be able to influence a process at all levels. Further, to create value, a business process needs to include activities that can convert raw materials to finished goods/products or services (operations). To carry out operations, a firm should have a good relationship with other firms that could be its manufacturer, suppliers, retailers, or partners. Thus, for a firm to create value, it should have a process in place that can seamlessly integrate data and information that its different partners generate and help the decision makers to make decisions. We argue that, to use BI&A effectively, a firm needs to leverage three different sets of capabilities that can influence the B2B process and enhance its effectiveness: 1) BI&A B2B orientation capability, 2) BI&A B2B engagement capability, and 3) BI&A B2B compatibility capability (see Figure 2). These capabilities result from individual employees' applying their skills and knowledge to BI&A and, hence, we conceptualize them as basic operant resources (Madhavaram & Hunt, 2008).

First, we define BI&A B2B orientation capability as the way a firm orients BI&A to meet needs related to the supply chain. For example, firms can use BI&A to improve data visibility in the supply chain to reduce inventory. Similarly, a firm can use BI&A to resolve supply chain-integration issues by identifying specific problem areas or to meet supply chain partners' needs through various analyses, such as production variability analyses to determine where to take remedial action and transport analyses to reduce costs and improve transport providers' efficiency. Furthermore, a firm can use the results from such analyses to anticipate market opportunities and to identify new business opportunities. Results from such analyses will further help firms to respond quickly to fluctuating market demands and, thereby, improve BI&A effectiveness.

Second, we define BI&A B2B engagement capability as using BI&A to engage new B2B partners and improve coordination with existing B2B partners. Firms can use BI&A to streamline B2B engagement and enhance approachability with their business partners. Enterprise data continuously changes, particularly when firms sign up new partnership deals. In such situations, firms can use BI&A to provide a single consistent version of business information (Ramakrishnan et al., 2012). Having a single consistent view of business information facilitates different stakeholders to collaborate and develop new applications and, thus, saves them time (Watson et al., 2004). Further, it enables different business partners to efficiently communicate as they have access to the same information (Massa & Testa, 2005). Successful B2B engagements rely on knowledge sharing, frequent interactions, and joint development of solutions. Thus, through BI&A B2B engagement capability, BI&A B2B process capability can improve BI&A effectiveness by helping B2B partners share knowledge, communicate, and collaborate.

Third, we define BI&A B2B compatibility capability as the extent to which BI&A improves process coordination and operational capability. Thus, organizations can use BI&A to optimize their process and, thereby, increase their efficiency and make the B2B process compatible with different channels and

stakeholders. For example, firms can use BI&A to analyze data for balancing supply chain resources with supply chain requirements and, thereby, improve supply chain consolidation and optimization. Further, organizations can use BI&A to make informed decisions about what and how many items to order. At the operational level, firms can use BI&A for stock location planning, inventory planning, transport management, purchasing/vendor analysis, and distribution and logistics. Therefore, by leveraging BI&A B2B compatibility, firms can improve BI&A effectiveness by making operations more efficient and improve coordination between different stakeholders at the operational level.

We propose that BI&A B2B process capability represents a formative second-order capability and a composite operant resource for two reasons. First, BI&A B2B orientation capability, BI&A B2B engagement capability, and BI&A B2B compatibility capability constitute and uniquely contribute to BI&A B2B process capability. Second, the three capabilities are distinct and complementary. Thus, BI&A B2B orientation capability, BI&A B2B engagement capability, and BI&A B2B compatibility capability represent BI&A B2B process capability's first-order formative constructs. Consequently, BI&A B2B process capability comprises BI&A applications related to integrating the supply chain, engaging new partners and improving coordination with existing partners, and using BI&A for process coordination and operational improvements. Furthermore, BI&A B2B process capability aids an organization's activities with its B2B partners due to insights it gains through greater insight into goods and information, business-level integration, and process-level coordination across channels. Together, BI&A B2B process capability provides firms with the capacity to derive analytical insights in its business processes, identify new business opportunities, and adapt to volatile industry/market changes. Therefore, we hypothesize:

**H3:**   BI&A B2B process capability has a positive influence on BI&A effectiveness.

## 3.4   BI&A Integration Capability, Effectiveness and Organizational Performance

Although firms need to leverage their BI&A process capabilities by incorporating B2B and customer-centric capabilities, they also need to acquire new intelligence, integrate it with existing intelligence, and use the intelligence (Işık et al., 2013; Ramakrishnan et al., 2012). Prior studies have identified many such aspects of integration capabilities such as capturing, assembling, exploiting, creating, transferring, and using intelligence (Gold et al., 2001). We can group these different aspects into two major categories: 1) acquiring intelligence and 2) converting it into a useful form.

Acquisition-oriented BI&A capabilities allow an organization to procure and share intelligence. Researchers have used different terms such as acquire, capture, create, collaborate, generate, and seek to describe this capability. However, these terms all share the generic theme of acquiring intelligence, which requires individual employees to apply their skills and knowledge and, thus, represents a basic operant resource. To acquire new intelligence, an organization needs a process in place to understand its current business and generate new intelligence from existing data and information (Inkpen & Dinur, 1998). An organization can also acquire intelligence through collaboration. Collaboration occurs between the individuals in an organization and between the organization and its business partners. Through such collaborations, organizations can share and disseminate intelligence regarding best practices and knowledge about new products, services, and innovation.

However, an organization needs to appropriately use intelligence rather than simply acquiring it to gain a competitive advantage. BI&A conversion capability allows an organization to make existing intelligence useful. Such capability can help an organization convert intelligence into a plan of action for new product design or service offerings. Again, note that this capability results from individuals' applying their skills and knowledge to BI&A (an operant resource) in a business context and, thus, represents a basic operant resource (Madhavaram & Hunt, 2008). Integrating this intelligence into a standard organizational framework will help organizations reduce redundancy and, thereby, improving efficiency (Davenport & Harris, 2007). Such a framework also enables organizations to replace outdated intelligence, combine different individuals' intelligence, and maximize efficiency. Thus, organizations should be able to integrate intelligence from different systems and individuals.

We propose that BI&A integration capability represents a formative second-order capability (and composite operant resource) for three reasons. First, BI&A acquisition capability and BI&A conversion capability constitute and uniquely contribute to BI&A integration capability. Second, an increase in one does not necessarily lead to increase the other. Third, they are distinct and complementary. Thus, BI&A integration capability comprises acquisition-oriented capabilities and conversion-oriented capabilities that make BI&A more effective. For example, customer-centric activities require that organizations acquire

business intelligence regarding customer behavior and experience, which, in turn, provides insights regarding business goals and requirements. Second, an organization can leverage BI&A to adequately respond to market and environmental changes by gathering and aggregating data from different types of sources across it. For example, aggregating healthcare data helps healthcare providers avoid uncertainty or volatile conditions and take appropriate decisions at the right time (Tremblay et al., 2007; Tremblay, Hevner, & Berndt, 2012). Hence, BI&A can provide insights regarding the nature of the change to which the organization needs to adapt and the internal changes it needs to make to do so. Third, aggregating, cleansing, and transforming this data can make it substantive and insightful, which can make subsequent decisions faster and more effective. Thus, via BI&A's integration capability, which can provide decision makers with timely and usable information, an organization can more effectively identify new business opportunities, respond quickly to new market demands, and increase its sales. Therefore, we hypothesize:

**H4:** BI&A integration capability has a positive influence on BI&A effectiveness.

## 3.5 BI&A Effectiveness to Organizational Performance

BI&A effectiveness refers to how effectively an organization uses BI&A to meet changes in market demands and environmental volatility. We lack any clear or well-defined notions about what it means to make an organization effective or how one can measure it (Gold et al., 2001). However, like any other organizational resource, BI&A should contribute to improving organizational performance. Therefore, we examined the literature on BI&A to ascertain its key contributions. Such contributions may include the ability to anticipate market changes and identify new business opportunities (Torres et al., 2018).

Similarly, BI&A may also provide organizations with the ability to become responsive to market demands and be able to adapt to volatile industry/market fluctuations. For example, Harrah's entertainment used BI&A to take advantage of the change in the gaming laws in the early 1990s and become a leader in its industry sector (Watson, 2009). Further, effectively using BI&A to identify new business opportunities or being able to adapt to volatile industry/market changes may also improve an organization's bottom line. For example, using BI&A to become responsive to market demands may result in increased sales. Further, identifying new business opportunities and capitalizing on them may improve an organization's financial performance such as its return on equity. Thus, in general, effective BI&A use may have a positive impact on organizational performance. Therefore, we hypothesize:

**H5:** BI&A effectiveness has a positive influence on organizational performance.

# 4 Methodology

In this study, we used primary data from India. To collect it, we followed a multi-step protocol for collecting data via surveys that previous work has developed (Kathuria et al., 2018a; Kathuria & Konsynski, 2012; Kathuria, Porth, Kathuria, & Kohli, 2010). We used the partial least square technique (PLS), a second-generation structural equation technique, to validate the measurement model and analyze our data. For robustness, we also estimated our models using ordinary least squares regression.

## 4.1 Operationalization of Constructs

First, to operationalize the constructs, we reviewed existing literature and developed an initial data-collection instrument using items from prior studies that we adapted to our context. We cross-validated these initial instrument items through a pre-test with seven scholars and industry respondents (senior managers in IT, marketing, and operations functions involved in implementing and using BI&A). We interviewed them about how they interpreted the items and solicited their thoughts on the survey items' content validity, appearance, terminology, clarity of instructions, organization and response format. We made adjustments to the questionnaire based on their comments. We further revised the items based on a pilot test with a small sample from the targeted population. We provide the final survey instrument in Table A2 in the Appendix. We measured all items on a seven-point Likert scale.

## 4.2 Development of Sample Frame

Second, we developed our sample frame by collating multiple industries, city, and state directories from the largest state (by gross domestic product) in India from which we obtained an initial list of approximately 1,500 firms. We pruned this list by removing organizations that had not filed public records

with India's Ministry of Corporate Affairs, had fewer than 50 employees, or had fewer than three directors based on the rationale that such organizations would not likely constitute mature IT organizations with BI&A implementations. This process resulted in a sample of 790 firms.

## 4.3    Data-collection Procedure

Third, we administered the questionnaire both online and in person to one respondent from each firm (the highest-ranking IT executive in the firm with designations such as chief information officer, chief technology officer, IT director, and IT manager) in our sample. Participants participated voluntarily and anonymously. We offered an executive summary of the findings and a small souvenir to incentivize participation. We collected usable data from 154 respondents using BI&A in their organizations across various industries (for a 19.5% response rate). We compared the means for firm age and BI&A effectiveness between early and late respondents, online and in-person respondents, and responders and non-responders. We did not find any statistically significant difference, which suggests our data lacked bias.

Further, 21 percent of respondents had responsibility over managing BI&A in their organizations, and around eight percent participated in evaluating and purchasing new BI&A tools. Further, more than 31 percent evaluated themselves as advanced BI&A users and around 30 percent as intermediate BI&A users. More than 38 percent used BI&A in the manufacturing sector, whereas around seven percent used it in the service industry. Around seven percent classified themselves as having a technical orientation towards BI&A, whereas more than 50 percent classified themselves as having a business orientation towards BI&A.

## 4.4    Analysis Technique

We chose PLS as our primary analysis technique as it allows one to estimate a series of interrelated dependence relationships simultaneously. Further, PLS better handles multi-level formative constructs compared to covariance-based SEM (Lowry & Gaskin, 2014), and our model contains multi-level formative constructs. PLS can also handle smaller sample sizes. We used SmartPLS 3.0 to conduct the analysis. Note that one should not automatically use PLS as a solution for small samples. Researchers commonly use the following heuristic to derive the sample size for PLS: "multiply 10 times the scale with the largest number of formative (such as causal) indicators or to multiply 10 times the largest number of structural paths directed at a particular construct in the structural model" (Lowry & Gaskin, 2014, p. 132). Our model has 11 formative constructs and no more than five independent constructs that influence a single dependent construct, which implies a minimum sample size of 110. Therefore, since we had sample size of 154, PLS suited our study.

## 4.5    Assessment of Measurement Model

The measurement model describes the relationship between the measured variables and their latent constructs. We addressed how well the measured variables relate to their latent constructs by assessing the measures' validity and reliability.

### 4.5.1    Assessment of Reflective Constructs

We assessed convergent validity for the reflective constructs by examining the average variance extracted (AVE). The AVE indicates the amount of variance that measurement items for a construct explain relative to the amount of variance due to measurement error. For a latent construct to exhibit adequate convergent validity, all factor loadings should exceed 0.7, and it should have an AVE score greater than 0.5. All the items of our constructs loaded on their respective constructs with a score higher than 0.7 (see Table 2 for variable correlations), and the AVE scores for all our latent reflective constructs exceeded 0.5. Thus, all constructs exhibited adequate convergent validity.

We assessed discriminant validity by observing the relationship between the correlation among the latent constructs and the square root of the AVEs for those constructs. If the square root of the AVEs exceeds the correlation among the latent constructs, then the indicators exhibit adequate discriminant validity. After dropping one item from the acquisition construct, the correlation among the constructs was lower than the square root of the AVEs (see Table 2), which suggests satisfactory discriminant validity for all our reflective constructs. Although the correlations among the first-order constructs seem a little high, they were still less than the prescribed cut-off of 0.9 (Fornell & Bookstein, 1982; Fornell & Larcker, 1981). To

assess our results' robustness, we re-ran the model after orthogonalizing the variables following the Gram-Schmidt procedure (Kathuria et al., 2018a; Sine, Mitsuhashi, & Kirsch, 2006). Since the results remained largely similar, we omitted them for brevity. We show the correlations between the second-order constructs in Table 3.

We evaluated our constructs' reliability by examining the composite reliability score and the Cronbach's alpha. For the constructs to exhibit adequate reliability, both these scores should exceed 0.7 (Nunnally, 1978). All the constructs exhibited adequate reliability (see Table 2).

**Table 2. Descriptive Statistics and Correlations among First-order Constructs**

| ID | Construct | # of items | Mean | SD | α | Rel. | AVE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BI&A technology | 3 | 4.67 | 1.45 | 0.91 | 0.95 | 0.85 | 1.00 | | | | | | | | | | | |
| 2 | BI&A culture | 5 | 4.76 | 1.63 | 0.95 | 0.96 | 0.84 | 0.56 | 1.00 | | | | | | | | | | |
| 3 | BI&A governance | 4 | 4.64 | 1.74 | 0.95 | 0.96 | 0.87 | 0.52 | 0.61 | 1.00 | | | | | | | | | |
| 4 | BI&A customer orientation | 3 | 4.61 | 1.79 | 0.96 | 0.98 | 0.93 | 0.55 | 0.57 | 0.63 | 1.00 | | | | | | | | |
| 5 | BI&A customer application | 3 | 4.34 | 1.83 | 0.96 | 0.97 | 0.92 | 0.53 | 0.68 | 0.68 | 0.65 | 1.00 | | | | | | | |
| 6 | BI&A B2B orientation | 4 | 4.47 | 1.89 | 0.97 | 0.98 | 0.91 | 0.51 | 0.66 | 0.54 | 0.54 | 0.62 | 1.00 | | | | | | |
| 7 | BI&A B2B engagement | 3 | 4.44 | 1.85 | 0.96 | 0.97 | 0.93 | 0.53 | 0.62 | 0.70 | 0.73 | 0.72 | 0.57 | 1.00 | | | | | |
| 8 | BI&A B2B compatibility | 3 | 4.52 | 1.91 | 0.96 | 0.98 | 0.93 | 0.58 | 0.65 | 0.65 | 0.70 | 0.73 | 0.54 | 0.73 | 1.00 | | | | |
| 9 | BI&A acquisition | 2 | 4.22 | 1.63 | 0.9 | 0.95 | 0.91 | 0.63 | 0.54 | 0.53 | 0.62 | 0.58 | 0.64 | 0.53 | 0.51 | 1.00 | | | |
| 10 | BI&A conversion | 3 | 4.27 | 1.79 | 0.95 | 0.97 | 0.91 | 0.54 | 0.69 | 0.63 | 0.62 | 0.71 | 0.76 | 0.64 | 0.63 | 0.68 | 1.00 | | |
| 11 | BI&A effectiveness | 4 | 4.98 | 1.74 | 0.96 | 0.97 | 0.88 | 0.49 | 0.61 | 0.64 | 0.67 | 0.68 | 0.52 | 0.74 | 0.75 | 0.45 | 0.59 | 1.00 | |
| 12 | Org. performance | 3 | 4.51 | 1.96 | 0.96 | 0.97 | 0.93 | 0.55 | 0.61 | 0.63 | 0.65 | 0.65 | 0.58 | 0.68 | 0.72 | 0.55 | 0.66 | 0.67 | 1.00 |

Rel: reliability.
We report Kendall rank correlations due to the ordinal nature of the variables.

**Table 3. Correlations among Second-order/Latent Constructs**

| ID | Construct | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1 | BI&A innovation infrastructure capability | 1.00 | | | | | |
| 2 | Customer centric process capability | 0.74 | 1.00 | | | | |
| 3 | B2B centric process capability | 0.75 | 0.79 | 1.00 | | | |
| 4 | BI&A integration capability | 0.66 | 0.68 | 0.75 | 1.00 | | |
| 5 | BI&A effectiveness | 0.66 | 0.76 | 0.68 | 0.55 | 1.00 | |
| 6 | Organizational performance | 0.69 | 0.70 | 0.72 | 0.63 | 0.67 | 1.00 |

### 4.5.2   Assessment of Formative Constructs

In addition to the above tests, we assessed the second-order formative constructs' construct validity (see Figure 2). The reliability of BI&A innovation infrastructure capability was 0.97, while the reliability of BI&A technology capability, BI&A governance capability, and BI&A culture capability was 0.95, 0.96, and 0.96, respectively. We found statistically significant path coefficients between the first-order dimensions BI&A

technology capability (β = 0.250, p < 0.01), BI&A governance capability (β = 0.357, p < 0.01), BI&A culture capability (β = 0.454, p < 0.01), and BI&A innovation infrastructure capability. The reliability of BI&A customer process capability was 0.97, and the reliability of BI&A customer orientation capability and BI&A customer application capability was 0.98 and 0.97, respectively. We found statistically significant path coefficients between BI&A customer orientation capability (β = 0.517, p < 0.01), BI&A customer application capability (β = 0.528, p < 0.01), and BI&A customer process capability. The reliability of BI&A B2B process capability was 0.98, while the reliability of BI&A B2B orientation capability, BI&A B2B engagement capability, and BI&A B2B compatibility capability was 0.98, 0.97, and 0.98, respectively. We found statistically significant path coefficients between BI&A B2B orientation capability (β = 0.389, p < 0.01), BI&A engagement capability (β = 0.322, p < 0.01), BI&A compatibility capability (β = 0.328, p < 0.01) and BI&A B2B process capability. Finally, the reliability of BI&A integration capability was 0.97, while the reliability of BI&A acquisition capability and BI&A conversion capability was 0.95, and 0.97, respectively. We found statistically significant paths between the first-order dimensions BI&A acquisition capability (β = 0.389, p < 0.01), BI&A conversion capability (β = 0.633, p < 0.01), and BI&A integration capability.
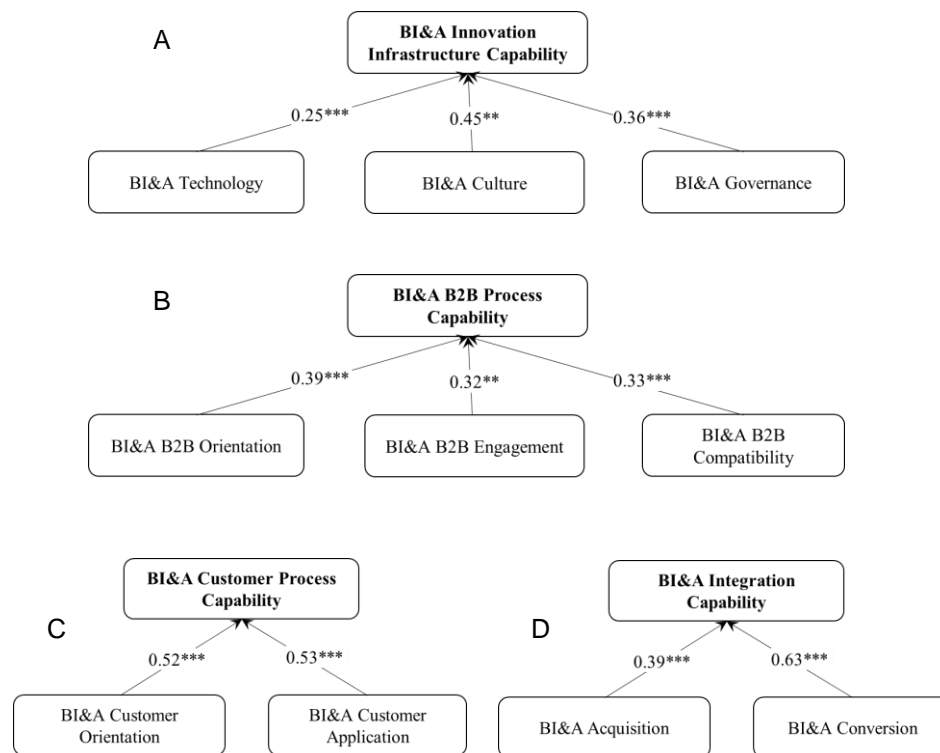


Note: 1) * p < 0.10, ** p < 0.05, *** p < 0.01; 2) N = 154 matched-pair responses

**Figure 2. Second-order Formative Constructs and Loadings**

We formed all four second-order constructs by calculating the weights of the first-order constructs to the second-order construct, and all weights were significant at p < 0.01 (Kathuria et al., 2018a; Pavlou & El Sawy, 2006). Further, correlations among first-order constructs were significant but not overly high, which evidences a formative model's appropriateness. Moreover, an alteration in any of the first-order dimensions did not necessarily cause a change in the other dimensions; a reflective model, therefore, seemed unlikely. Thus, we found support for the proposed second-order formative constructs. Taken together, these tests suggest the measurement model's psychometric adequacy.

## 4.6    Assessment of Structural Model

A structural model evaluates the relationship between the theoretical constructs. We performed bootstrapping with a sample size of 500 to assess the structural model's statistical significance. We tested our hypotheses using a one-tailed t-test due to their unidirectional nature. Prior studies have indicated that implementing BI&A in an organization involves considerable cost. Thus, the revenue that an organization

generates will play a role in its BI&A implementation. Further, effectively using BI&A will depend on the experience and the BI&A user's BI&A orientation (technical or business side). Therefore, we controlled for revenue, BI&A experience, organization type, and BI&A orientation for both BI&A effectiveness and organizational performance.

### 4.6.1 Structural Model Test Results

Structural model tests results (see Table 4) indicate that BI&A innovation infrastructure capability, BI&A customer process capability, and BI&A B2B process capability had significant positive relationships with BI&A effectiveness (BI&A_IIC: $\beta = 0.30$, t-statistic = 2.17, $p < 0.01$; C_PC: $\beta = 0.74$, t-statistic = 3.67, $p < 0.01$; B2B_PC: $\beta = 0.30$, t-statistic = 1.64, $p < 0.05$), which supports H1, H2, and H3. Interestingly, although our results indicate that BI&A integration capability had a significant relationship with BI&A effectiveness, the sign of the path coefficient was negative. Thus, we found a relationship in the opposite direction to what we hypothesized (BI&A_IIC: $\beta = -0.42$, t-statistic = 3.66, $p < 0.01$). We discuss this finding in Section 5. Further, we found that BI&A effectiveness had a significant positive relationship with organizational performance (BI&A_effectiveness: $\beta = 0.86$, t-statistic = 30.02, $p < 0.01$), which supports H5. Overall, our model (see Figure 3) explained approximately 89 percent of the variance in BI&A effectiveness and 79 percent of the variance in organizational performance.

**Table 4. Results of Hypotheses Testing**

| | Hypothesis | β coeff | T stat. | P-value | Result |
|---|---|---|---|---|---|
| H1 | BI&A innovation infrastructure capability has a positive influence on BI&A effectiveness. | 0.299 | 2.17 | 0.01*** | Supported |
| H2 | BI&A customer process capability has a positive influence on BI&A effectiveness. | 0.736 | 3.67 | 0.00*** | Supported |
| H3 | BI&A B2B process capability has a positive influence on BI&A effectiveness. | 0.301 | 1.64 | 0.05** | Supported |
| H4 | BI&A integration capability has a positive influence on BI&A effectiveness. | -0.416 | 3.66 | 0.00*** | Supported (opposite sign) |
| H5 | BI&A effectiveness has a positive influence on organizational performance. | 0.861 | 3.02 | 0.00*** | Supported |
| Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01 | | | | | |
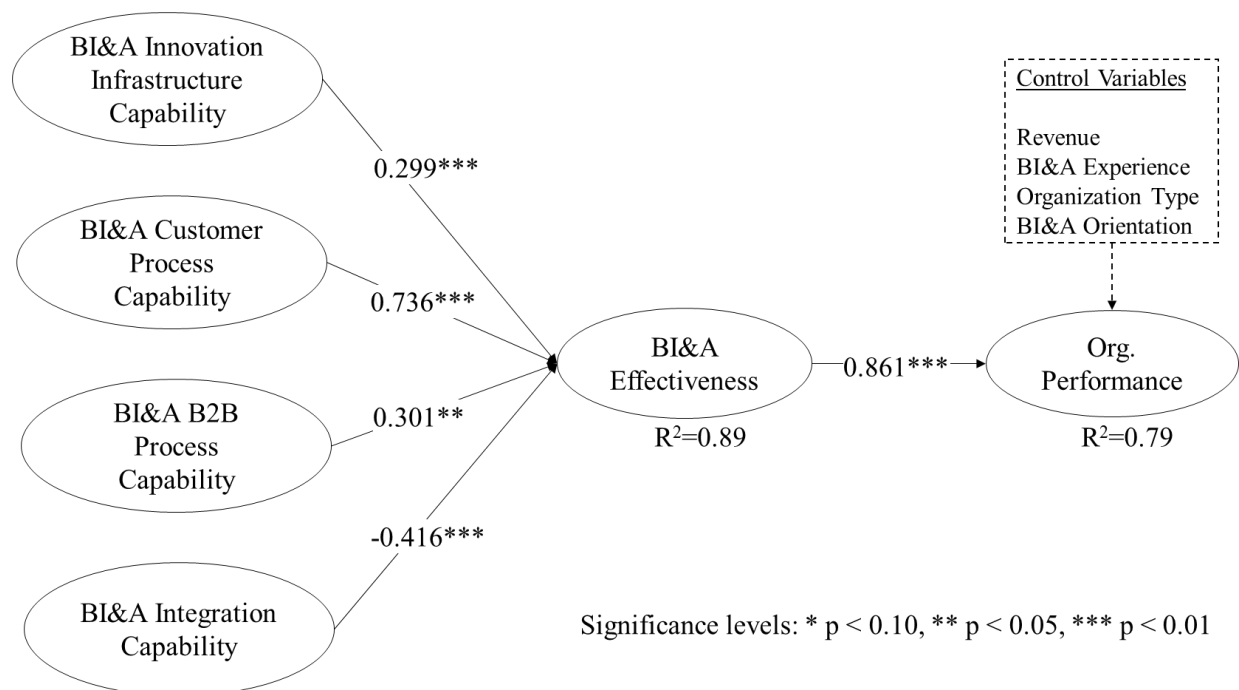


**Figure 3. PLS Estimation Results**

### 4.6.2 Robustness Tests

For robustness, we estimated ordinary least squares to test the hypotheses (see Table 5 for results). The table shows the effect that the four BI components had on BI&A effectiveness, the effect that BI&A effectiveness had on organizational performance, and the effect that the BI components and BI&A effectiveness had on organizational performance. These results largely resemble the results we obtained from the structural equation models.

Also, since our measure of organizational performance could have contained bias, we performed supplementary analyses. First, though many respondents we surveyed worked at private firms, we were able to collate an objective measure of organizational performance—return on assets—for a significant proportion of the sample. This measure was significantly positively correlated ($< 0.80$) with the self-reported measure of firm performance. We ran OLS estimations with return on assets and received qualitatively similar results. Second, in our survey questionnaire, we had asked respondents to indicate their firm's revenue. As a robustness test, we used this coarse measure to re-estimate our econometric specification and again received similar results. We do not report these results for brevity.

**Table 5. OLS Estimation Results**

|  | BI&A effectiveness | Org. performance |
|---|---|---|
| BI&A effectiveness |  | 0.88*** (0.04) |
| BI innovation infrastructure capability | 0.23** (0.10) |  |
| BI customer process capability | 0.71*** (0.13) |  |
| BI B2B process capability | 0.31** (0.15) |  |
| BI integration capability | -0.34*** (0.07) |  |
| BI orientation | 0.00 (0.03) | 0.06 (0.03) |
| Organization type | -0.03 (0.03) | 0.05 (0.04) |
| BI experience | -0.04 (0.03) | 0.003 (0.04) |
| Revenue | 0.06** (0.03) | -0.03 (0.04) |
| F-statistic | 151.05*** | 131.19*** |
| Adjusted R-square | 0.88 | 0.82 |
| Observations (N) | 154 | 154 |
| Note: standard errors in parentheses. Significance: * p < 0.10, ** p < 0.05, *** p < 0.01 We included intercept but, in the interest of space, do not show the estimates. | | |

### 4.6.3 Assessment of Common Method Bias

We performed three analyses to assess common method bias. We conducted Harman's one-factor test (Podsakoff & Organ, 1986) by entering all variables in exploratory factor analysis. Per expectations, no single major factor emerged, and the largest factor accounted for only 27 percent of the variance. Second, we used the partial correlation method (Podsakoff & Organ, 1986) in which we added the highest factor from the factor analysis to the PLS model as a control variable. This analysis did not produce a significant change in explained variance. Third, we performed the marker variable test (Lindell & Whitney, 2001) by adding a theoretically unrelated construct (organizational size) to the model. The correlations among variables did not change significantly after accounting for common method variance. Thus, these findings suggest that common method bias did not pose a significant concern in our study.

# 5 Discussion

## 5.1 Findings

This study has some important findings. First, our results indicate that BI&A effectiveness does impact organizational performance. Thus, using BI&A effectively can have a positive impact on an organization's bottom line. Therefore, effectively using BI&A to identify new business opportunities, becoming responsive to market demands, and adapting to market changes will improve an organization's financial performance. Second, in order to use BI&A effectively, an organization needs to leverage different capabilities that BI&A can provide. The different BI&A capabilities include BI&A innovation infrastructure capability, BI&A customer process capability, BI&A B2B process capability, and BI&A integration capability.

We found that BI&A innovation infrastructure capability had a positive influence on BI&A effectiveness, which suggests that, in order to use BI&A effectively, organizations need to leverage BI&A's governance, technological, and cultural capabilities. Organizations should have appropriate BI&A tools for collecting, integrating, and sharing data and information internally. Further, they need proper governance to help their employees use these BI&A tools. BI&A governance must allow employees to share and exchange intelligence and information across internal organizational boundaries. Organizations should have process and policies in place that encourage their employees to use BI&A. They must further create a culture that encourages employees to use BI&A. Leveraging these different dimensions will help firms improve their BI&A effectiveness.

BI&A customer process capability had a positive impact on BI&A effectiveness, which suggests that organizations will be able to useBI&A better to meet market demands and identify new business opportunities if they can leverage BI&A's customer-centric capabilities. To do so, organizations should have two BI&A processes in place: one that can help learn from customer-handling mistakes and gain knowledge from customers and one to incorporate and integrate data and information gathered from interacting with customers and use it to solve customer issues, improve customer retention, and meet customers' long-term needs.

As we hypothesized, BI&A B2B process capability had a positive impact on BI&A effectiveness. Organizations can effectively use BI&A to identify new business opportunities and anticipate market changes by leveraging BI&A B2B process capability. Employing BI&A to engage with B2B partners and different stakeholders may provide organizations with a single consistent view of relevant and timely information. Such information may help their partners such as suppliers or manufacturers to deliver raw materials or products in time for organizations to meet market demands. Further, using BI&A to integrate the supply chain process and coordinate different processes will help organizations manage demand and control inventory and, thus, improve their organizational performance and BI&A effectiveness. Thus, organizations can leverage BI&A B2B process capability by implementing BI&A for B2B engagement capability, B2B orientation capability, and B2B compatibility capability to improve BI&A effectiveness.

Our results indicate that BI&A integration capability hurts BI&A effectiveness. This surprising and counter-intuitive finding does not represent a generalized justifiable relationship. We suggest that it may have arisen due to the firms in our sample. As we state in Section 4, we obtained data from firms in India. The contextual conditions in India concerning information technology use across firms may explain our results (Kathuria, Kathuria, & Kathuria, 2018b). First, although most firms in India avidly use information technology, when it comes to leveraging BI&A, they may be still exploring the early BI&A implementation stages of BI&A (i.e., focusing only on BI&A technological capabilities). In other words, organizations in our sample may not have implemented BI&A integration capability to derive any benefits from it or not have made plans regarding BI&A integration.

Second, a significant portion of respondent organizations belonged to the manufacturing and services sector (45%), and more than 60 percent of organizations were novice or intermediate BI&A users. These figures support our assertion that BI&A usage remains at a nascent stage in India. A high percentage novice and intermediate users would not have used BI&A at a higher level.

Third, BI&A integration capability refers to efficiently and effectively acquiring and converting business intelligence. In other words, an organization needs to align its BI&A efforts to its business strategies and goals to be effective, which IT capabilities studies have widely suggested to be a missing process or problem for organizations (Coltman, Tallon, Sharma, & Queiroz, 2015; Segars, Grover, & Teng, 1998). We posit that, because firms in our sample did not sufficiently strategically align their BI&A efforts and

comprehended BI&A capabilities in an ad hoc way, we saw that BI&A integration had a negative effect on BI&A organizational effectiveness.

To sum up, we submit that the negative impact that BI&A integration capability had on BI&A organizational effectiveness arose because we sampled firms from an emerging country and because the firms did not understand how to align their BI&A efforts to effectively use BI&A. Also, we also note that these findings may not generalize to other contexts such as firms in developed countries that understand how to leverage BI&A or firms that have implemented BI&A to an advanced degree, such as Uber, Google, and Amazon. Nevertheless, conceptually, we suggest that organizations can implement BI effectively by ensuring that they properly integrate their data sources. An organization's BI efforts depend on its data; therefore, an organization needs skills in acquiring and integrating data from different sources to enhance its BI&A effectiveness. For example, Continental Airlines achieved success in BI by integrating different data sources from crew data, flight data, marketing, operations, revenue, and more.

Further, organizations need to not only acquire data and intelligence but also convert the insight they gain from integrating it into an actionable plan. In the previous example, Continental Airlines used the intelligence it captured by integrating the different data sources to develop new applications in days rather than months and, thus respond in an agile fashion (Watson, 2010). Thus, leveraging BI&A integration capabilities will help organizations use BI&A effectively. Interestingly, we did not find any significance in the relationship between BI&A integration capability and organizational performance. Thus, we need further research to examine the lack of significant relationship between BI&A integration capability and organizational performance and more so in developed countries or across different industry sectors and different firm types.

## 5.2    Theoretical and Managerial Contributions

This study has both theoretical and managerial contributions. First, we identify specific BI&A capabilities that BI&A effectiveness requires. Thus, we examine specific underlying BI&A features or causal pathways that may explain how BI&A affects organizational performance. We found that organizations can achieve success by effectively employing BI&A. Further, we take a microscopic view on the different capabilities that BI&A offer and that firms can leverage to use BI&A effectively.

From a theoretical perspective, this study adds to the existing literature on BI&A capabilities. We conceptualize BI&A capabilities in a way that integrates organizational and technological perspectives and, thereby, enrich the discourse on BI&A. We focus on analyzing and discussing the BI&A's core capabilities that organizations need to leverage to successfully use BI&A. This contribution has importance because many firms tend to implement BI&A simply as a tool without considering its different capabilities that can warrant any measure of success. Through theoretical analysis and empirical testing, we provide evidence to support that BI&A endows organizations with different capabilities. Firms can leverage these capabilities to use BI&A effectively and, thereby, improve organizational performance. In line with prior studies, our results indicate that organizations need to effectively use BI&A to improve their performance. However, unlike prior studies, we found that one cannot simply measure BI&A capabilities in terms of the tools that organizations use or the analyses that they can conduct using BI&A. Instead, different and multi-faceted BI&A capabilities that reside at the operational and strategic levels exist. For example, one capability, the innovation-infrastructure capability, has technological, governance, and cultural dimensions.

Similarly, organizations can leverage customers and B2B process capability to effectively use BI&A. They can do so by either focusing on BI&A customer orientation capability and BI&A customer application capability or on B2B compatibility capability, B2B engagement capability, and/or the orientation-level dimensions of the B2B process capability. Along the same lines, organizations can focus on BI&A acquisition capability and BI&A conversion capability to leverage BI&A integration capability and use BI&A effectively.

From a managerial perspective, we provide a framework for both IS and business executives to understand and evaluate BI&A capabilities and help them pursue their future development. We provide direction to managers for implementing BI&A in their organization. Managers continuously face many challenges in their daily operations and strategic planning. Effectively using BI&A helps an organization provide managers with established and accurate numbers regarding demand and supply. As our results show, using BI&A effectively to meet market innovation or volatile market demands will help an organization improve its overall performance. Further, in order to ensure that it effectively uses BI&A, an

organization needs to mobilize and deploy BI&A to support innovation in the organization. Managers must devote time and money to establish BI&A innovation infrastructure capability to leverage BI&A functionalities.

Similarly, managers have to ensure that the BI&A in their organizations support their business processes. Target lost about US$1 million because it poorly controlled its inventory. Using BI&A B2B process capability, Target could have better controlled the integration between its warehouses and storage space. Thus, our results show that managers need to leverage their BI&A B2B process capability to effectively use BI&A. Organizations generate much customer data through social media and the Internet. Organizations can capture information such as customers' likes and dislikes, their satisfaction rating about products, the services that an organization offers, and customers' perceptions about the products or services to improve customer satisfaction. Managers can leverage BI&A customer process capability to analyze this information and effectively use BI&A to improve their organizational performance. As organizations pursue deploying BI&A for analyzing the increasing amounts of data, they need to focus on implementing BI&A and BI&A capabilities that they need to achieve these specific goals. Organizations that succeeded in this endeavor include Amazon, which successfully leverages its BI&A B2B process capability to determine where to store more than three billion products so that it quickly ship them to customers, and Starbucks, which successfully leverages its BI&A customer process capability to offer recommendations and rewards to customers based on their shopping history and to introduce new menu items to customers based on their tastes.

## 5.3 Limitations

Readers should interpret our results with certain limitations in mind. First, although we obtained a sufficient sample size to conduct PLS analysis, larger sample size may have permitted a more robust and comprehensive analysis. Second, less than 10 percent of the respondents had a technical orientation towards BI&A, which could have influenced their ability to accurately assess BI&A innovation infrastructure capability. Third, our findings may not generalize across all contexts or all firms. Indeed, this limitation should encourage future research to either replicate or extend the study to a different firms, industry sectors, and national contexts. Finally, the study may also have limitations in terms of the scope of the variables we considered. In this study, we examine the impact that BI&A capabilities have on BI&A effectiveness and organizational performance. However, we left out other factors such as competitive pressure, institutional pressure, and other such external factors that may have an impact on BI&A effectiveness and organizational performance due to time and scope reasons. Thus, we need further research that incorporates all the factors to understand BI&A effectiveness.

## 5.4 Future Research

In the age of big data, an increasing number of firms will embrace BI&A. This trend will engender opportunities for future research that can examine how emerging capabilities, such as those related to artificial intelligence and deep learning, interact with BI&A capabilities. The hierarchy of capabilities that we present in this manuscript provides a foundation on which researchers can conceptualize and empirically test higher-order capabilities.

We also encourage capability research on how BI&A capabilities that we identify in this study integrate with other IT capabilities for process and business innovation. Future studies could also examine how these relationships vary across different environmental contingencies (e.g., Khuntia, Kathuria, Saldanha, & Konsysnki, 2019). Finally, we acknowledge that other BI&A capabilities exist, and future work can examine other BI&A operant resource capabilities.

## 5.5 Conclusion

In conclusion, we note that, with the advent of business intelligence, organizations have somewhat experienced a "fad" effect around this tool. In practice, while BI&A has attracted much attention, it resembles the story about the six blind men went to see the elephant. In other words, BI&A perspectives and viewpoints vary across firms with differing concepts, definitions, and applications. While eliminating the differences would be a herculean task, integrating BI&A perspectives into a holistic model can certainly be a fruitful approach. In this study, we provide such a holistic view around BI&A integration in an organization albeit with a bias towards capability perspective. By taking the capabilities perspective, we can highlight the fact that BI&A does not just represent a fad or buzz in the practice and academic

discourse but that it can help garner higher organizational performance. Overall, we take an integrative approach to BI&A. We focus on four dimensions of BI&A capability and relate them to organizational performance. We used the survey methodology to collect data. Our findings provide a capability-integrative framework for BI&A implementation and motivate managers to see BI&A from an organizational performance-improvement perspective.

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# References

Agarwal, R., & Selen, W. (2009). Dynamic capability building in service value networks for achieving service innovation. *Decision Sciences, 40*(3), 431-475.

Allred, C. R., Fawcett, S. E., Wallin, C., & Magnan, G. M. (2011). A dynamic collaboration capability as a source of competitive advantage. *Decision Sciences, 42*(1), 129-161.

Ang, S., & Inkpen, A. C. (2008). Cultural intelligence and offshore outsourcing success: A framework of firm‐level intercultural capability. *Decision Sciences, 39*(3), 337-358.

Azvine, B., Cui, Z., Nauck, D. D., & Majeed, B. (2006). Real time business intelligence for the adaptive enterprise. In *Proceedings of the 8th IEEE International Conference on E-Commerce Technology.*

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99-120.

Bharadwaj, A. (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Quarterly, 24*(1), 169-196.

Bhatt, G. D., & Grover, V. (2005). Types of information technology capabilities and their role in competitive advantage: An empirical study. *Journal of Management Information Systems, 22*(2), 253-277.

Chau, M., & Xu, J. (2012). Business intelligence in blogs: Understanding consumer interactions and communities. *MIS Quarterly, 36*(4), 1189-1216.

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly*, *36*(4), 1165-1188.

Chen, X., & Siau, K. L. (2012). Effect of business intelligence and IT infrastructure flexibility on organizational agility. In *Proceedings of the Thirty Third International Conference on Information Systems.*

Coltman, T., Tallon, P., Sharma, R., & Queiroz, M. (2015). *Strategic IT alignment: Twenty-five years on.* Berlin: Springer.

Corte-Real, N., Oliveira, T., & Ruivo, P. (2014). Understanding the hidden value of business intelligence and analytics (BI&A). In *Proceedings of the Twentieth Americas Conference on Information Systems.*

Davenport, T. H., & Harris, J. G. (2007). *Competing on analytics: The new science of winning.* Brighton, MA: Harvard Business Review Press.

Delen, D., & Demirkan, H. (2013). Data, information and analytics as services. *Decision Support Systems*, *55*(1), 359-363.

Elbashir, M. Z., Collier, P. A., & Davern, M. J. (2008). Measuring the effects of business intelligence systems: The relationship between business process and organizational performance. *International Journal of Accounting Information Systems, 9*(3), 135-153.

Elbashir, M. Z., Collier, P. A., Sutton, S. G., Davern, M. J., & Leech, S. A. (2013). Enhancing the business value of business intelligence: The role of shared knowledge and assimilation. *Journal of Information Systems, 27*(2), 87-105.

Elliott, T., & Objects, B. (2008). *Why business intelligence projects fail—and what to do about it.* Paper presented at the Business Objects User Conference.

Fornell, C., & Bookstein, F. L. (1982). Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research*, *19*(4), 440-452.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39-50.

Gebauer, J., & Schober, F. (2006). Information system flexibility and the cost efficiency of business processes. *Journal of the Association for Information Systems, 7*(3), 122-147.

Gold, A. H., Malhotra, A., & Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. *Journal of Management Information Systems, 18*(1), 185-214.

Gonzales, R., Wareham, J., & Serida, J. (2015). Measuring the impact of data warehouse and business intelligence on enterprise performance in Peru: A developing country. *Journal of Global Information Technology Management, 18*(3), 162-187.

Goodwin, B. (2011). Poor communication to blame for business intelligence failure, says Gartner. *ComputerWeekly.* Retrieved from https://www.computerweekly.com/news/1280094776/Poor-communication-to-blame-for-business-intelligence-failure-says-Gartner

Herschel, R. T., & Jones, N. E. (2005). Knowledge management and business intelligence: The importance of integration. *Journal of Knowledge Management, 9*(4), 45-55.

Inkpen, A. C., & Dinur, A. (1998). Knowledge management processes and international joint ventures. *Organization Science, 9*(4), 454-468.

Işık, Ö., Jones, M. C., & Sidorova, A. (2013). Business intelligence success: The roles of BI capabilities and decision environments. *Information & Management, 50*(1), 13-23.

Jourdan, Z., Rainer, R. K., & Marshall, T. E. (2008). Business intelligence: An analysis of the literature. *Information Systems Management, 25*(2), 121-131.

Kathuria, A., & Konsynski, B. R. (2012). Juggling paradoxical strategies: The emergent role of IT capabilities. In *Proceedings of the International Conference on Information Systems.*

Kathuria, A., Mann, A., Khuntia, J., Saldanha, T. J., & Kauffman, R. J. (2018a). A strategic value appropriation path for cloud computing. *Journal of Management Information Systems, 35*(3), 740-775.

Kathuria, R., Kathuria, N. N., & Kathuria, A. (2018b). Mutually supportive or trade-offs: An analysis of competitive priorities in the emerging economy of India. *The Journal of High Technology Management Research*, 29(2), 227-236.

Kathuria, R., Porth, S. J., Kathuria, N., & Kohli, T. (2010). Competitive priorities and strategic consensus in emerging economies: Evidence from India. *International Journal of Operations and Production Management, 30*(8), 879-896.

Khuntia, J., Kathuria, A., Saldanha, T. J. V., & Konsynski, B. R. (2019). Benefits of IT-enabled flexibilities for foreign versus local firms in emerging economies. *Journal of Management Information Systems*, *36*(3), 855-892.

Kim, G., Shin, B., Kim, K. K., & Lee, H. G. (2011). IT capabilities, process-oriented dynamic capabilities, and firm financial performance. *Journal of the Association for Information Systems, 12*(7), 487.

Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology, 86*(1), 114-121.

Lönnqvist, A., & Pirttimäki, V. (2006). The measurement of business intelligence. *Information Systems Management, 23*(1), 19-23.

Lowry, P. B., & Gaskin, J. (2014). Partial least squares (PLS) structural equation modeling (SEM) for building and testing behavioral causal theory: When to choose it and how to use it. *IEEE Transactions on Professional Communication, 57*(2), 123-146.

Madhavaram, S., & Hunt, S. D. (2008). The service-dominant logic and a hierarchy of operant resources: developing masterful operant resources and implications for marketing strategy. *Journal of the Academy of Marketing Science, 36*(1), 67-82.

Massa, S., & Testa, S. (2005). Data warehouse-in-practice: Exploring the function of expectations in organizational outcomes. *Information & Management, 42*(5), 709-718.

Mishra, S., Modi, S., & Animesh, A. (2013). The relationship between information technology, inventory efficiency, and shareholder wealth: A firm-level empirical analysis. *Journal of Operations Management, 31*(6), 298-312.

Mithas, S., Ramasubbu, N., & Sambarurthy, V. (2011). How information management capability influences firm performance. *MIS Quarterly, 35*(1), 237-256.

Negash, S. (2004). Business intelligence. *Communications of the AIS, 13*, 177-195.

Nunnally, J. (1978). *Psychometric methods*. New York, NY: McGraw-Hill.

O'Marah, K. S. (2018). Supply chain lessons from the KFC fowl-up. *Forbes.* Retrieved from https://www.forbes.com/sites/kevinomarah/2018/03/01/three-supply-chain-lessons-from-the-kfc-fowl-up

Pavlou, P. A., & El Sawy, O. A. (2006). From IT leveraging competence to competitive advantage in turbulent environments: The case of new product development. *Information Systems Research, 17*(3), 198-227.

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

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management, 12*(4), 531-544.

Popovic, A., Hackney, R., Coelho, P. S., & Jaklic, J. (2014). How information-sharing values influence the use of information systems: An investigation in the business intelligence systems context. *Journal of Strategic Information Systems, 23*(4), 270-283.

Popovič, A., Hackney, R., Coelho, P. S., & Jaklič, J. (2012). Towards business intelligence systems success: Effects of maturity and culture on analytical decision making. *Decision Support Systems, 54*(1), 729-739.

Press, G. (2017). Predictions for the $203 billion big data analytics market. *Forbes.* Retrieved from https://www.forbes.com/sites/gilpress/2017/01/20/6-predictions-for-the-203-billion-big-data-analytics-market/#8b9932c20838

Ramakrishnan, T., Jones, M. C., & Sidorova, A. (2012). Factors influencing business intelligence (BI) data collection strategies: An empirical investigation. *Decision Support Systems, 52*(2), 486-496.

Ransbotham, S., & Kiron, D. (2017). Analytics as a source of business innovation. *MIT Sloan Management Review, 58*(3).

Ransbotham, S., Kiron, D., & Prentice, P. K. (2016). Beyond the hype: The hard work behind analytics success. *MIT Sloan Management Review, 57*(3).

Ray, G., Muhanna, W. A., & Barney, J. B. (2005). Information technology and the performance of the customer service process: A resource-based analysis. *MIS Quarterly*, *29*(4), 625-652.

Sabherwal, R., & Kirs, P. (1994). The alignment between organizational critical success factors and information technology capability in academic institutions. *Decision Sciences, 25*(2), 301-330.

Sambamurthy, V., & Zmud, R. W. (1997). At the heart of success: Organizationwide management competencies. In C. Sauer & P. W. Yetton (Eds.), *Steps to the future: Fresh thinking on the management of IT-based organizational transformation* (pp. 143-163). San Francisco, CA: Jossey-Bass.

Seddon, P. B., Constantinidis, D., Tamm, T., & Dod, H. (2017). How does business analytics contribute to business value? *Information Systems Journal, 27*(3), 237-269.

Segars, A. H., Grover, V., & Teng, J. T. (1998). Strategic information systems planning: Planning system dimensions, internal coalignment, and implications for planning effectiveness. *Decision Sciences, 29*(2), 303-341.

Sine, W. D., Mitsuhashi, H., & Kirsch, D. A. (2006). Revisiting burns and stalker: Formal structure and new venture performance in emerging economic sectors. *Academy of Management Journal, 49*(1), 121-132.

Spence, E. (2016). The trouble with Apple's AirPods. *Forbes.* Retrieved from https://www.forbes.com/sites/ewanspence/2016/11/01/apple-iphone-airpods-delay/

Sukumaran, S., & Sureka, A. (2006). Integrating structured and unstructured data using text tagging and annotation. *Business Intelligence Journal, 11*(2), 8-16.

Tamm, T., Seddon, P., & Shanks, G. (2013). Pathways to value from business analytics. In *the Proceedings of the International Conference on Information Systems.*

Torres, R., Sidorova, A., & Jones, M. C. (2018). Enabling firm performance through business intelligence and analytics: A dynamic capabilities perspective. *Information & Management*, 55(7), 822-839.

Tremblay, M. C., Fuller, R., Berndt, D., & Studnicki, J. (2007). Doing more with more information: Changing healthcare planning with OLAP tools. *Decision Support Systems, 43*(4), 1305-1320.

Tremblay, M. C., Hevner, A. R., & Berndt, D. J. (2012). Design of an information volatility measure for health care decision making. *Decision Support Systems, 52*(2), 331-341.

Trkman, P., McCormack, K., De Oliveira, M. P. V., & Ladeira, M. B. (2010). The impact of business analytics on supply chain performance. *Decision Support Systems, 49*(3), 318-327.

Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. J.-F., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. *Journal of Business Research, 70*, 356-365.

Watson, H. J. (2009). Tutorial: Business intelligence—past, present, and future. *Communications of the Association for Information Systems, 25*, 487-510.

Watson, H. J. (2010). BI-based organizations. *Business Intelligence Journal, 15*(2), 4-6.

Watson, H. J., Fuller, C., & Ariyachandra, T. (2004). Data warehouse governance: Best practices at Blue Cross and Blue Shield of North Carolina. *Decision Support Systems, 38*(3), 435-450.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal, 24*(10), 991-995.

Yeoh, W., & Popovic, A. (2016). Extending the understanding of critical success factors for implementing business intelligence systems. *Journal of the Association for Information Science and Technology, 67*(1), 134-147.

Zhu, K. (2004). The complementarity of information technology infrastructure and e-commerce capability: A resource-based assessment of their business value. *Journal of Management Information Systems, 21*(1), 167-202.

# Appendix A

## Table A1. Illustrative Prior Studies Related to BI&A, Capabilities, and Performance

| Study | Research question | Methodology | Key finding/s |
|---|---|---|---|
| Peters et al. (2016) | Examines the linkage between BI, management control systems, performance, and competitive advantage. | An empirical study that uses survey data from 324 firms. | BI infrastructure integration influences competitive advantage. BI functionality, performance measurement capability, and self-service mediate the relationship between BI infrastructure integration and functionality. |
| Yeoh & Popovic (2016) | Examines CSF for Implementing BI systems. | Case study analysis. | Organizational factors such as committed management support and sponsorship, a clear vision, and a well-established business case play an important role in BIS implementation success. |
| Gonzales, Wareham, & Serida (2015) | Assess the impact that BI has on enterprises' performance in a developing region. | Mixed method study with 23 interviews and 110 survey responses. | Information quality and service quality influence user satisfaction, and user satisfaction influences the individual impact of BI usage. |
| Popovic, Hackney, Coelho, & Jaklic, (2014) | Examines how information-sharing values influence how organizations use IS in the BI context. | An empirical study, using survey data for 146 medium and large firms | In the BI context, information sharing values do not directly influence IT-enabled information use. However, it has a positive impact on information quality and also moderates the relationship between information quality and information use. |
| Corte-Real, Oliveira, & Ruivo (2014) | Examines how BI&A can create competitive value and improve firm performance. | Conceptual model | Suggests that BI&A capabilities offer dynamic capabilities based on effective knowledge management, which enables firms to achieve competitive value, which in turn can improve firm performance. |
| Isik et al. (2013) | Examines the influence that BI capabilities have on BI success and the influence that the decision environment has on the relationship between BI capabilities and BI success. | An empirical study using survey data from 97 respondents | Data quality, integration with other systems, user access, and flexibility influence BI success. The relationship between risk mgmt. support and BI success was not significant. The variables' decision types and information characteristics moderated the relationship between risk management support and BI success and flexibility and BI success. |
| Mishra, Modi, & Animesh (2013) | Examines the relationship between IT capability, inventory efficiency, and shareholder wealth. | An empirical study using firm-level secondary data | IT capability influences inventory efficiency, which, in turn, increases stock market returns and reduces stock market risk. Further, IT capability also directly influences stock market returns positively and stock market risk negatively. |
| Tamm, Seddon, & Shanks, (2013) | Examines how business analytics (BA) contributes to business value. | Conceptual model | Identifies three pathways that comprise providing advisory services; creating and enhancing BA tools and the BI platform, and end users' using BA tools through which BA contributes to business value. |
| Ramakrishnan et al. (2012) | Examines the factors that influence BI data-collection strategies. | An empirical study using survey data from 63 respondents | Institutional pressure drives organizations to employ BI to achieve consistent data and information. A comprehensive BI data-collection strategy best suits an organization that implements BI to achieve consistent information and transform. |
| Popovic et al. (2012) | Examines BI success by investigating the role of BI system maturity and culture on decision making. | An empirical study using survey data from 181 medium and large firms | BIS maturity influences information content quality and information access quality. Further, information content quality impacts how organizations use information systems in business processes. Although analytical decision-making culture influences how organizations use information in business processes, it hurts the relationship between information content quality and the use of information in business processes. |

**Table A1. Illustrative Prior Studies Related to BI&A, Capabilities, and Performance**

| | | | |
|---|---|---|---|
| Chau & Xu (2012) | Proposes a framework for gathering BI from blogs. | A qualitative study that proposes a framework | Designs a framework and system for automatically collecting blogs. This framework can reveal patterns that answer important questions in the BI blog domain. |
| Chen & Siau (2012) | Examines the effect that BI use and IT infrastructure flexibility have on organizational agility. | An empirical study using survey data from 214 respondents | BI usage and IT infrastructure flexibility influence organizational agility. IT infrastructure flexibility has a positive influence on BI usage. |
| Mithas, Ramasubbu, & Sambarurthy (2011) | Examines IT capabilities influence on firm performance | An empirical study using archival data about 160 firms | Information management capability influences firm capabilities such as performance management capability, customer management capability, and process management capability. These firm capabilities influence firm performance. |
| Gold et al. (2011) | Examines knowledge management from an organizational capabilities perspective. | An empirical study using 300 survey response | Knowledge infrastructure capability and process capabilities are second-order constructs with technology, structure, and culture forming the dimensions of knowledge integration capability and acquisition, conversion, application, and protection forming the dimensions of knowledge process capability. Both these capabilities have a positive influence on organizational effectiveness. |
| Trkman et al. (2010) | Examines the influence that business analytics has on supply chain performance. | Empirical analysis using 310 survey responses | Business analytics for the plan, source, make, and delivery has a positive impact on supply chain performance. Further, information systems support and business process orientation moderates the relationship between business analytics and supply chain performance. |
| Watson (2009) | Describes comprehensive, generic BI environment and discusses four important BI trends. | A qualitative study that identifies available BI resources for faculty and students. | Identifies three BI targets: development of single of few BI applications, the creation of infrastructure that can support BI needs, an organizational transformation where BI can change how a company competes in the marketplace. Identifies four BI trends: scalability, pervasive BI, operational BI, and BI-based organization |
| Elbashir et al. (2008) | Examines the relationship between business process performance and organizational performance. | An empirical study using survey data from 419 respondents | Business process performance has a positive influence on organizational performance. The industry type moderates the relationship between business process performance and organizational performance with non-service industries having a stronger moderating effect between the relationships in comparison to the service industries. |
| Jourdan, Rainer, & Marshall (2008) | The genesis of BI. | Reviews and synthesizes literature on BI from 1997 to 2006 | Early work on BI from 1997 to 2006 fits into the following categories: artificial intelligence, benefits, decisions, implementations, and strategies. |
| Herschel & Jones (2005) | Examines the difference and the relationship between BI and knowledge management. | Reviews and synthesizes literature from 1986 to 2004. | Suggests that one should view BI as a subset of knowledge management since BI focuses on explicit knowledge, but knowledge management encompasses both tacit and explicit knowledge. |
| Negash (2004) | Proposes a BI framework and potential research topics. | Qualitative conceptual model | Develops a framework that highlights the importance of unstructured data. Further, it discusses the need to develop BI tools for its acquisition, integration, cleanup, search, analysis, and delivery. |

### Table A1. Illustrative Prior Studies Related to BI&A, Capabilities, and Performance

| | | | |
|---|---|---|---|
| Zhu (2004) | Examines the business value of e-commerce capability and information technology infrastructure in the context of electronic business at the firm level. | An empirical study using primary and secondary data. | E-commerce capability and IT Infrastructure exhibit positive relationships with firm performance measures. The integration of e-commerce capability and IT infrastructure (interaction effect of IT infrastructure and EC capability) reinforces the main effect. |

The table is not comprehensive and lists only a few illustrative studies to show the uniqueness and newness of the present study about relevant previous work. Also, we take much of the text in this table verbatim from the corresponding studies.

### Table A2. Survey Instrument

| Variable | Items |
|---|---|
| Scale: 1 = strongly disagree, 7 = strongly agree. | |
| Organizational performance | *The degree to which organizational performance has improved.*<br><br>Over the past three years, our financial performance has exceeded our competitors<br>Over the past three years, our sales growth has been outstanding.<br>Over the past three years, we have been more profitable than our competitors. |
| BI&A effectiveness | *The degree to which BI&A has contributed to making the organization effective in different dimensions to meet market/innovation/coordination/volatile demands.*<br><br>My organization has improved its ability to identify new business opportunities.<br>My organization has improved its ability to anticipate market opportunities.<br>My organization has improved its ability to adapt to volatile industry/market changes.<br>My organization has become responsive to market demands.<br>My organization has improved its ability to innovate new products/services.*<br>My organization has improved its ability to reduce redundancy in knowledge-centric effects.* |
| BI&A technology | *The degree to which BI&A technology is implemented in an organization.*<br><br>My organization uses BI&A technology to retrieve and use intelligence about products and processes.<br>My organization uses BI&A technology to collaborate with individuals inside and outside the organization.<br>My organization uses BI&A technology to search for new knowledge and map a specific type of knowledge.*<br>My organization uses BI&A tech. to allow employees in multiple locations to learn as a group from a single (multiple) sources at a single (multiple) point of time. |
| BI&A culture | *The way the use of BI&A for decision-making has become the norm in an organization.*<br><br>Employees understand the importance of BI for the success of the organization.*<br>Employees are encouraged for intelligence exploration and experimentation.<br>Senior management support the role of BI&A in our firms' success.<br>My organization expects a high level of participation in intelligence capture, share, and transfer.<br>My organizations have an underlying value of on-job training and learning around BI&A.<br>In my organization, the vision and objective around BI&A are clearly stated and understood. |
| BI&A governance | *The degree to which BI&A structure is defined in an organization, including rules, policies, procedures, processes, the hierarchy of reporting patterns and relationships.*<br><br>My organization's structure of departments inhibits exchange and sharing of intelligence .<br>My organization promotes collective intelligence rather than individualistic acumen.<br>My organization Incentivizes performance based on BI.*<br>My organization has processes to facilitates exchange and sharing of intelligence.<br>My organization facilitates the transfer of intelligence across structural boundaries. |

**Table A2. Survey Instrument**

| | |
|---|---|
| BI&A customer orientation | *The way BI&A is oriented to meet an organization's customers' needs and serve them).*<br><br>Our BI&A system helps employees in solving customer issues.<br>The use of BI&A in our organization has improved customer retention.<br>The use of BI&A in our organization has helped us meet the long-term needs of the customers.<br>The goals of the customers are met through our BI system* |
| BI&A customer application | *The process to absorb customer related intelligence in the organization using BI&A).*<br><br>My organization has processes for applying BI&A learned from customer handling mistakes<br>My organization has processes for using BI&A in development of new customer-oriented channels.<br>My organization has processes to take advantage of knowledge acquired from customers |
| BI&A B2B orientation | *The way BI&A is oriented to address supply chain related needs.*<br><br>Our BI&A focuses on meeting supply chain needs.<br>The goals of our supply chain partners are met through our BI&A system.<br>Our BI&A system helps in resolving supply chain integration issues.<br>Our BI&A facilitates the transfer of information across the downward supply chain.<br>Our BI&A helps in upward management of supply chain.* |
| BI&A B2B engagement | *Usage of BI&A to engage new B2B partners and improve coordination with existing B2B partners.*<br><br>The use of BI&A has streamlined B2B engagement.<br>The use of BI&A has increased engagement with our business partners.*<br>The use of BI&A has enhanced approachability with our business partners.<br>The use of BI&A has provided synchronized coordination with our business partners. |
| BI&A B2B compatibility | *The degree to which BI&A has contributed towards process coordination and operational capability improvement through increased compatibility.*<br><br>BI&A has provided us the capability to be compatible with e-commerce capability.<br>BI&A has provided us the capability to be compatible with different channels<br>BI&A has provided us the capability to be compatible with different stakeholders |
| BI&A acquisition | *Processes to acquire business intelligence.*<br><br>My organization has processes for acquiring intelligence about our business.<br>My organization has processes for distributing intelligence throughout the organization. *<br>My organization has processes for acquiring intelligence about new product/services/innovation. |
| BI&A conversion | *Processes to convert business intelligence.*<br><br>My organization has processes for converting intelligence into new product design/service offering<br>My organization has a process for converting intelligence into a plan of action<br>My organization has processes for transferring organizational intelligence to individual employees<br>My organization has processes for absorbing intelligence from individual employees into an organizational framework. * |
| Revenue | Please select the response that best describes the total annual revenue of your organization (Less than $100 million, $100 million - $499 million, $500 million - $1 billion, higher than $1 billion) |
| BI experience | Please indicate your experience with BI (new BI user, intermediate BI user, advanced BI user) |
| Organization type | Please indicate your organization type (manufacturing, service, healthcare, government, others) |
| BI orientation | Please indicate your BI orientation (technical, business) |

**Table A3. Illustrative Examples of Process Failures with the Potential Role of BI&A Capabilities**

| Company | Description | Impact | Role of BI&A capabilities |
|---|---|---|---|
| Target[1] | Target tried to enter into the new market with 124 shops and three distribution centers without testing or predictable operations of its distribution network first. The problem arose due to a poorly designed ordering system. | Overflowing warehouses with stock, empty store shelves, and lost control of inventory. The firm lost around US$1 billion | Leveraging BI&A B2B process capability would have allowed Target to effectively use BI&A to test and ensure proper integration between warehouse and store shelf before opening the system. |
| Apple[2] | The iPhone X's facial recognition software required two modules. One module was created at a faster rate, which left an unequal amount of the other part to couple off with. | Increased cost and a limited supply of OLED displays. Reduced the number of iPhone X during its November launch. | Apple could have leveraged BI&A innovation infrastructure capability to use BI&A effectively to ensure that it had an equal number of both modules. |
| KFC[3] | Changed its delivery partner. The partner had trouble delivering fresh chicken to 900 restaurants across the UK. | Many branches of KFC in the UK had to be closed. | If KFC had effectively used BI&A by leveraging BI&A B2B process capability and BI&A customer process capability, it could have ensured that that its partner delivered chicken to all the restaurants promptly. |
| Boeing Dreamliner[4] | Launched production of the twin-engine 787 in 2007 and vowed to set record production times. | Many glitches such as running out of fasteners caused delays that escalated into a revised timeline amounting to years. | Using BI&A effectively by leveraging BI&A integration capability would have ensured that Boeing Dreamliner had all the materials to finish the production during the estimated time. |
| Apple[5] | An unexpected manufacturing problem at scale. | Wireless earphones that were promised to be delivered to retailers by September were not delivered even by December. | BI&A B2B process capability could have ensured the effective use of BI&A for lot sizing, lot scheduling, and optimizing the sequence of orders in the manufacturing line, which would have helped in resolving the manufacturing problem. |
| Compaq | Compaq could not capitalize on the new microprocessors that Intel unveiled. When vendors announced changes in engineering specifications, they incurred more reworking costs. | It took more time than its rivals to launch the next generation of PCs. Compaq did not reap many benefits when the price of the components fell. | BI&A customer process capability would have improved the effective use of BI&A to provide the required agility for the supply chain to take advantage of the market changes. |
| Ericsson | A Philips facility in Albuquerque that supplied the required radio frequency chips to Ericsson and Nokia burnt down. | Ericsson had to scale back production for months after the fire. It had to delay the launch of a significant new product. Nokia stole market share from Ericsson. | BI&A innovation infrastructure capability would have improved how effectively the company used BI&A to help it quickly conduct design changes and contact backup suppliers. |
| HP | HP's integrated circuit division kept low inventory as one of its key success factors. | This resulted in long lead times for the supply of ICs to HP's ink-jet printer division. The ink-jet printer division had to create a large inventory of printers to offset the long lead time. More expensive. | Leveraging BI&A integration capability to effectively use BI&A would have helped HP be more cost effective. |
| Cisco[6] | The demand for its products slowed down in 2001 and it had excess inventory. | Stock dropped 50%. The company took a US$2.2 billion inventory write-down. | Analytical capability in the planning process with supply and demand planning would have avoided this bull-whip effect. |

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[1] https://channels.theinnovationenterprise.com/articles/5-great-supply-chain-failures
[2] https://www.afflink.com/blog/the-biggest-supply-chain-blunders-of-2017
[3] https://www.thebci.org/news/supply-chain-failure-closes-more-than-half-of-kfc-fast-food-outlets.html
[4] https://venturebeat.com/2017/01/01/the-top-5-supply-chain-fuckups-of-2016/
[5] https://www.raconteur.net/business/10-supply-chain-disasters
[6] http://www.scdigest.com/assets/reps/SCDigest_Top-11-SupplyChainDisasters.pdf

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