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Business intelligence and organizational learning: An empirical investigation of value creation processes

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ABSTRACT

With the aim of bridging the gap between well-established research on information technology (IT) value creation and the emergent study of business intelligence (BI), this study develops and tests a model of BI value creation that is firmly anchored in both streams of research. The analysis draws on the resource-based view and on conceptualizations of organizational learning to hypothesize about the paths by which BI assets and BI capabilities create business value. The research model is first assessed in an exploratory analysis of data collected through interviews in three firms and then tested in a confirmatory analysis of data collected through a survey.

1. Introduction

The business value of information technology (IT) has been demonstrated repeatedly in the past decades [13,36,83]. However, a major shortcoming of this field of research has been its disposition to study the business value of overarching IT concepts instead of the value gained by specific classes of information systems. The primary goal of those general IT studies has been to capture the organizational effects attributed to all IT assets and capabilities available to the organization. Those studies have been complemented by specific IT studies, aimed at understanding the business value of specific platforms and systems, such as electronic commerce [105] and enterprise resource planning (ERP) [62,66]. The contribution of the latter studies is based on the often implicit rationale that different technologies bring about different processes of value creation. Therefore, it is essential to understand the unique value creation mechanisms at play for each technology.

In terms of value creation, business intelligence (BI) appears to be among the most promising technologies in recent years, at least as reflected in the attitudes of IT executives [61]. However, despite this dramatic shift in investment patterns and value perceptions, little empirical research has addressed the value creation processes unique to BI systems (e.g., Refs. [33,124]). Although some efforts have been made to capture how BI generates business value, it is safe to conclude that there is much to learn about the value creation processes induced by this dominant IT domain.

Against this backdrop, we seek to answer the following research question: What are the distinct mechanisms of value creation underlying the business value of BI? We argue in this paper that understanding the business value of BI requires the integration of *general* knowledge about the processes of IT value creation and *specific* knowledge about the features unique to BI deployment. We integrate the two by taking stock of well-established findings about IT value creation and adapting them to the context of BI value creation. In particular, general IT findings include the relationships observed in previous research among IT assets, IT capabilities, organizational resources, and business value [64,79,82,102], whereas specific BI adaptations involve the distinction between operational and strategic BI capabilities and the moderating role of organizational learning [74]. We demonstrate that organizational learning is an important theoretical lens for understanding how BI creates business value, especially given that BI systems are deployed to facilitate decision support, environmental adaptation, and organizational innovation. Specifically, the framework of exploration and exploitation in organizational learning [76] is applied because of the conceptual fit between the two types of BI capabilities (operational and strategic) and the two mechanisms of organizational learning (exploitation and exploration). In concert with the resource-based view (RBV) of the firm [8,122], these theoretical bases allow us to formulate a comprehensive research model of how the deployment of BI resources creates business value.

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In this paper, we adopt the process view prevalent in the literature on general IT business value [64,79,80,98], and we develop a research model that considers BI capabilities (operational and strategic) as mediating the effects of BI assets (BI infrastructure and BI team) on business value (operational and strategic). The research model also accounts for the moderating effects of exploration and exploitation on the relationships between assets and capabilities. The development of the research model is based on a comprehensive literature review, which shows that the diffusion of knowledge from the literature on IT value to that on BI value has been sporadic and inconsistent. A preliminary assessment of our research model relies on qualitative data collected in 11 interviews in three organizations. Subsequently, the model is tested with cross-sectional data collected from managers. Data analysis, using structural equation modeling (SEM), generally confirms the research model and shows that the lens of organizational learning and the distinction between operational and strategic BI capabilities are critical to understanding BI value creation.

The contribution of this study is attributed to our dual approach, which integrates insights gained from both general IT and specific BI research. The study therefore contributes to both streams of research. First, it contributes to BI research by providing a model of value creation specific to this domain, which, despite being a high-priority investment in many organizations, suffers from a lack of empirical grounding. BI research also suffers from insufficient theoretical development, and the present study demonstrates that organizational learning is a useful theoretical lens to further our understanding of BI value. Second, the study contributes to IT value research by showing that "opening the grey box of IS business value creation" [102,p. 149] may not be entirely possible unless value creation processes are grounded in a specific technological context. Finally, our dual approach is easily transferable to other technological domains, offering a promising avenue to advance research on domain-specific value creation processes.

This paper proceeds as follows: the next section provides the theoretical background, which leads to the development of the research model. The third section describes the research methodology used to test the research model, and the fourth section describes the data analysis and results. Finally, the concluding section discusses the key findings, contributions, limitations, and directions for future research.

2. Theoretical background and research model

The theoretical analysis begins with a short introduction of research on the business value of BI systems. We then present three consistent observations about the business value of IT; we also demonstrate, through a structured literature review, that the implications of these observations on the business value of BI have yet to be fully studied. This theoretical background is the foundation upon which the research model is constructed in the rest of this section.

2.1. BI systems

BI is as an overarching term for decision support systems that are based on the integration and analysis of organizational data resources toward improving business decision making. The term BI is widely used to describe a variety of different applications of information analysis that enable informed decision making based on wider knowledge [120]. In this work, the term "BI systems" is used to describe the technical artifacts that provide BI functionality to users. BI systems aim at improving the quality of information used in the decision-making process as a consequence of simplification of storage, identification, and analysis of information [81]. They offer a comprehensive view of the entire organization, permit the analysis of business activities from multiple perspectives, and enable rapid reactions to changes in the business environment [78].

Some studies have emphasized the organizational impacts of BI, suggesting that the introduction of BI systems into an organization implies not only technological enhancement but also a revolutionary way of performing and managing business activities and decision-making processes. Davenport [24] highlights the transition toward a culture of fact-based decision making that is associated with the use of business analytics and the adoption of BI systems. Watson and Wixom [120] describe the benefits of BI systems, including cost and time savings, improved information and business processes, better decisions, and superior strategic performance, on a continuum that ranges from local impacts on specific business processes to global impacts on the entire organization. In an empirical study of 85 firms, Lee et al. [68] show a positive impact of BI systems on supplier operations, market segmentation, and sales activities, but no impact on financial performance. These findings are consistent with those of other empirical studies (e.g., Ref. [33]).

2.2. What we know about IT value creation

A large body of research has converged on the notion of a fundamental mechanism of IT value creation, according to which business value is the product of capabilities that are generated through the interaction between IT assets and organizational resources [64,79,82,102]. Specifically, this fundamental mechanism represents the integration of three consistent findings: (i) causal relationships exist between IT assets, IT capabilities, and business value; (ii) IT capabilities are created through the interaction between IT assets and organizational resources; and (iii) business value can be categorized as either operational or strategic. Next, we discuss these three consistent observations.

First, the RBV has often been adopted to describe the effect of IT assets on IT capabilities and the effect of IT capabilities on business value. The RBV maintains that the heterogeneity and immobility of firm resources result in superior performance, and that firms may be strategically differentiated based on firm resources that are valuable, rare, imperfectly imitable, and non-substitutable [8]. This view incorporates an important distinction between two types of firm resources: assets and capabilities [116]. Assets are defined as anything tangible or intangible that the firm can use in its processes, whereas capabilities are repeatable patterns of actions in the use of assets [101]. While assets are the basic units of analysis, a capability is the capacity for a group of assets to cooperatively perform an organizational activity [49]. Therefore, firm assets are the basic building blocks of firm capabilities, which represent integrated and coordinated arrangements of assets [2,108]. The notion that asset availability determines a firm's ability to develop capabilities suggests a cause-and-effect relationship between firm assets and capabilities [94]. Furthermore, because capabilities are considerably more heterogeneous and immobile than assets, they represent the primary source of strategic value. Such value may be manifested in overall firm performance or in the effectiveness of specific business processes [96]. In line with these RBV conceptualizations, IT capabilities, defined as "combinations of IT-based assets and routines that support business conduct in value-adding ways" [100,p. 108], have been considered as the foundation of IT business value [13,14,35,36,63].

Second, research has confirmed that IT capabilities are created by the interaction between IT assets and organizational resources. This research has often drawn upon contingency theory, explicitly or implicitly, to underpin the importance of organizational resources. Contingency theory, one of the most dominant theories in the study of organizational design and performance, is based on the assumption that there is no one best way of organizing and that any particular way is not equally effective under all conditions [43,48]. This theory suggests that the structure and process of an organization must fit its context for it to be effective [29]. This reasoning has often been applied to address the complementarity between IT and organization in describing the business value of IT (e.g., Refs. [28,37,40,44,89,121]).

Third, the organizational impacts of IT have frequently been classified as either operational or strategic. Based on a review of the literature on IT business value, Melville et al. [79] describe two common formulations of performance: efficiency and effectiveness. Whereas the former "emphasizes an internal perspective employing such metrics as cost reduction and productivity enhancement," the latter "denotes the achievement of organizational objectives in relation to a firm's external environment and may be manifested in the attainment of competitive advantage" [79,p. 287]. Accordingly, research has distinguished between the impacts of IT at the intermediate process level and at the organization-wide level (e.g., Refs. [37,90,102]).

2.3. What we know about BI value creation

The main objective of this study was to integrate the knowledge gained in previous research about general IT and specific BI mechanisms of value creation. Thus, we examined the extent to which research on BI business value drew on knowledge gained in research on IT business value. In particular, we focused on the extent to which research on BI business value applied the three consistent findings discussed in the preceding section.

However, the finding that IT capabilities are created by the interaction between IT assets and organizational resources could not be straightforwardly applied to the BI context. Given the broad spectrum of organizational resources that potentially interact with IT assets, such interactions have typically been examined through a lens that focuses on specific organizational resources [79,82]. In the BI context, we argue that a critical lens for understanding how assets are transformed into value-generating capabilities is that of organizational learning and innovation. Organizations learn by encoding inferences from history into routines that guide behavior, implying that organizational learning is routine based, history dependent, and target oriented [71]. From a practice-based standpoint, organizational learning is viewed as the bridge between working and innovating [15]. In their most fundamental form, BI systems are designed to transform organizational data into intelligence through a process that combines data integration with data analysis. This process of extracting knowledge from data does not take place in an organizational vacuum—it is either facilitated or inhibited by the organizational routines through which knowledge is accumulated and utilized, alternatives are considered, and decisions are made and implemented. The business value of BI assets is therefore contingent on their complementarity and compatibility with the target-oriented organizational routines through which learning generates organizational intelligence.

We consequently reviewed the recent literature on the business value of BI. Because this literature review was only the first step in our empirical investigation and not the main objective of this paper, we decided to focus on the past decade of research (i.e., 2000–2013). In this literature review, we identified 34 papers that examined the business value of BI, data warehouse (DW), or business analytics. Ten of these papers were conceptual and 24 were empirical, including single-case studies, multiple-case studies, surveys, and secondary data analyses. Table 1 summarizes the findings of the literature review. We examined each paper through three lenses—the relationships between BI assets and capabilities, the distinction between strategic and operational business value, and the influence of learning and innovation as organizational resources.

The literature review showed that BI research in the past decade generally applied the fundamental knowledge gained in research on IT business value. First, studies of the business value of BI frequently depicted BI capabilities as separate from and contingent on BI assets, both physical (i.e., BI hardware and software) and human (i.e., knowledge and skills of the BI team). Second, these studies frequently distinguished between the operational and strategic impacts of BI resources, where the former impacts included efficiency improvement, process optimization, and time and cost reduction, whereas the latter impacts included improvements in effectiveness, profitability, market share, and customer satisfaction. Third, these studies acknowledged the importance of having organizational capabilities of learning and innovation to the ability to derive business value from BI resources. However, notwithstanding the above, the literature review confirmed the lack of studies that made an explicit and comprehensive attempt to apply the knowledge accumulated in IT value research in the BI context while defining fine-grained relationships among BI assets, BI capabilities, and organizational learning processes. Therefore, we address this challenge in the next section.

2.4. A model of BI value creation

The model of BI value creation constructed in this study is presented in Fig. 1. The first step of model construction is to define BI assets and capabilities and to account for their interrelationships. Generally, the IT business value literature has distinguished between physical and human IT assets [17,27,79]. Whereas physical IT assets include the IT infrastructure shared across the organization and specific business applications that utilize the infrastructure [79], human IT assets include the technical, behavioral, and business knowledge and skills possessed by IT personnel [10,36,67]. Following the same conceptual approach, we rely on the general IT literature to define BI assets as comprising BI infrastructure and BI team.

The BI infrastructure represents the physical aspect of BI assets. Davenport [24] argues that deploying BI systems, that is, BI hardware and software, is necessary for becoming an organization that uses analytics as a main element of its strategy. A typical BI infrastructure consists of data storage, processing, and delivery [120]. Data storage includes a large-scale repository of integrated organizational data and the hardware for managing and storing it. Such a repository typically includes a centralized DW that covers a broad range of business activities, and a collection of departmental data marts (implemented with relational database management or multidimensional cube technologies), dedicated to specific decisional needs. Data processing includes automated utilities, commonly termed as extract–transform–load (ETL), for transferring and transforming data within the system. Such utilities are often implemented with dedicated commercial ETL platforms that support a broad range of protocols to allow flexible connectivity to different data sources and targets, as well as with graphical user interface (GUI)-supported tools for defining data transformations and executing transfer processes. Data delivery includes software platforms for developing end-user tools such as reports, user-initiated interactive data inquiry (commonly termed on-line analytical processing, OLAP), digital dashboards, and data mining [18]. The combination of these infrastructural technologies and tools creates a technological environment that enables organizations to develop BI capabilities, leading to better decision making and improved organizational performance.

The BI team represents the human aspect of BI assets. The literature suggests that there are various approaches to the

Table 1
Summary of the literature on the business value of BI.

Study	Methodology—Description	BI Resources: Assets and Capabilities	Business Value of BI: Strategic, Operational	Organizational Resources: Learning and Innovation
Cooper et al. [21]	Empirical—A case study of business strategy transformation aided by DW infrastructure	Investments in assets are directed by an alignment with corporate strategy	Transformation to client-centric strategy, improvement in financial performance	Benefits are gained by transforming and improving existing processes
Watson et al. [117]	Conceptual—A framework for understanding the typical growth path of a DW initiative	Investments in assets and capability formation are relatively small at early stages and scale up as the DW initiative matures	Initially, the value gained is mostly operational and tactical; strategic impact is visible only at later maturity stages	
Wixom and Watson [124]	Empirical—A survey of DW professionals toward understanding how the characteristics of DW initiatives affect their success	System/data quality mediated the effect of team skills, technological infrastructure, and BI capabilities	Benefit from the point of view of the DW manager in terms of reducing the time and efforts needed to support decision-making needs	
Couhinen et al. [22]	Conceptual—A framework for evaluating investments in a DW from both economic and information-requirements perspectives	BI capabilities are built through an ongoing process, which must consider shifting requirements and environmental conditions	Focus on strategic benefits (tangible versus intangible) as determined by the interaction with the external environment	Adaptation to environmental changes—particularly with respect to customer preferences
Watson et al. [119]	Empirical—A multiple case study for assessing a framework that explains the potential benefits of investments in a DW	Gaining benefits requires building strong capabilities, beyond investing in BI assets	In some cases, the benefits are comprehensive and assessed at the strategic level; in others, the effects are incremental	
Hannula and Pirttimäki [52]	Empirical—A survey-based study of the use of BI systems and their impact in large corporations	Benefits are gained by turning investments in BI assets into capabilities, such as better information quality, enhancement of knowledge base, and improved decision making	Benefits are gained at both operational and strategic levels	Companies in the IT sector are more likely to adopt BI and develop capabilities compared to manufacturing and service-oriented sectors
Loveman [73]	Empirical—A case study of the benefits gained from investing in data analysis capabilities	A key success factor—developing a culture of data collection and analysis	Strategic benefits (increase in revenues and profits) stem from operational benefits that were gained from using BI	Transformation in how the business is positioned and managed, together with incremental enhancements to certain processes
Lee et al. [68]	Empirical—A survey-based study of the impact of DW on firm performance in the retail industry	Investments in BI are associated with the establishment of stronger analytical capabilities	Better understanding of external factors, such as customers, market segments, and vendors; no clear evidence of financial gains associated with DW investments	
Lehman et al. [3]	Empirical—A case study of a large corporation that uses real-time BI to transform key business processes	Major investments in BI/DW technologies and team; building analytical capabilities and a culture of data usage at all firm levels	Comprehensive operational improvements, which are translated at the bottom line to a major increase in profitability	Major technological and operational transformation, together with ongoing incremental changes to business processes and routines
Davenport [24]	Empirical—A multiple case study of firms that developed competitive advantage by investing in data analysis infrastructures and capabilities	Investment in BI/DW technologies is insufficient; firms that gained benefits also invested in building skilled teams and data analysis capabilities	BI resources can be a source of value at both operational and strategic levels	An innovative and entrepreneurial culture cultivates the use of BI, but may also lead to some tension with respect to the requirement of evidence
Lönnqvist and Pirttimäki [72]	Conceptual—Development of an instrument for assessing BI contribution and success at different levels	BI capabilities are seen as an overarching concept that covers technology and team skills and competencies	Stakeholders (sponsors vs. users) may assess value differently, requiring the development of multiple measures of BI success	
Benaroch et al. [11]	Empirical—A case study of longitudinal investments in DW technologies from a viewpoint of value maximization	Main focus is on optimal policy for investment in technology, which derives other costs	Benefits are conceptualized as the net present value (NPV) of customer-related payoffs	
Clark et al. [19]	Conceptual—A theoretical model that explains the benefit gained from BI and other decision support technologies	Benefits depend on many different factors—user training, knowledge base, system and data quality, management support	Emphasis on perceived benefits, as true benefits are context dependent and difficult to assess	
March and Hevner [77]	Conceptual—A framework for understanding the contribution of data warehousing and BI to decision support in organizations	Investments in BI assets promote organizational interpretation, innovation, and decision-making capabilities	Value is gained by the acquisition and interpretation of data on business environment and processes	BI may promote innovation of different types and at different levels, which must be aligned with corporate vision and strategy
Sidahmed [103]	Conceptual—A theoretical model that links information processing and organizational performance to BI infrastructure and resources	BI capabilities are built from the interaction between technology infrastructure, human skills, and additional intangible resources	Value can be conceptualized in terms of both the ability to process information and the overall organizational performance	
Tremblay et al. [110]	Empirical—A case study that links the availability and design of BI utilities to organizational performance in a large health-care organization	Benefits and performance gains are achieved through a fit between task characteristics, human skills, and technology resources	BI improves task outcomes, but intangible benefits (e.g., reputation) can also be clearly recognized	

Table 1 (*Continued*)

Study	Methodology—Description	BI Resources: Assets and Capabilities	Business Value of BI: Strategic, Operational	Organizational Resources: Learning and Innovation
Watson and Wixom [120]	Conceptual—An overview of BI implementations, contributions, and challenges	BI success depends on a variety of key factors—management support, ongoing usage, fit to business needs, strong technology support	A broad spectrum of potential benefits—cost and time saving, enhanced information and decision capabilities, process improvement, strategic goal support	Harrah's Entertainment as an example of business transformation aided by BI capabilities
Elbashir et al. [33]	Empirical—A survey-based study of the contribution of BI to business performance	Business process improvement is key to understanding the benefits gained by BI	Benefits are assessed at the organizational level, reflecting several aspects—operations, market position, financial performance, and others	
Mannino et al. [75]	Empirical—A survey-based study of factors that reflect the efficiency of DW operations	Emphasis on system and data capabilities	Value is gained through the flexibility to support a broad range of usages simultaneously	
Ramamurthy et al. [92]	Empirical—A survey-based study that links organizational outcomes to the infusion of DW technologies and, further, to certain organizational and DW implementation characteristics	Benefits are gained through DW infusion—adoption and ongoing usage; infusion is gained by organizational support, DW management capabilities, and DW compatibility	organization-level benefits (e.g., cost-saving and decision capabilities) and stakeholder satisfaction	
Ramamurthy et al. [93]	Empirical—A survey-based study that investigates factors that affect DW adoption and its influence on DW complexity and organizational benefits	DW adoption is affected by a variety of factors—technology, skills, knowledge, etc.	Internal/operational benefits—information resources, decision capabilities, process improvements, data-sharing culture	Innovation culture may have an important influence on adoption
Wixom et al. [125]	Empirical—A case study that investigates DW maturity in a large firm by assessing changes to organizational culture and demonstrating several business process transformations	Maturity is gained through a continuous process of developing technological infrastructure, personnel, and BI usage skills	The scope and magnitude of benefits is likely to grow as the DW matures; maturity shifts the scope of benefit from local/operational to global/strategic	
Petrini and Pozzebon [84]	Empirical—A multiple case study that associates firm sustainability with the support of BI systems	The current focus of BI skill capabilities is mostly on economic benefits; enhancing social and environmental benefits requires additional awareness and efforts	BI contribution in terms of supporting economic, social, and environmental benefits	
Popovic at al. [88]	Conceptual—Development of a model that links business performance and value to BI maturity, information quality, and the use of information in business processes	Business processes are the vehicle through which BI benefits are realized; improvement to business processes is gained by BI maturity that leads to higher information quality	Benefits are realized through business performance improvement in terms of economic benefits	
Trkman et al. [111]	Empirical—A survey-based study of the impact of analytical capabilities on performance in the context of supply-chain management	Focus on analytical capabilities, supported by data collection	Benefits in terms of improving the performance of supply-chain activities	
Wixom and Watson [123]	Conceptual—An overview of different roles that BI systems play in organizations	Benefits are gained by investing in systems, technologies, and maintenance processes, but more so from the practices that evolve around them	Benefits can be assessed at different organizational levels and from multiple contribution perspectives	BI may contribute to both radical business transformations and incremental improvements
Brynjolfsson et al. [16]	Empirical—A survey-based firm-level analysis of the contribution of data-driven decision capabilities and BI systems	Firms that developed data-driven decision-making capabilities show higher performance	Impact on firm performance in terms of productivity, profitability, and market value	Data-driven decision making helps the creation of new products and services as well as incremental improvements
Elbashir et al. [34]	Empirical—A survey-based study of BI assimilation and usability	Success depends on forming relevant BI-related knowledge, beyond investment in systems and infrastructure	Improving business control and monitoring capabilities	Dependence on absorptive capacity—the ability to learn, assimilate, and apply new technologies
Maghrabi et al. [74]	Conceptual—Development of a model that explains the contribution of BI by distinguishing between explorative and exploitative usages	BI capabilities can be built at both strategic and operational levels	Impact on both strategic and operational performance	BI used for exploration may lead to radical service innovation, whereas BI used for exploitation may lead to incremental service innovation
Popovic et al. [87]	Empirical—A survey-based firm-level analysis of BI-related factors that influence the use of information in business processes	Value is gained through the support of BI to information use in business processes	BI systems are linked primarily to managerial tasks, where benefits are realized through improvement in business process performance	
Ramakrishnan et al. [91]	Empirical—A survey-based firm-level analysis of factors that direct BI investments	The goal may affect the BI system architecture and data collection procedures	BI may serve different goals—from gaining insights on specific issues to broad organizational transformations	BI supports business transformation toward matching the competitive environment and aligning with it
Isik et al. [57]	Empirical—A survey-based firm-level analysis of factors that influence BI success	BI success is affected by both technology-related and management-related capabilities, but not always as expected Investment in BI is observed as a whole	The success of BI is perceived as consistency with corporate objectives	

Table 1 (*Continued*)

Study	Methodology—Description	BI Resources: Assets and Capabilities	Business Value of BI: Strategic, Operational	Organizational Resources: Learning and Innovation
Rubin and Rubin [99]	Empirical—An analysis of the association between BI investments and stock return volatility, based on public-domain data		Value is measured externally, in terms of stock price performance; investment in BI reduces price volatility	
Vuksic et al. [115]	Empirical—A multiple case study that analyzes the impact of business process management and BI in different industries	Value can be gained by integrating BI systems into business process measurement systems	BI-supported measurement leads to business process improvement which, in turn, improves firm-level performance	Business process measurement may foster business innovation and create strategic agility

formation of a BI team, ranging from decentralized groups of super users who assist other users in interacting with BI systems to centralized, cross-functional competency centers with permanent, formal organizational structures [26,39]. Consistent with the general IT literature, which focuses on centralized human IT assets as the source of business value [13,36,98], the BI team is broadly defined here as a centralized team of BI professionals that is responsible for leading organizational BI initiatives. As the main objective of BI is to help decision makers understand the business environment and achieve business goals, the importance of the BI team is well understood [88]. Given the centralized nature of the BI team, it is expected to lead cross-organizational initiatives and to serve as an intermediary between business users and the larger IT area [39]. Technical skills are necessary but insufficient to accomplish this goal [18]. The BI team should indeed possess the technical skills to integrate data from multiple sources (DW and data marts, and ETL engines and processes), develop new BI applications (reports, digital dashboards, and OLAP utilities), and generally support the needs of users. Importantly, however, the BI team should also possess the behavioral skills to interact with and direct others, including executives and decision makers, users from different organizational domains, and external data and BI platform providers, as well as the business skills to understand the overall business environment and specific organizational context. These skills should allow the BI team to align BI systems with organizational strategy and processes.

Although the general IT literature is fairly consistent in classifying IT assets as either physical or human [17,64,79], it includes different ways in which the two types of assets are related to each other. One approach is that IT-related knowledge and skills are complementary to physical IT assets, implying that they are orthogonal to each other [6]. An alternative approach is that the experience and expertise of IT personnel may constrain the quality of physical IT assets [30], and therefore a model that accounts for the effect of human IT assets on physical ones is superior to alternative models of reversed causality or orthogonality [36]. Given that studies of BI implementation emphasize the importance of a highly qualified BI team to the successful deployment of BI infrastructure (e.g., Refs. [3,24]), we follow the latter approach in this study and hypothesize that the BI team affects the BI

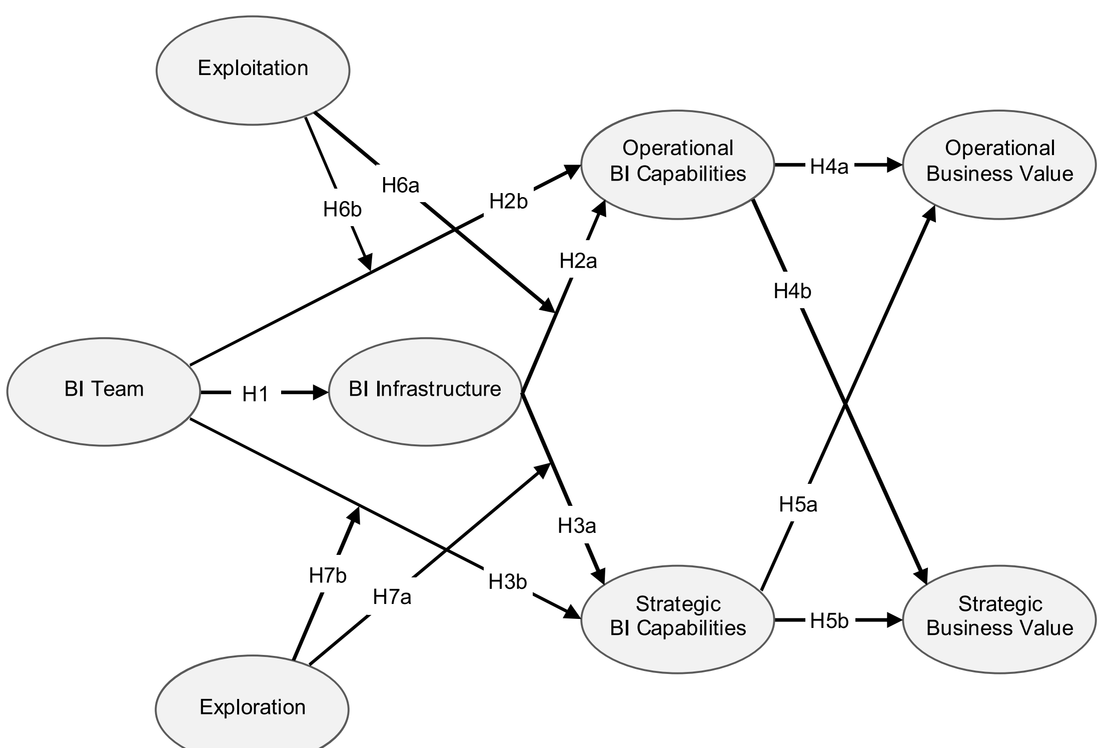

Fig. 1. Research model.

infrastructure. For instance, the first step in the implementation of a strategic decision to develop BI capabilities as a basis for competitive advantage is to form a BI team with the skills to effectively manage such a strategic project. This team then facilitates the development of the BI infrastructure [3].

Hypothesis 1. The BI team positively affects the BI infrastructure.

The general IT literature also distinguishes between operational and strategic aspects of IT-based performance [79]. This distinction is valuable in describing the evolution of BI capabilities. When first introduced to the business community in the 1990s, BI systems were positioned as a means of supporting strategic purposes, such as business transformation, corporate performance management, customer relations optimization, business activity monitoring, and traditional decision support [21,81]. However, as the field of BI advanced, firms recognized the merits of using BI for operational and tactical decision support [110,111], for example, improving production and service processes, optimizing supply-chain management activities, and cutting operational costs. At present, BI systems have reached an advanced level of maturity in many firms [24,123,125]. They are widely used at all organizational levels, and they support several decision making tasks—strategic and operational.

Following this differentiation between the different uses of BI systems, our study distinguishes between operational and strategic BI capabilities. This distinction represents a departure of our specific BI model from the general IT literature, which distinguishes between operational and strategic business value, but not between operational and strategic IT capabilities. To define operational and strategic BI capabilities, we rely on the definition of organizational capabilities as repeatable patterns of actions in the use of assets to perform an organizational activity [2,49,101] and on the definition of IT capabilities as combinations of IT-based assets that support business conduct in value-adding ways [63,100]. Accordingly, we define strategic BI capabilities as repeatable actions of using BI assets to support strategic organizational activities, such as measuring organizational performance; identifying trends, opportunities, and threats in the business environment; and formulating new corporate strategies. Similarly, we define operational BI capabilities as repeatable actions of using BI assets to support operational organizational activities, such as integrating certain forms of data analysis within transactional activities; modeling and optimizing production and service processes; and sharing information across business units.

Both strategic and operational BI capabilities are contingent on the BI assets of infrastructure and team. The literature on IT business value considers physical and human IT assets as the building blocks of IT capabilities [13,95], and this theoretical observation should not be affected by the distinction introduced previously between strategic and operational BI capabilities. Therefore, both BI infrastructure and team are needed to produce both strategic and operational BI capabilities. The differences between the two types of capabilities lie in different combinations of particular assets. Specifically, strategic BI capabilities are likely to require a BI infrastructure that can provide a complete and comprehensive view of the organization and its competitive environment, as well as a BI team that has the business and behavioral skills to align the BI infrastructure with organizational strategy and the ability to understand the information needs of corporate-level managers. For instance, a centralized DW and a BI team with a strong understanding of the business are preconditions for having the strategic BI capabilities to measure organizational performance and to present a comprehensive picture of an organization's status as a basis for decision making by senior executives. Conversely, operational BI capabilities are likely to require a BI infrastructure that can provide operational intelligence based on accurate and timely information from different parts of the organization, as well as a BI team that has the technical and behavioral skills to integrate multiple systems and develop new applications while interacting with managers and users across the organization. For example, interactive tools for data analysis and mining and a BI team with the skills to develop such tools to accommodate the analytical needs of business users are preconditions for having operational BI capabilities to use modeling and optimization on an ongoing basis to improve business processes. These differences notwithstanding, both BI infrastructure and team are crucial for developing strategic and operational BI capabilities.

Hypothesis 2a and b. (a) BI infrastructure and (b) BI team positively affect operational BI capabilities.

Hypothesis 3a and b. (a) BI infrastructure and (b) BI team positively affect strategic BI capabilities.

The second step of model construction is to account for the relationships between BI resources (assets and capabilities) and business value. It is well established in the general IT literature that IT capabilities (defined as the use of IT assets in business processes) mediate the business value of IT assets [64,104], because capabilities are considerably more heterogeneous and immobile than assets [116]. While IT assets are highly susceptible to imitation or substitution, they are transformed into IT capabilities through a path-dependent, causally ambiguous, and socially complex process. The present study, therefore, considers BI capabilities as the direct source of business value.

This study further converges with the general IT literature by defining business value as comprising operational value and strategic value. Consistent with Melville et al. [79], operational value represents improvements in the efficiency of business processes, including cost reduction and productivity enhancement, whereas strategic value represents the ability to meet organizational objectives, including improvements in financial performance and competitiveness. The BI context, however, calls for a more elaborate depiction of the relationships between capabilities and business value than those common in the general IT literature. First, as noted previously, the distinction between operational and strategic BI capabilities is critical to understanding BI value creation. BI capabilities comprise two value creation mechanisms, operational and strategic, which may coexist and provide business value independent of each other [3,73,118]. Second, while the dichotomy between operational and strategic business value echoes the distinction between operational and strategic BI capabilities, in the BI context it is possible to expect strategic value to directly originate from operational capabilities and operational value to directly originate from strategic capabilities. Indeed, we anticipate an operational path from capabilities to value and a strategic path. For example, the use of detailed transactional data to optimize business processes is likely to create operational value, whereas the use of integrated and aggregated data to identify business opportunities is likely to create strategic value. However, operational BI capabilities may provide strategic benefits. For instance, operational, real-time BI applications may help a firm significantly transform its industry position [3]. In a similar manner, strategic BI capabilities may provide operational benefits, for instance, when senior executives leverage the breadth of integrated information and the depth of analysis capabilities to achieve organizational efficiency improvements. In other words, although we distinguish between operational and strategic BI capabilities as two independent value creation mechanisms, we maintain the notion of capabilities as sources of both operational and strategic value.

Hypothesis 4a and b. Operational BI capabilities positively affect (a) operational business value and (b) strategic business value.

Hypothesis 5a and b. Strategic BI capabilities positively affect (a) operational business value and (b) strategic business value.

2.5. The moderating role of organizational learning

The third step of model construction is to account for the interaction between BI assets and organizational resources in the creation of BI capabilities. As noted earlier, a common theme in general IT research has been that IT capabilities are created by the interaction between IT assets and organizational resources [82]. This interaction mechanism is founded on the fundamental premise of contingency theory that organizational effectiveness depends on the fit between organizational structure and context [29]. This interaction takes place when IT assets and organizational resources complement each other such that the marginal benefit of using IT assets increases with the adoption of specific organizational practices [54]. Arguments for the complementarity between IT and organizational practices have frequently been used to justify the business value of IT [20,83,89]. Following the same rationale, Nevo and Wade [82] argue that business value is generated when IT assets and organizational resources are compatible, defining this compatibility as “the ability of an organizational resource to apply an IT asset in its regular activities and routines” [82,p. 170].

We apply these notions of complementarity and compatibility to reason that organizational learning is a key organizational resource for gaining business value from BI assets. Arguably, the prevailing typology in describing how organizations learn and innovate is March’s [76] framework of exploration and exploitation. According to March [76], adaptive organizational processes balance between the exploration of new competencies and the exploitation of existing ones. Whereas exploration is captured by terms such as search, experimentation, risk taking, flexibility, and discovery, exploitation is captured by terms such as refinement, production, efficiency, selection, implementation, and execution. Exploration and exploitation have often been discussed as two distinct modes of innovation, where exploitative innovations build on the existing technological trajectory to extend existing products and services, and exploratory innovations involve a shift to a different technological trajectory in pursuit of new products and services [12]. Therefore, exploration and exploitation are often used to distinguish between radical and incremental innovations [59].

An important issue regarding exploration and exploitation is whether the relationship between the two is continuous or orthogonal [50]. On the one hand, March [76] argues that exploration and exploitation compete for scarce organizational resources; thus, they should be addressed as two ends of a continuum. On the other hand, in some situations, exploration and exploitation are orthogonal to each other. For instance, if the resource is unlimited or the organization has access to external resources, then the constraint of scarce internal resources is relaxed. In such situations, organizations need to become ambidextrous, capable of simultaneously engaging in both exploration and exploitation [53,58,112].

We follow recent conceptualizations of simultaneous exploration and exploitation [65] and assume that organizations can become ambidextrous in the utilization of BI assets. Furthermore, we rely on the fundamental distinction between operational and strategic decision making, according to which the former is a structured process of considering day-to-day organizational concerns, whereas the latter is a complex and open-ended process of addressing long-term concerns related to organizational goals [1,23]. These conceptualizations are the basis on which we postulate that operational and strategic BI capabilities reflect the complementarity between BI assets and organizational routines of exploitation and exploration, respectively. Similar to Maghrabi et al. [74], we perceive operational BI capabilities as being compatible with the exploitation mode and strategic BI capabilities as compatible with the exploration mode. Consistent with Nevo and Wade [82], exploitation and exploration are considered organizational resources, specifically organizational routines, that moderate the effects of assets on capabilities. Specifically, the BI infrastructure and team are likely to generate stronger operational BI capabilities in organizational environments that are exploitative in nature, whereas these BI assets are likely to generate stronger strategic BI capabilities in organizational environments that are exploratory in nature.

Operational BI capabilities are generated by using BI assets to improve the efficiency of business processes. Process management activities tend to accentuate incremental, exploitative innovation because they aim at streamlining organizational activities within the existing technological trajectory [12]. Organizational exploitation involves first-order responses, which are rapid and match standard operating procedures [69]. It generates clearer, earlier, and closer feedback than exploration [70]. As such, it increases the marginal benefit of using BI assets to create operational BI capabilities. For example, BI capabilities that involve the ongoing use of operational and administrative data for process modeling and optimization purposes are expected to be more readily generated from BI assets when organizational routines are more oriented toward frequent, incremental improvements in existing products and services. An organizational environment characterized by high exploitation, oriented toward efficiency, refinement, production, and execution, is likely to facilitate the transformation of BI assets into operational BI capabilities.

Hypothesis 6a and b. Exploitation positively moderates the effect of (a) BI infrastructure and (b) BI team on operational BI capabilities.

Strategic BI capabilities are generated by using BI assets to support strategy formulation and implementation. These strategic activities involve radical, exploratory innovations that open up a new technological trajectory. Organizational exploration involves second-order responses, which are slower and entail changes in search behavior, technological opportunities, and organizational goals [69]. Exploration is a second-order organizational competence to create new knowledge by recombination of knowledge across technological or organizational boundaries [97]. Its main purpose is to identify ways of positioning the organization to address environmental change and to create new streams of knowledge as the sources of competitive advantage [56]. As such, exploration increases the marginal benefit of using BI assets to create strategic BI capabilities. For example, BI capabilities that involve the in-depth analysis of integrative cross-organizational data to identify opportunities and threats in the business environment and to assist in strategy formulation are expected to be more readily generated from BI assets when organizational routines are more oriented toward radical innovations and the pursuit of new products and services. An organizational environment characterized by high exploration, oriented toward flexibility, risk taking, and discovery, is likely to facilitate the transformation of BI assets into strategic BI capabilities.

Hypothesis 7a and b. Exploration positively moderates the effect of (a) BI infrastructure and (b) BI team on strategic BI capabilities.

3. Research methodology

The methodology for developing and testing the research model included two stages, exploratory and confirmatory. The first stage involved an exploratory analysis of the theoretical premises underlying the research model, in particular the relationships among BI assets, BI capabilities, and business value, as well as the distinction between operational and strategic BI capabilities. The moderating role of organizational learning was not explored at this stage because of the intricate nature of such relationships. The main objective of this stage was to validate the theoretical foundations of the model based on multiple cases of BI system implementation. This stage was not designed as a rigorous test of the research hypotheses but rather as a preliminary test of our theoretical approach. The second stage involved a confirmatory analysis of the model and hypotheses using the survey method common in the literature on IT business value. Although uncommon, the approach of combining case studies and survey research methods reinforces the strength of the research model [42].

3.1. Exploratory analysis

The exploratory analysis was based on semi-structured interviews in three leading Israeli firms from three different industries: AE (a provider of agricultural equipment), CI (a provider of communication infrastructure), and TS (a provider of telecom services). These three firms covered both manufacturing and service sectors and both low- and high-tech sectors. Furthermore, all three firms already had a functional BI system for several years when the study was conducted; thus, they were in a position to provide insight on how BI systems generate business value.

Before the interviews were conducted in each firm, we met with the chief information officer (CIO) or his/her representative, to make sure that the firm met the preconditions for inclusion in the exploratory analysis [5], in particular the possession of a functional BI system. Interviews were carried out in each firm with three to four interviewees who were highly familiar with the BI system. The interviewees included IT and business managers, chosen together with a senior contact person in each firm. Interviewing both IT professionals and business users allowed for the triangulation of data from different perspectives (providers and users). The interviews were conducted within a 2-month period per firm (all between February and May 2010) to avoid the possibility of radical organizational or technological changes between interviews.

In all three firms, the interviewees emphasized the improvement in managerial decision making as a result of strengthening BI capabilities. Before BI systems were implemented, decisions were mostly based on heuristics, previous experience, and subjective assessments and less on data resources and documented knowledge. Although data resources were available in all firms even before BI implementation, their use was hindered by slow retrieval performance and data quality issues, as data were often missing or were inconsistent when integrated from multiple sources. With the implementation of BI systems, managerial discussions became more focused, largely due to a greater consensus on the reliability of the data. The integration of data from multiple sources created a unified corporate view, on which the firms relied. Disagreements on data reliability, if existing, were usually addressed before meetings, so that the meetings remained focused on data interpretation rather than on the accuracy of the facts. In addition, the integration of data created “a single corporate language,” so it was clear to all what a certain concept meant. BI systems also supported the up-to-date monitoring and control of work plans. The BI systems in all three firms were initially designed to support managerial processes and decision making at the strategic level. Supporting operational processes, if it occurred, was usually a much later development.

The data collected in the interviews suggested that BI assets are positively associated with BI capabilities. TS invested more resources in developing and implementing its BI system than AE and CI did. Among the three firms, the BI team of TS included the largest number of employees (several dozens), its BI capabilities were the strongest (e.g., use of advanced analytical tools), and its BI system was the most integrated into business processes. By contrast, AE had only made minor investments in BI and its BI capabilities were relatively limited.

At TS, the system was widely used by service providers and decision makers. Mid-level managers used the system to segment customers and identify their preferences and potential for abandonment. At CI, some employees in operational units used the system to identify customer preferences and aid certain supply-chain management activities. At AE, inventory management and workload distribution had been far more efficient since the BI system was implemented. These findings strengthened the notion that investments in BI assets and the resulting BI capabilities have significant benefits not only at the strategic level but also for lower-level management and operations, resulting in reduced inventory, cost savings, and shorter response time.

Although it is difficult, if not impossible, to attribute improvement in profitability directly to BI systems, some interviewees explicitly stated that one reason for profitability improvement is that better decisions are made when decision making is based on real information and knowledge rather than on assumptions or gut feelings. For instance, two TS interviewees explicitly noted that the BI system improved profitability and suggested that BI implementation had a positive effect on the market value of the firm. Other interviewees noted improvement in productivity, at least in some areas. At AE, for example, the marketing department requested a production increase, but in-depth analysis using the BI system showed no need for this increase. Thus, the firm saved hundreds of thousands of dollars. Similar cost-saving incidents were also noted at CI, supporting the notion that the improvement in decision making arising from the use of BI systems may create tangible value for the organization, apart from intangible benefits.

Some interviewees attributed improvement in operational processes to the increased amounts of information that became available and accessible to users in a convenient and simple manner via the BI system. Improving operational processes can lead to value creation by lowering costs, better identifying opportunities and threats, and responding promptly to problems. For example, after using the BI system and analyzing the relevant data, AE lowered its costs by changing the frequency of delivery from daily to three times a week. At TS, the BI system was used for customer retention purposes, including identification of customer intention to switch to another service provider.

The findings of the exploratory analysis are summarized in Table 2. These findings align, to a great extent, with the BI adoption stages predicted by Watson et al. [117]. The state of BI at AE can be associated with the relatively early “initiation stage,” which focuses on operational impact and benefits. CI appears to be at the “growth stage,” in which the use of BI to support higher-level decisions by mid-level managers becomes more common. TS seems to have reached the “maturity stage,” which is characterized by wide adoption of BI capabilities, both traditional and advanced, for a diverse variety of strategic and operational decision-making tasks at all organizational levels [125].

In conclusion, the interviews confirmed the notion that BI generated business value, both tangible (improvement in organizational performance) and intangible (perceived improvement in structural and cultural aspects). The interviews also made it clear

Table 2
Summary of the findings of the exploratory analysis.

Firm	TS	CI	AE
Industry	Telecomm services	Communication infrastructure	Agricultural equipment
Experience with BI	~10 years	~4 years	~3 years
Investments in BI	Relatively high	Medium	Relatively low
BI team	Several dozen professionals	15–20 professionals	Less than 10 professionals
Business scope and coverage	High—most corporate functions and business activities are reflected and covered by the BI system	Medium—most key business functions (mainly with respect to marketing and supply-chain activities) are covered; other functions are expected to be covered in the future	Limited—focus on financial analysis and operations management
BI sophistication	High—extensive use of advanced analytics, data mining, and prediction	Medium—mainly reporting and data visualization, with some analysis of past transactions; no use of sophisticated tools and techniques	
BI adoption and use at different organizational levels	Broad, diverse, and extensive use of BI at all levels: • Strategic—BI is used in board meetings; high exposure of senior management to BI capabilities • Operational—BI is used for budgeting, planning, and performance monitoring; BI capabilities are integrated in customer-facing service processes	Greater adoption and use at lower management levels: • Strategic—relatively low adoption by senior management • Operational—BI is used for customer analysis and optimization of supply-chain activities (e.g., logistics and inventory management); extensive use for optimizing production and service processes	Limited use, mostly focused on financial reporting and operational cost saving: • Strategic—relatively low adoption by senior management • Operational—BI is used for a variety of operational tasks (e.g., budget monitoring, performance measurement, and workforce allocation)
Perceived tangible benefits	• Increase in market value, higher profitability • Improved efficiency of service processes	• Successful marketing initiatives • Increase in profitability • Higher efficiency of supply-chain activities	• Higher efficiency and substantial cost savings with respect to inventory management • Improved workload distribution
Perceived intangible benefits	•Unified business terminology and language •Improved management in terms of transparency and focused decision making •Better planning and monitoring capabilities		

that an in-depth analysis of the value contribution of BI must treat the BI infrastructure and BI team separately. Some interviewees mentioned that investment in the BI infrastructure itself is needed, but it cannot generate value without adequate investment in a BI team. Although no consistent differences were found between industries, the interviews highlighted the need to distinguish between exploration and exploitation as two separate mechanisms of learning and innovation.

3.2. Confirmatory analysis

The confirmatory analysis of the research model followed the common methodology in studies on general IT business value. This methodology involved the construction of an instrument to measure the constructs in the research model, the collection of data via a cross-sectional survey, and the analysis of data using SEM techniques (e.g., Refs. [14,36,109]).

The survey instrument was developed based on the existing literature, to the extent possible. The BI team construct was operationalized using six items from Ross et al. [98], adapted to the BI context. Whereas Ross et al. [98] offered an instrument to assess general IT knowledge and skills, we adapted their instrument to the specific BI context by focusing on the knowledge and skills necessary to develop, implement, and maintain BI systems. The operational and strategic business value constructs were operationalized by adapting eight measures from Elbashir et al. [33], who developed a comprehensive instrument to measure the performance effects of BI systems. However, because their instrument was based on a more fine-grained definition of performance effects, distinguishing between strategic effects and three different dimensions of operational effects (supplier relations, internal efficiency, and customer intelligence), we used the measures that better aligned with our conceptual definitions of operational and strategic business value. These measures, addressing specific performance indicators (e.g., operating costs and revenues), were then complemented by additional measures based on the distinction between organizational efficiency and effectiveness proposed by Melville et al. [79]. Specifically, two operational value items addressed the improvement in organizational processes and their efficiency, and six strategic value items addressed various aspects of organizational effectiveness (e.g., achievement of organizational objectives) and competitiveness (e.g., inimitability by competitors). Finally, exploration and exploitation were operationalized by adapting six and seven items, respectively, from Jansen et al. [59].

Measures of BI infrastructure and measures of operational and strategic BI capabilities were not based on an existing instrument due to the limited empirical research conducted in this area. Therefore, these measures were developed based on the existing BI literature, the conceptual definitions presented earlier in this paper, and the findings of the exploratory analysis. Measures of BI infrastructure assessed its qualities in terms of database synchronization, user accessibility, response time, maintainability, tool development, and meeting of technological needs. Measures of operational BI capabilities generally addressed BI-enabled routines of ongoing process improvement by middle management. Finally, measures of strategic BI capabilities generally addressed the BI-enabled abilities of organizational performance measurement and presentation that facilitate business environment analysis and organizational strategy formulation by senior management.

All measures used a seven-point scale, with the ratings “strongly agree” and “strongly disagree” on either end. The questionnaire also included a section to obtain background information. The initial instrument was pretested in three semi-structured interviews with BI experts, who held BI management positions in large firms. Each interviewee was briefed on the purpose of the study and was asked to evaluate the questionnaire items for comprehensibility, relevance, and completeness. Following these interviews, the survey instrument was revised and finalized.

The final instrument was administered to IT and business managers in a large, cross-sectional, Web-based survey. The use of Web-based surveys as the primary method of data collection is common in both general IT studies (e.g., Refs. [36,114]) and specific BI studies (e.g., Refs. [33,52]). IT and business managers were chosen as the target population because of the need to collect data from informants who were highly familiar with the BI system, BI capabilities, organizational learning and innovation processes, and organizational performance. The use of diversified measures – technological and organizational, operational, and strategic – called for the use of a diversified population.

Given the increasing difficulty of collecting organizational data via large-scale surveys [9], we used two complementary channels to reach the target population. First, we distributed the questionnaire to a list of about 500 managers who, in one way or another, expressed interest in annual symposiums on IT management in a leading Israeli university. Second, we distributed the questionnaire to a larger population of managers through the primary IT community provider in Israel. In both cases, potential respondents were contacted via an e-mail cover letter that contained a link to the questionnaire Web page. The cover letter described the objectives of the study and the types of managers encouraged to participate in it. The cover letter also provided information on and means of communication with the authors, to minimize potential concerns about the legitimacy of the study. Finally, to incentivize managers to participate in the study, the cover letter provided the option of registering to receive a practitioner-oriented version of the findings, once the study is complete. All e-mails were distributed only once, with no reminders.

In total, 91 questionnaires were returned via the first distribution channel and 87 via the second one. *T*-test comparisons of the responses received via the two channels found statistically significant mean differences for only three of the 54 questionnaire items, each measuring a different construct (BI infrastructure, operational business value, and strategic business value), rejecting the possibility that the distribution channel significantly biased the collected data. From the 178 returned questionnaires, 19 had to be excluded because of a large number of missing values (five questionnaires) or unanswered items regarding a specific construct (14 questionnaires), to ensure that values in the dataset were missing at random. Table 3 presents the characteristics of the final sample of 159 respondents.

For the final dataset, we tested the possibility that IT managers provided responses that were different from those of other managers. *T*-tests comparing the responses of IT managers with those of the rest of the sample found statistically significant mean differences for only two of the 54 questionnaire items: one item measuring operational business value (OBV6) and one item measuring strategic business value (SBV6). Therefore, the possibility that respondent position significantly biased the data was rejected.

The nonresponse bias was evaluated by comparing early and late responses [7]. *T*-tests comparing early responses (lower quartile of response time) with late responses (upper quartile of response time) found no statistically significant mean differences for the first distribution channel and two statistically significant mean differences (one item measuring exploration and one item measuring strategic business value) for the second distribution channel. Thus, the possibility of a dominant nonresponse bias was rejected.

Table 3
Sample characteristics.

Characteristic	Frequency	Percent
Position		
Senior executives		
CEO	10	6.3%
VP	16	10.1%
IT executives		
CIO	41	25.8%
IT manager	14	8.8%
BI team		
BI manager	33	20.8%
BI expert	19	11.9%
Other	26	16.3%
Time with the company		
Less than a year	13	8.2%
One to two years	20	12.6%
Three to five years	41	25.8%
More than five years	85	53.4%
Industry		
Commerce	11	6.9%
Finance	17	10.7%
Government	6	3.8%
Manufacturing	31	19.5%
Non-profit organization	6	3.8%
Research & development	21	13.2%
Services	42	26.4%
Other	25	15.7%
Number of employees		
<50	6	3.8%
51–100	12	7.5%
101–200	15	9.4%
201–500	20	12.6%
501–1000	21	13.2%
>1000	85	53.5%

4. Results

To analyze the collected data, we used covariance-based SEM techniques with the AMOS 20 software and maximum likelihood estimation (MLE). Although our sample size was close to the lower bound of the recommended sample size for covariance-based SEM [51], we preferred covariance-based SEM techniques over the partial least squares (PLS) techniques, because the former allows the assessment of the plausibility of the hypothesized research model through goodness-of-fit tests [46,47]. The data were analyzed by following the common two-step approach, where the measurement model was separately estimated and respecified before estimating the full structural model that simultaneously modeled measurement and structural relationships [4]. In the following subsections, we describe the analysis of the measurement, structural, and multigroup models.

4.1. Measurement model

The measurement model included the six exogenous and endogenous constructs in the research model, excluding the moderating constructs of exploration and exploitation, which were relevant to the assessment of moderation in the multigroup models. Consistent with our operationalization of constructs, which aimed at including measurement items that represented manifestations of the construct, shared the same nomological net, and were expected to covary with one another, the constructs were modeled as reflective [60,85]. The procedure for the estimation and respecification of the measurement model followed the standard

SEM methodology of sequentially dropping items that shared a high degree of residual variance with other items [51]. A confirmatory factor analysis showed satisfactory model fit—the adjusted χ^2 (ratio of χ^2 to degrees of freedom) was 1.73 (χ^2_{419} = 723.526), below the recommended threshold of 3. Fit indices—the comparative fit index (CFI) at 0.936, incremental fit index (IFI) at 0.937, normed fit index (NFI) at 0.861, and root mean square error of approximation (RMSEA) at 0.068–were within or slightly outside the accepted levels for confirmatory factor analysis [45,51]. Table 4 presents the questionnaire items, their descriptive statistics, and the standardized item loadings for the initial and revised measurement models.

Before testing the structural model, the constructs in the revised measurement model were tested for construct reliability, convergent validity, and discriminant validity. All composite reliability (CR) values were considerably above the commonly used threshold of 0.70, suggesting good reliability [51]. Standardized item loadings for the revised measurement model were above 0.70 for all items ($p < 0.001$), representing satisfactory convergent validity [47]. In addition, all average variance extracted (AVE) values were above the recommended threshold of 0.50, indicating that the variance captured by the construct was larger than the variance attributed to measurement error [38]. Discriminant validity was assessed by comparing two nested models for each pair of constructs in the measurement model: an unconstrained model that freed the correlation between the two constructs and a constrained model that set the correlation between them to 1.0. A significantly lower χ^2 value for the unconstrained model indicated that the constructs were not perfectly correlated and provided evidence of discriminant validity [51]. The χ^2 difference was significant ($p < 0.001$) for all possible paired comparisons of the constructs. Table 5 presents the correlation matrix, including the CR and AVE values.

4.2. Structural model

The analysis of the structural model aimed at testing H1–H5, which described the relationships among BI assets (infrastructure and team), BI capabilities (operational and strategic), and business value (operational and strategic). The results of this analysis are presented in Fig. 2. Generally, the model fit indices showed that the research model was supported by the data. The adjusted χ^2 at 2.00 (χ^2_{425} = 851.05), CFI at 0.910, IFI at 0.911, and RMSEA at 0.080 were all within accepted levels. Similar to the results for the measurement model, only the NFI at 0.837 was below the recommended threshold of 0.90.

The standardized path coefficients in the structural model supported all hypotheses but two. While the BI team had a strong effect on the BI infrastructure (supporting Hypothesis 1) and the BI infrastructure had strong effects on operational and strategic BI capabilities (supporting Hypotheses 2a and 3a), the direct effects of the BI team on BI capabilities were weak (the coefficient for Hypothesis 2b was significant at the 0.10 level and the coefficient for Hypothesis 3b was nonsignificant). These results generally confirmed the mediating role of the BI infrastructure in the relationship between the BI team and BI capabilities. The path coefficients further confirmed the positive effects of operational BI capabilities on operational and strategic business value (supporting Hypotheses 4a and b). While the effect of strategic BI capabilities on operational business value was nonsignificant (the coefficient for Hypothesis 5a had a p-value of 0.116), their effect on strategic business value was significant at the 0.10 level (the coefficient for Hypothesis 5b had a p-value of 0.057). The structural model explained most of the variance in BI infrastructure (73.6%), operational BI capabilities (68.6%), and strategic BI capabilities (58.5%), but only about a third of the variance in operational business value (38.8%) and strategic business value (30.3%).

To reject the possibility that the significant paths in the structural model were a consequence of using a single instrument to measure all constructs, a rigorous test of common method bias was conducted [86]. A common-method variance factor was added to the structural model, and all the items of the endogenous constructs were allowed to load on this factor as well. The variance of a specific item was thus partitioned into trait, method, and random error. Retesting the structural model with the method factor resulted in a similar pattern of significant paths (the two paths that were significant at the 0.10 level became nonsignificant), ruling out the substantial influence of common method bias.

4.3. Multigroup models

The moderating effects of exploitation (Hypotheses 6a and b) and exploration (Hypotheses 7a and b) were examined using a series of multigroup analyses, in which the path coefficients were compared between the subgroups of each moderator. Because exploitation and exploration were measured with multiple items, we performed a principal component analysis (PCA) to calculate exploitation and exploration scores for each organization. PCA was preferred to other factor analysis methods based on our theoretical assumption of exploitation and exploration being orthogonal to each other. Furthermore, the use of PCA to calculate exploitation and exploration scores was consistent with the methodology used by Jansen et al. [59], who originally developed these scales. The PCA confirmed the existence of two factors (eigenvalues > 1.0), while the Varimax-rotated component matrix showed that two exploitation items (EI1 and EI3) loaded significantly (above 0.6) only on exploration. Further, three exploitation items (EI2, EI4, and EI7) had to be dropped because they failed to load significantly on a single factor.

The exploitation and exploration subgroups were created based on two separate median splits of the sample into high- versus low-exploitation subgroups and high- versus low-exploration subgroups. Differences in path coefficients between subgroups were analyzed by estimating a series of nested multigroup models. First, the structural model was estimated by allowing all model parameters to be free across subgroups. Next, a particular path was constrained to be equal across subgroups. A statistically significant χ^2 difference between the constrained and unconstrained multigroup models (with one degree of freedom) indicated that the difference in path coefficients between subgroups was statistically significant and that the particular path was affected by the moderator. This procedure was followed for the paths from BI infrastructure and BI team to operational BI capabilities for the high- versus low-exploitation subgroups (Table 6) and for the paths from BI infrastructure and BI team to strategic BI capabilities for the high- versus low-exploration subgroups (Table 7). Tables 6 and 7 present the unconstrained standardized path coefficients in each subgroup (as if each subgroup was estimated independently), the constrained–unconstrained χ^2 differences, and the statistical significance of these differences.

Table 6 shows that the χ^2 differences for exploitation were not statistically significant; therefore, exploitation did not moderate the effects of BI infrastructure and BI team on operational BI capabilities (Hypotheses 6a and b were not supported). By contrast, Table 7 shows that the χ^2 differences for exploration were statistically significant; thus, exploration moderated the effects on strategic BI capabilities (Hypotheses 7a and b were supported). In particular, the unconstrained path coefficients in Table 7 show that strategic BI capabilities were affected by different BI assets in different exploration subgroups—by the BI infrastructure in the

Table 4
Descriptive statistics and standardized loadings of items.

Item	Wording	*N*	Mean	Std. Dev.	Loading (Initial)	Loading (Revised)
	BI Infrastructure (BII)					
BII1	The BI infrastructure enables fast response time to the uses of the system	158	5.361	1.429	0.832	0.831
BII2	The BI infrastructure is well synchronized with other organizational databases	158	5.190	1.585	0.794	0.794
BII3	The BI system is accessible to users	159	5.491	1.475	0.870	0.869
BII4	The BI infrastructure meets the technological needs of the organization	158	5.146	1.591	0.905	0.906
BII5	The organization invests the resources required for the acquisition and maintenance of the BI infrastructure	159	4.805	1.659	0.793	0.791
BII6	The BI infrastructure enables the development of easy-to-use and intuitive tools	158	5.089	1.586	0.762	0.762
	BI Team (BIT)					
BIT1	The BI team has knowledge and technical capabilities corresponding to the requirements from the BI system	159	5.579	1.515	0.943	0.944
BIT2	The BI team has the ability to lead the process of designing and developing the BI system	159	5.516	1.602	0.911	0.916
BIT3	The BI team maintains the system in a satisfactory way	158	5.475	1.496	0.916	0.915
BIT4	The BI team has business understanding compatible with business requirements	157	5.350	1.568	0.878	0.881
BIT5	The interpersonal capabilities of the BI team are compatible with organizational characteristics	157	5.490	1.492	0.855	0.856
BIT6	BI team managers and senior executives agree on the nature and role of the BI system	157	5.057	1.711	0.816	Dropped
	Operational BI Capabilities (OBIC)					
OBIC1	The organization makes extensive use of modeling and optimization to improve business processes	158	4.038	1.666	0.729	Dropped
OBIC2	The organization comprehensively analyzes operational and administrative information on an ongoing basis	159	4.931	1.627	0.729	0.716
OBIC3	The organization combines data from the BI system in its ongoing processes	159	5.245	1.574	0.907	0.920
OBIC4	Departments in the organization commonly share information and insights generated from the BI system	158	4.323	1.713	0.817	0.804
OBIC5	The organization integrates BI tools in its ongoing processes	155	5.032	1.692	0.901	0.913
OBIC6	Mid-level managers are significantly assisted by the BI system for decision making	158	4.829	1.675	0.832	0.834
	Strategic BI Capabilities (SBIC)					
SBIC1	The BI system enables real-time identification of trends	157	4.694	1.708	0.708	Dropped
SBIC2	The BI system serves as a complementary tool for measuring organizational performance and for displaying the results	158	5.335	1.587	0.819	Dropped
SBIC3	Senior executives are significantly assisted by the BI system for decision making	158	4.956	1.835	0.865	Dropped
SBIC4	The BI system enables a complete and comprehensive presentation of the organization's status	158	4.481	1.711	0.883	0.911
SBIC5	The BI system provides in-depth analysis capabilities of the organization's status	157	4.739	1.725	0.910	0.948
SBIC6	The BI system is used to identify trends, opportunities, and threats in the business environment	156	4.167	1.722	0.696	0.710
SBIC7	Information derived from the BI system significantly assists in formulating the organizational strategy	156	4.468	1.728	0.888	0.880

Item	Wording	*N*	Mean	Std. Dev.	Loading (Initial)	Loading (Revised)
	Operational Business Value (OBV)					
OBV1	Significant steps of improving production/service processes are performed in the organization	159	5.346	1.441	0.764	0.780
OBV2	The internal processes in the organization are efficient in terms of time and cost	157	4.618	1.435	0.814	0.808
OBV3	Employee productivity has been increasing	158	4.842	1.333	0.865	0.878
OBV4	Inventory levels have been reducing	141	4.362	1.708	0.451	Dropped
OBV5	The geographic distribution of sales/service activities has been expanding	155	4.903	1.480	0.546	Dropped
OBV6	Operating costs have been reducing	152	4.684	1.388	0.725	0.704
OBV7	Customer service has been improving	158	5.133	1.297	0.803	0.796
	Strategic Business Value (SBV)					
SBV1	Profits have been increasing	151	4.947	1.672	0.835	0.814
SBV2	Revenues have been increasing	153	5.131	1.673	0.832	0.796
SBV3	Return on investment (ROI) has been increasing	144	4.597	1.632	0.831	Dropped
SBV4	Decision-making processes have been improving	157	4.809	1.507	0.832	Dropped
SBV5	The organization responds well to changes in the business environment	157	4.911	1.521	0.885	0.901
SBV6	The organization responds well to competitors' activities	153	4.882	1.437	0.856	0.887
SBV7	The organization has a better understanding of customer needs	156	5.026	1.353	0.860	0.874
SBV8	The organization provides unique products/services that competitors find difficult to imitate or substitute	151	4.523	1.673	0.627	Dropped
SBV9	The organization meets its objectives	157	5.191	1.419	0.772	0.781
	Exploration					
ER1	The organization accepts demands that go beyond existing products/services	154	5.097	1.361		
ER2	The organization is constantly developing new products/services	157	5.408	1.515		
ER3	The organization experiments with new products/services in targeted markets before distribution	153	4.529	1.836		
ER4	The organization frequently utilizes new opportunities in new markets	156	4.660	1.624		
ER5	The organization regularly explores new distribution channels	155	4.523	1.661		
ER6	The organization regularly searches for and approaches new clients in new markets	158	5.146	1.567		
	Exploitation					
EI1	The organization frequently refines the provision of existing products/services	158	4.589	1.690		
EI2	The organization regularly implements small adaptations to existing products/services	157	5.108	1.466		
EI3	The organization introduces improved, but existing products/services for the local market	155	5.045	1.645		
EI4	The organization invests considerable resources in developing existing markets	157	5.223	1.555		
EI5	Lowering costs of internal processes is an important objective of the organization	158	5.241	1.582		
EI6	The organization invests considerable resources in improving production/service processes	157	5.248	1.431		
EI7	The organization expands services for existing clients	156	5.122	1.346		

Table 5
Correlation matrix.

Construct	CR	AVE	Correlation Matrix					
			BII	BIT	OBIC	SBIC	OBV	SBV
BI infrastructure (BII)	0.928	0.684	1					
BI team (BIT)	0.957	0.815	0.857	1				
Operational BI capabilities (OBIC)	0.923	0.707	0.799	0.759	1			
Strategic BI capabilities (SBIC)	0.923	0.752	0.742	0.694	0.780	1		
Operational business value (OBV)	0.895	0.632	0.612	0.496	0.602	0.523	1	
Strategic business value (SBV)	0.936	0.711	0.504	0.447	0.522	0.486	0.844	1

CR = composite reliability; AVE = average variance extracted.

high-exploration subgroup and by the BI team in the low-exploration subgroup. In other words, the BI infrastructure fully mediated the effect of the BI team on strategic BI capabilities in the high-exploration subgroup, but no such mediation existed in the low-exploration subgroup.

5. Discussion

5.1. Key findings

The findings of this study validate the reasoning that operational and strategic BI capabilities should be considered separately and that organizations may become ambidextrous in their BI capabilities in the same way they can become ambidextrous in their approach to organizational learning. The study advances the perception that business value is generated from BI assets via two parallel mechanisms, operational and strategic, based on two orthogonal sets of respective capabilities. This dual approach to BI value creation represents the next step in the evolution of BI business value models. The literature on BI business value, summarized in Table 1, frequently analyzes the organizational impacts of BI by a single conceptualization of business value [57,88,92,110]. More elaborate research models distinguish between operational and strategic impacts, demonstrating that the former precede and bring about the latter [33,117]. When BI capabilities are addressed formally as part of such models, they are defined with a single construct [92,103]. Against this literature, the present study presents a nuanced description of operational and strategic routes from BI assets to business value, in which BI capabilities play a pivotal role. While the findings are consistent with the literature in that the path from operational (capabilities) to strategic (business value) is supported and the path from strategic (capabilities) to operational (business value) is not, the results validate the notion of two separate mechanisms. Our approach to BI value generation is consistent with studies showing that firms that excel in the development of BI-based analytical skills often gain competitive advantages only after the broad integration and utilization of BI in their operational processes (e.g., Refs. [24,73,125]). Our approach, however, implies that this path from operational BI capabilities to strategic business value is one of several possible paths from capabilities to business value for BI.

Insights gained in our exploratory study of three firms confirm our dual approach to BI value creation. The three cases show that the various constructs reflecting BI investments, capabilities, and business value are often synchronized with one another, where larger investments in BI are associated with stronger BI capabilities and higher business value (e.g., the case of TS versus the case of AE). The cases also show that operational and strategic BI capabilities may be aligned with each other (e.g., the TS case, where both are strong), but they may also be misaligned (e.g., the AE case, where operational BI capabilities are strong and strategic BI capabilities are weak). These exploratory findings are indicative of a general

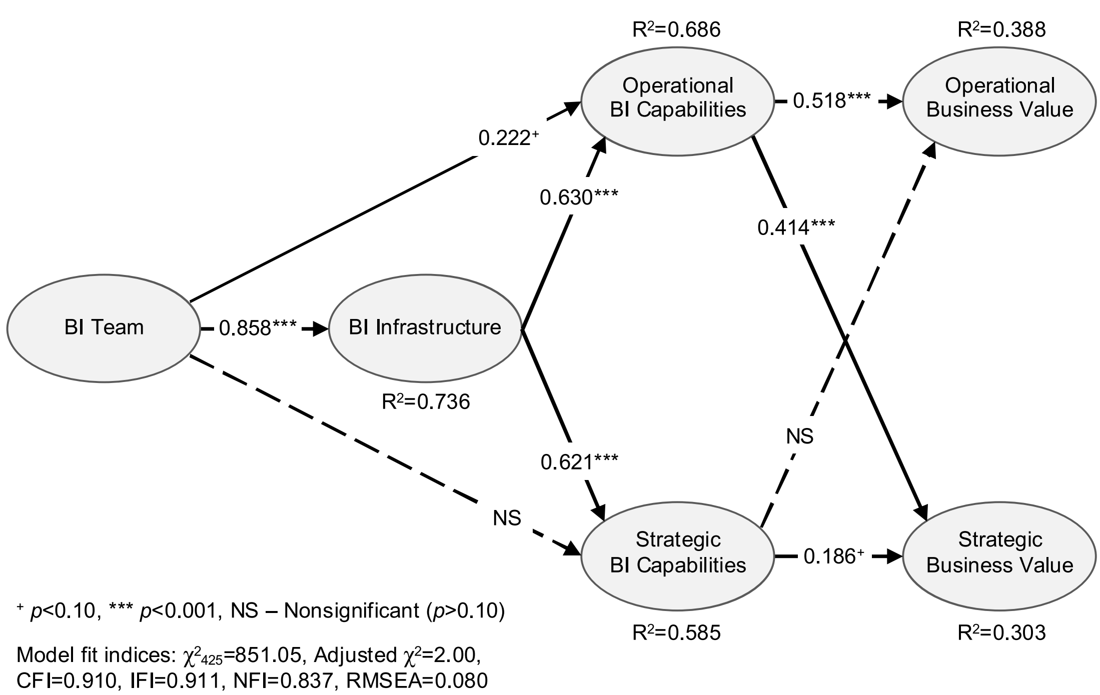

Fig. 2. Standardized solution of structural model.

Table 6
Moderating effect of exploitation.

Path	Difference in χ^2 (1 df)	p	Low Exploitation ($N = 79$)	High Exploitation ($N = 80$)
BI team → operational BI capabilities	0.194	0.660	0.275	0.156
BI infrastructure → operational BI capabilities	0.141	0.707	0.561**	0.675***

** $p < 0.01$.
*** $p < 0.001$.

process of BI value creation in which operational and strategic BI capabilities may evolve independently.

Our empirical analysis supports the notion that the BI infrastructure (e.g., DW servers, ETL software platforms, and data visualization and analysis tools) mediates the effect of the BI team (BI-related knowledge and skills) on BI capabilities. To the best of our knowledge, this study is the first to formally model BI infrastructure as mediating the value contribution of the BI team. Previous research has focused on the effects of BI infrastructure (e.g., Refs. [68,92]) or observed the effects of both BI infrastructure and team without formally analyzing the interrelationships between them [75,103][e.g.,75,103]. However, this mediated effect alone fails to capture the full relationship between BI assets and capabilities because the BI team may influence BI capabilities directly, without mediation by the BI infrastructure. In other words, the findings point to two routes to BI capabilities: a primary route mediated by the BI infrastructure and a secondary route running directly from the BI team to BI capabilities. This primary route of independent BI use is consistent with the emergence of self-service BI, which describes the use of platforms that provide end users with the ability to develop BI utilities and explore data on their own, without being dependent on the BI team [55]. However, self-service BI has not been applied successfully because of the relatively high complexity of BI tools, leading users to rely on the BI team [31]. In light of our findings, a question of why the direct route from the BI team is significant for operational BI capabilities but not for strategic BI capabilities remains unanswered. This question should be explored, because senior managers, who use BI for strategic purposes, are likely to have less motivation to engage in technical work than mid-level managers, who use BI primarily for operational purposes. Senior managers are therefore expected to rely more heavily on professional BI support. This may be because senior managers may rely on power users within their staffs as substitutes for frequent interaction with the BI team [32]. Mid-level managers, by contrast, may not have such resources at their disposal, requiring them to interact with the BI team more often. Furthermore, the use of BI for operational purposes may involve considerable technical sophistication; for instance, real-time BI typically requires access to recently collected online data [125], possibly in integration with historical data that have already been archived in a DW. Although we could not determine whether self-service or a third-party service was responsible for our results, strategic BI capabilities were found to evolve with little direct interaction with the BI team.

These different modes of BI use may explain the moderating effect of exploration. Among other benefits, the BI infrastructure offers an integrated presentation of the current organizational state, as well as the ability to form data-driven predictions of future scenarios under various conditions. These benefits are likely to be more valuable to organizations with high levels of exploration, characterized by an environment of intensive learning and radical innovation. Senior managers in such organizations are more likely to utilize the BI infrastructure for strategic decision making, either by directly engaging with the BI infrastructure or by obtaining support from local power users. By contrast, organizations with low levels of exploration are less likely to provide an environment in which the BI infrastructure is strategically valuable. Senior managers in such organizations are less likely to be motivated to directly engage with the BI infrastructure. Instead, they may seek assistance from the BI team for their informational and decision-making needs. Our results indeed show that reliance on the BI infrastructure is the dominant mode in organizations characterized by high exploration, whereas reliance on the BI team is the dominant mode in organizations characterized by low exploration.

Interestingly, this moderating effect is found for exploration and strategic BI capabilities but not for exploitation and operational BI capabilities. The different orientations of operational and strategic BI capabilities explain this discrepancy. Operational BI capabilities are defined as repeatable actions of using BI assets to support operational activities, which are typically mandatory activities that generate more certain, short-term returns. Conversely, strategic BI capabilities are defined as repeatable actions of using BI assets to support strategic activities, which are typically voluntary and involve long-term returns that are less certain. It is reasonable to find less variance in the use of the BI infrastructure for mandatory activities than for voluntary activities. Operational BI capabilities should therefore be less susceptible to differences in organizational learning than strategic BI capabilities. In other words, it is possible that exploitation does not moderate the effects of BI team and BI infrastructure on operational BI capabilities and that BI infrastructure is a significant mediator across different levels of exploitation. This is due to the more structured and mandatory nature of operational activities, which makes them less dependent on the level of incremental learning mechanisms. Our results indeed confirm that reliance on the BI infrastructure is the dominant mode in organizations characterized by either high or low exploitation.

5.2. Contributions and implications

The primary objective of this study is to advance the understanding of BI value creation by integrating the mechanisms of value creation identified in general IT and specific BI research. The main contributions of this study emerge from this integration. On the one hand, the literature on the business value of IT has taken center stage in information systems research since the 1980s. Although this literature is substantial and well developed, its imprint on research into value creation processes that are unique

Table 7
Moderating effect of exploration.

Path	Difference in χ^2 (1 df)	p	Low Exploration ($N = 79$)	High Exploration ($N = 80$)
BI team → strategic BI capabilities	3.107	0.078	0.387+	−0.080
BI infrastructure → strategic BI capabilities	10.348	0.001	0.287	0.986***

+ $p < 0.10$.
*** $p < 0.001$.

to specific technologies and systems is less obvious. On the other hand, the literature on the business value of BI has only recently gained momentum, and this evolution is likely to benefit from convergence with established streams of information systems research. This study confirms that BI creates value along the path described in the general IT literature from assets, through capabilities, to value, at both operational and strategic levels, and that this path is moderated by specific organizational resources. However, an important contribution of this study lies in identifying mechanisms of value creation unique to BI. We find that the distinction between operational and strategic BI capabilities is crucial to understanding BI value creation. Without such a fine-grained approach to BI capabilities, it is difficult to observe the differences in how the BI assets of infrastructure and team affect BI capabilities (i.e., more reliance on the BI team for operational BI capabilities), how BI capabilities affect business value (i.e., operational BI capabilities affect both operational and strategic business value), and how organizational learning moderates the effects of BI assets on BI capabilities (i.e., exploration moderates the effects on strategic BI capabilities). The last finding is particularly important given the need to theoretically advance BI research and the ability to address this need through the lens of organizational learning. We demonstrate the merits of applying the framework of exploration and exploitation to better understand why and how the organizational context may be important for the transformation of BI assets into BI capabilities. This specific framework is particularly valuable because of the conceptual fit between the two types of BI capabilities and the two mechanisms of organizational learning, suggesting that interactions between BI resources and organizational resources simultaneously occur at both strategic and operational levels. Future research should draw on related conceptualizations of organizational learning, adaptation, and innovation to strengthen the theoretical foundations of BI research.

Several implications for practice emerge from our findings. Managers should seek to deploy BI systems by investing first in the formation of a highly skilled and knowledgeable BI team, whose expertise in data integration, analysis, and presentation seldom exists in organizations with no BI experience. A strong team of experts is critical to gaining competitive advantage by developing analytical capabilities [24]. Such a team should possess a variety of skills, including technical skills in deploying and maintaining BI infrastructure (e.g., ETL, DW, and OLAP). To provide decision support, the team should also be capable of understanding business issues and framing appropriate analytical solutions based on knowledge in the areas of accounting, finance, management, marketing, logistics, and operation management [18]. Finally, the team cannot achieve its organization-wide goals unless its members are able to communicate effectively with business and domain experts across the organization. Building a strong BI team, however, is far from being trivial, given that the demand for business-analytics experts is constantly on the rise [25]. Once the BI team is formed, it can facilitate the deployment of the BI infrastructure (primary route) as well as provide information and decision support services to those who fail to effectively use the infrastructure (secondary route). These physical and human BI assets should then become the basis for organizational routines that create business value. Managers should be aware that such transformations from BI assets to BI capabilities can occur at both operational and strategic levels, involving different sets of capabilities and impacts. In particular, mid-level managers may interact with the BI team more often than senior managers do, because of the technical challenges associated with the operational use of BI. Nevertheless, failure to address either operational or strategic levels may lead to missed opportunities to enhance organizational performance. Furthermore, managers should be attentive to the moderating effects of organizational resources, in particular the breadth and depth of organizational learning. This study provides evidence of different uses of BI assets in organizations with different levels of exploration, implying that an understanding of the organizational context is critical for gaining business value from BI investments. In particular, managers should be aware that the BI infrastructure is likely to be more strategically valuable when organizational learning routines are more oriented toward exploration, intensive learning, and radical innovation.

5.3. Limitations and future research

Directions for future research are also drawn from the limitations of this study. First, the measurement of constructs at one point in time implies that the dynamics of longitudinal processes cannot be captured. This limitation implies that the present study can complement, but not substitute for, case studies of how the business value of BI evolves over time. Second, the heterogeneous population sampled in this study, while enhancing the external validity of its findings, may convey the unsupported notion that BI value creation processes do not vary across industries. Third, this study examines the moderating role of organizational resources through a lens that focuses on exploration and exploitation. We believe that future research should apply the approach taken in this study in more homogeneous settings of BI deployment while placing greater emphasis on the organizational context.

Fourth, the relatively small sample size calls for careful interpretation of the results. Although this sample size is considered acceptable for SEM [47], especially given the relatively large numbers of items with high loadings per construct [51], the power of statistical tests to detect significant effects is an issue. This issue is less consequential in this study because almost all paths in the structural model are found to be statistically significant despite the limited statistical power. The analysis of multigroup models should be affected by this issue to a greater extent. However, this analysis focuses on a small number of paths, and it does produce statistically significant moderating effects. Notwithstanding these, interpretations of our results should take into account the increased risk of Type II errors (failure to reject a false null hypothesis) associated with our sample size.

Finally, although this study uses one of the most popular methodologies in research on IT business value, we believe that the combined use of objective and subjective measures of BI usage and organizational performance may provide more insight than subjective measures alone. Using executives' perceptions in evaluating organizational performance may entail bias or subjectivity [106]. Due to the complexity of modern corporations, accurate assessment of the business value of IT is difficult, and executives may exaggerate their views on this value as a means of self-promotion [107]. We used perceptual measures in the present study because of (i) the unavailability of objective cross-sectional data to allow a process-oriented investigation of BI value creation, (ii) the popularity of this methodology in research on general IT value, which served as the foundation for developing the research model, and (iii) the desire to capture some of the intangible benefits of BI [33]. Previous research has demonstrated that perceptual measures of IT business value strongly correlate with objective measures of realized value; therefore, they are acceptable operationalizations of this value [107,113]. Notwithstanding the above, our methodological approach is not meant to replace the use of objective secondary data to empirically investigate the business value of BI. Just as BI advocates the use of data hidden in organizational repositories for advancing organizational knowledge, we advocate using these data to advance theoretical knowledge. Richer data would allow researchers to investigate the interrelationships among dimensions of readiness, intensity, and impact [41].

In conclusion, this study draws on established knowledge about IT value creation to develop a model of BI value creation. Following a comprehensive literature review, an exploratory analysis of data collected in interviews in three firms, and a confirmatory analysis of data collected in a cross-sectional survey, our findings generally support the hypothesized processes of BI value creation, which involve specific relationships among BI assets (physical and human), BI capabilities (operational and strategic), and business value (operational and strategic). The findings also show that organizational resources, in particular the degree to which the organization has an exploratory orientation, have an effect on the transformation of BI assets into strategic BI capabilities. This line of inquiry, which draws on knowledge established in other areas of information systems research and on organizational theory, has the potential to significantly advance our understanding of the organizational contribution of BI.

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