Abstract. Business analytics has the potential to deliver performance gains and competitive advantage. However, a theoretically grounded model identifying the factors and processes involved in realizing those performance gains has not been clearly articulated in the literature. This paper draws on the literature on dynamic capabilities to develop such a theoretical framework. It identifies the critical roles of organizational routines and organization-wide capabilities for identifying, resourcing and implementing business analytics-based competitive actions in delivering performance gains and competitive advantage. A theoretical framework and propositions for future research are developed.

Keywords. Business analytics, data warehouse, data analysis, performance gains, competitive advantage, dynamic capabilities

Introduction

Recent literature has argued that business analytics can contribute to organizational performance and create sustainable competitive advantage [1, p. 47-50]. However, as experience with earlier generations of decision support applications suggests, performance gains and competitive advantage do not always follow from the acquisition and use of information technologies [2-5]. In particular, Information Systems (IS) scholars have stressed the importance of organizational factors in obtaining performance gains and competitive advantage from IT applications [6, 7]. For instance, performance gains from enterprise systems have been associated with cross-functional integration of business processes and the creation of organizational configurations characterized by a high level of internal fit [7-9].

The literature has described a number of applications of business analytics and speculated on how they might contribute to performance gains and competitive advantage. However, a clearly articulated theoretically grounded model of the factors and processes involved in realizing the potential performance gains from the use of business analytics assets has not yet been proposed in the literature. From a theoretical perspective, this precludes an understanding of the factors and processes contributing to the successful use of business analytics. From the perspective of practitioners, it is not clear what organizational changes are needed to obtain performance gains and competitive advantage from the use of business analytics.
The goal of this paper is to address the above limitations. Accordingly, this paper develops a theoretical framework and research agenda for understanding the role of business analytics in obtaining performance gains and competitive advantage. The framework draws on the strategic management literature and, in particular, the literatures on dynamic capabilities and organizational routines [10-13]. The paper begins by describing a number of applications of business analytics articulated in the literature and identifying the hypothesized mechanisms through which they contribute to performance gains and competitive advantage. It then reviews a number of case studies describing the use of business analytics to obtain performance gains and competitive advantage. Drawing on insights obtained from the review, the paper then develops for future research a theoretical framework and propositions for understanding the strategic role of business analytics in driving organizational performance and delivering sustainable competitive advantage. The paper concludes with challenges for future research to empirically test the theoretical framework developed.

1. Business analytics applications and organizational performance

Business analytics refers to the collection, storage, analysis and interpretation of data in order to make better decisions and improve organizational performance [1]. The data analyzed often resides in integrated databases and data warehouses and the analysis is often conducted employing tools such as data mining, visualization, on-line analytical processing, statistical and quantitative analysis, and explanatory and predictive models [14]. Recent interest in business analytics has been sparked by the availability of highly integrated inter- and intra-organizational information systems such as enterprise systems, supply chain management systems and customer relationship management systems. Such integrated systems provide rich, fine-grained and real-time data that can be analyzed by sophisticated business analytics applications to obtain performance gains.

Scholars and commentators have described several applications of business analytics that can contribute to organizational performance. For instance, Kohavi et al. [15, p. 47] describe applications in marketing that can potentially “reduce customer attrition, improve customer profitability, increase the value of e-commerce purchases, and increase the response of direct mail and email marketing campaigns”. Similarly, applications have been described in the areas of production and manufacturing that “provide insights about the performance of suppliers and partners, material expenditures, accuracy of sales forecasts for controlling materials inventory, accuracy of production plans, and accuracy of plans for order delivery” [15, p. 47]. Applications in other areas, such as finance, human resources, and R&D have also been described [1, 16]. Table 1 lists a number of such applications and the mechanisms through which they contribute to performance gains and competitive advantage.

However, while the literature identifies the potential of business analytics to deliver performance gains and competitive advantage, a theoretically grounded framework linking these constructs has not yet been clearly articulated in the literature. Specifically, it is not clear what organizational capabilities, structures and processes are required to capture performance gains from business analytics. To address these limitations, we review the descriptions of business analytics applications in the literature and, in particular, Kohli’s [17] description of the use of business analytics at
United Parcel Service (UPS), to ground the phenomena within a theoretical framework. We then develop the theoretical framework and a research agenda for future research.

1.1. Business analytics applications

The availability of large integrated databases, such as in data warehouses, and increasingly powerful tools for visualization and data analysis has sparked recent interest in the use of business analytics to improve decision-making and contribute to organizational performance and obtain competitive advantage [1, 16]. However, the study of benefits from the use of decision support tools in organizations has a fairly long history [18]. In particular, the use of analytics in quality and resource planning functions is now fairly mature, both in the research literature as well as in practice, e.g. the use of business analytics by Japanese automakers, such as Honda and Toyota, is well documented [19, p. 519 footnote 36].

Table 1. Business analytics applications in industry

<table>
<thead>
<tr>
<th>Application</th>
<th>Mechanisms contributing to performance gains and competitive advantage</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP’s development of an algorithm for revenue prediction that improved upon the previous algorithm</td>
<td>“Quickly identify emerging trends, make predictions, and take prompt action.”</td>
<td>Davenport and Harris [1, p. 61]</td>
</tr>
<tr>
<td>Insurance underwriting process</td>
<td>Speed up underwriting process, reduce costs and attract more customers. Optimal pricing of insurance policies to better reflect risks.</td>
<td>Davenport and Harris [1, p. 62]</td>
</tr>
<tr>
<td>Activity-based costing system developed by Royal Bank of Canada enabling fine-grained analysis of customers, products, channels and transaction types</td>
<td>Accurate costing of products and services. Accurate pricing of products and services. Accurate assessment of customer profitability.</td>
<td>Davenport and Harris [1, p. 64]</td>
</tr>
<tr>
<td>Analysis of customer data to determine the effectiveness of a marketing campaign</td>
<td>Design more effective marketing campaigns</td>
<td>Kohavi et al. [15, p. 46]</td>
</tr>
<tr>
<td>Analysis of clickstream data generated by a Web site</td>
<td>Reduce shopping cart abandonment. Improve ad effectiveness</td>
<td>Kohavi et al. [15, p. 46]</td>
</tr>
<tr>
<td>Human resources function: Applications to “identify work force trends (such as attrition rates) and perform HR management tasks (such as compensation and benefits analyses)”</td>
<td>Attract and retain talent</td>
<td>Kohavi et al. [15, p. 48]</td>
</tr>
<tr>
<td>Price optimization</td>
<td>Optimize revenue and profits</td>
<td>Kohavi et al. [15, p. 48]</td>
</tr>
<tr>
<td>IBM’s options trading application for a financial services company</td>
<td>Optimize profits from arbitrage</td>
<td>Hamm [16]</td>
</tr>
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</table>

More recently, Kohli’s [17] analysis of United Parcel Service (UPS) demonstrates the value that a business analytics infrastructure can create for organizations. More importantly, it highlights the critical role of organizational capabilities and processes for identifying and implementing value-creating opportunities. One value-creating opportunity that Kohli describes is when UPS managers examined “the costs of
outbound logistics in its internal value chain.” Such analysis was enabled by “Sustained IT investments [that] provided the company with highly integrated information systems. These systems allowed UPS managers to calculate the cost for each business activity … UPS cost accountants used activity-based costing (ABC) to identify the profitability of thousands of routes” [17, p. 202].

The role of UPS’s data warehouse and other business-analytics assets in analyzing the cost structure is evident. However, the subsequent identification and implementation of a value-creating strategy relied on a different set of organizational capabilities such as sourcing, logistics, budgeting and process change. Specifically, UPS managers identified that UPS could outsource some rural routes to a competitor, the United States Postal Service (USPS), for whom it could be a profitable arrangement [17]. While Kohli’s description of the case does not touch on the issue, this decision would probably have been preceded by UPS managers discussing a number of possible alternatives, identifying the USPS-outsourcing option as the preferred option, presenting the proposal to their senior management for approval, as well as negotiating with USPS’s senior management for their acceptance. Further, the case mentions that both UPS and USPS had to make changes to their sorting, consolidation and delivery processes so that UPS could provide seamless tracking capability to its customers even for the packages that were physically delivered by USPS.

The key point in this example is that UPS captured performance gains from the use of business analytics only after reconfiguring its resources and making product-market interventions to capture those gains. Business analytics helped UPS identify a potential opportunity for performance gains. However, capturing those potential gains relied on UPS’s organizational capabilities to make decisions and reconfigure its resources to create market change.

Similarly, Kohli [17, p. 204] describes another value-creating opportunity that originated with UPS’s managers noticing a growing backlog of packages. In response, UPS’s operations managers mined their data and discovered that the “backlog resulted from incorrect or incomplete delivery information entered by customers”. UPS managers responded by converting this knowledge into a business opportunity. Specifically, they invested in and developed a technical capability to correct such customer-generated errors and, further, charge customers for the service. This not only created a new revenue stream for UPS, but also helped UPS reduce its backlog and costs. Again, while UPS’s business-analytics assets helped its managers identify the source of the backlog, the subsequent product-market intervention to profit from that opportunity had its origins not in the business analytics assets but in organizational capabilities and routines to formulate, resource and implement value-creating competitive actions.

1.2. Performance gains from business analytics

The above cases provide a number of insights regarding how organizations can achieve performance gains and competitive advantage through the use of business analytics.

One, business analytics involves multiple users across multiple functional areas of an organization. As Kohavi et al. [15, p. 45] describe: “The key consumer [of business analytics] is the business user, whose job, possibly in merchandising, marketing, or sales, is not directly related to analytics per se, but who typically uses analytical tools to improve the results of some business process”. Even though, in the ideal case, the architecture and infrastructure to support business analytics may be integrated,
performance gains are the result of dispersed exploitation. Success with business analytics requires centralized investment in infrastructure but diffused exploitation across functional areas and hierarchical levels.

Two, organizational processes to intervene in the product, customer, and supplier spaces are essential for obtaining performance gains from business analytics. In the absence of such competitive actions, organizations will not be able to obtain performance gains.

Three, performance gains from business analytics cannot be planned or predicted at the time an organization makes its investments in the business analytics infrastructure. As in the UPS case, the specific business opportunities that were identified and pursued were an outcome of entrepreneurial processes in response to local conditions, not of ex-ante planning.

Four, the magnitude of the performance gain available from business analytics applications is often incremental, rather than radical. This is unlike enterprise systems, where quantum gains in performance are expected. UPS’s savings from outsourcing “some less-traveled rural routes” to USPS, and from its ability to correct customer-generated errors could only have been marginal compared to the size of its operations. Echoing this point, Kohli [17, p. 203] describes another application that saved UPS “roughly three million gallons of fuel” annually. However, organizational performance gains resulting from the accumulation of small gains from multiple applications across multiple functions could be substantial. Thus, business analytics may not be “a killer application” by itself. Rather, it may provide a platform from which a number of incremental improvements could be launched.

2. Business analytics, performance gains and competitive advantage: A research agenda

Business analytics involves acquiring new knowledge through an analysis of data and information in its information assets, and employing that knowledge to develop and implement value-creating competitive actions. The literature on business analytics has investigated knowledge discovery [20], the potential applications of this knowledge to develop new value-creating strategies, and argued that performance gains and competitive advantage that could be gained from the use of business analytics [see, for example, 15, 21]. However, the organizational factors and processes that lead to the development and implementation of value-creating competitive actions have not been investigated in the theoretical literature. To address this limitation, the rest of this paper theorizes on the processes of obtaining performance gains from value-creating competitive actions based on knowledge generated from an organization’s business-analytics infrastructure.

We propose here that since performance gains and competitive advantage from business analytics are often likely to be the result of accumulation of small performance gains arising from the entrepreneurial actions of multiple dispersed actors, it is likely to be the outcome of organizational-level capabilities, rather than of

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1 To put the numbers in perspective, for the year ending 31st December 2006, UPS’s total revenue (Source: http://finance.yahoo.com/q/is?z=2 UPS&annual) was US$47.5 billion with an operating income of US$6.6 billion. At roughly US$1.50 per gallon (in 2006, the year for which the data are presented), this translates to an annual saving of US$ 4.5 million, or 0.07% of UPS’s operating income for the year.
individual-level skills. Multiple unit and sub-unit managers can simultaneously use business analytics to achieve performance gains only when supported by an organization-level capability; it is unlikely to be the result of sporadic independent actions. Benefiting from the capabilities of business analytics requires the frequent reconfiguration of internal resources to intervene in the external and/or internal environment, for instance in the customer, product, and supplier spaces. Below, we draw on the literature on dynamic capabilities to understand how business analytics can contribute to performance gains and competitive advantage.

Dynamic capabilities are defined as an organization’s “processes to integrate, reconfigure, gain and release resources – to match and even create market change” [10, p. 678]. Here, ‘resources’ refers to specific physical, human and organizational assets “that can be used to implement value-creating strategies” [11, p. 1107]. Similarly, Kogut and Zander [22] focus on the roles of knowledge assets and the organizational processes “by which firms synthesize and acquire knowledge resources, and generate new applications from these resources” [11, p. 1107]. Drawing on the above literature, Wheeler [23, p. 125] proposes that a “firm’s ability to create customer value through the business use of digital networks” is a dynamic capability that underpins its ability to undertake innovative actions that utilize its IT assets to create customer value through a configuration of firm resources.

Drawing on the above, we propose that an organization’s ability to capture performance gains and competitive advantage from the use of business analytics rests on its dynamic business-analytics capability. We define dynamic business-analytics capability (DBAC) as a specific dynamic capability that utilizes the operational and other data available in an organization’s information assets to develop, resource and implement value-creating competitive actions. This dynamic-capabilities-based perspective provides insights into the factors and processes through which business-analytics infrastructure can lead to performance gains and competitive advantage.

Our conceptualization of business-analytics capabilities as a generator of digital options that can be exploited through competitive actions is consistent with Sambamurthy et al. [24, p. 238]. They, too, draw on the dynamic capabilities literature to conceptualize the role of IT in contemporary firms as a digital options generator. We concur with Sambamurthy et al. [24, p. 238] that IT investments in conjunction with dynamic capabilities create competitive advantage. However, the relationship between IT investments, dynamic capabilities and performance is not clear. Sambamurthy et al. [24, p. 241] argue for a direct causal link between IT investment, the development of dynamic capabilities and performance: They propose that IT investments create “dynamic capabilities that permit firms to flexibly combine different IT and business resources and stimulate competitive actions through innovations in products, services and channels”. In contrast, we argue here that dynamic capabilities are independent of IT investments and that the effect of dynamic capabilities on performance is not direct. Extending Sambamurthy et al.’s model, we develop below a framework identifying the joint effects of dynamic organizational capabilities, and organizational structures and processes on competitive actions and performance.

2.1. Theoretical framework

Figure 1 summarizes the theoretical framework proposed in this paper. Each hypothesis in Figure 1 is presented and justified in the sections that follow.
Dynamic capabilities enable organizations to apply resources to undertake actions to deliver performance gains and competitive advantage [19, 24]. Organizations can undertake a variety of actions to accomplish this goal. For instance, they could launch new products or product extensions, launch promotion campaigns targeted at particular customer segments, introduce differential pricing or create new channels for customer interaction [1, 15]. Such actions could also be focused on supply chain partners or internal operations. DBAC are a specific dynamic capability that enables organizations to undertake competitive actions that are informed by knowledge obtained through the analysis of data residing in their information assets. For instance, UPS’s offer to correct customer-generated errors [17] is an example of a product extension whose creation was informed by insights obtained by mining its data. DBAC result in performance gains only when they generate competitive actions. Formally,

H1: Competitive actions mediate the effect of dynamic business analytics capabilities on organizational performance.

![Diagram showing Dynamic Business Analytics Capabilities, Competitive Actions, and Organizational Performance](image)

**Figure 1:** Dynamic business-analytics capabilities and organizational performance

Dynamic capabilities rest on routines for identifying competitive actions, allocating resources for competitive actions and implementing competitive actions [11]. Given *inter-firm heterogeneity*, the extent of such capabilities will vary across organizations. Further, given *intra-firm heterogeneity*, the extent of such capabilities will also vary across organizational units within an organization. Organizations (and organizational units) that enact formalized and well communicated routines for identifying, resourcing and implementing competitive actions will be more effective at undertaking competitive actions. Formally,

H2a: Organizations (and organizational units) that enact formalized and well-communicated routines for identifying competitive actions (product, market and channel interventions) will be more effective at undertaking competitive actions.
H2b: Organizations (and organizational units) that enact formalized and well-communicated routines for allocating resources for undertaking competitive actions (product, market and channel interventions) will be more effective at undertaking competitive actions.

H2c: Organizations (and organizational units) that enact formalized and well-communicated routines for implementing competitive actions (product, market and channel interventions) will be more effective at undertaking competitive actions.

Organizations’ business analytics infrastructures can create options for competitive actions when managers analyze data to obtain insights. Organizations (and organizational units) with well-developed DBAC (i.e. formalized, communicated and enacted) are likely to undertake a greater number of competitive actions as the existence of such practiced routines lowers the barriers for managerial action.

The search and interpretation of data are guided by the existing cognitive frameworks of the persons analyzing the data. The search for competitive actions based on analysis of data is usually local, i.e. constrained by bounded rationality and within the action repertoire of existing routines [12]. Henderson and Clark [13] illustrate the powerful effect of routines, managerial cognition and organizational structure on organizational response to change. Despite the quasi-automatic nature of routines, actors can mindfully alter routines [12]. Moreover, a well-developed dynamic capability such as DBAC would develop managerial competencies in mindfully altering existing action repertoires. This would guide the search for competitive actions away from local solutions towards more sophisticated foresights involving novel, improvised action patterns for their realization [12]. A practice-based capability, such as DBAC would also enable managers to develop more complex competitive actions, i.e. actions that include interventions on multiple dimensions of product, market or channel [24]. For instance, UPS’s outsourcing of rural routes to USPS [17] involves a high degree of novelty as collaborating with competitors on an organization’s core business operation is unusual [25]. Further, it involves a high degree of complexity as it requires changes to channels, technology, and core operational processes. Formally,

H3a: Organizations (and organizational units) that enact formalized and well-communicated routines for identifying, resourcing and implementing competitive actions will undertake more competitive actions.

H3b: Organizations (and organizational units) that enact formalized and well-communicated routines for identifying, resourcing and implementing competitive actions will undertake more novel competitive actions.

H3c: Organizations (and organizational units) that follow formalized and well-communicated routines for identifying, resourcing and implementing competitive actions will undertake more complex competitive actions.

Organizational structure also plays an important role in the development of dynamic capabilities [12]. Gavetti identifies four structures commonly found in practice – cognitive control, autonomy, coordination, and cognitive circulation – and discusses their likely impact on the development of dynamic capabilities and performance. Dynamic capabilities develop through an interplay between the cognitions of local managers and those of corporate management. In structures where corporate management exerts strong control over the strategies of business units, the cognitions of corporate management play a more dominant role in the development of business unit strategies than the cognitions of business unit managers. The effect on dynamic capabilities and performance depends on the heterogeneity of environments faced by the business units and the degree of tangible interrelationships between the...
business units, such as economies of scale and scope [12]. Higher autonomy implies a higher level of resources available for discretionary allocation by organizational units. This enables units to be more effective at undertaking competitive actions. Similarly, units that are independent of other units, i.e., do not share resource or decision interdependencies with other units on account of economies of scale or scope, will be more effective at undertaking competitive actions. Formally,

H4a: Organizational units with high local autonomy will be more effective at undertaking competitive actions (number, novelty and complexity of actions).

H4b: Organizational units with high local autonomy will deliver higher levels of organizational performance.

H5a: Organizational units with low tangible relationships (independence) with other units will be more effective at undertaking competitive actions (number, novelty and complexity of actions).

H5b: Organizational units with low tangible relationships (independence) with other units will deliver higher levels of organizational performance.

Social capital is an important enabler of dynamic capability [10]. “Social ties facilitate inter-unit resource exchanges and promote product innovation … Absent this social capital, resources remain unconnected and opportunities go unrealized” [10, p. 680]. Developing and implementing business analytics-based strategies requires support, sponsorship and alliances with other internal actors. Social ties enable trust, communication, and coordination leading to the allocation of resources and commitment for the successful implementation of strategies. Formally,

H6a: Social capital (of organizations and organizational sub-units) will moderate the effect of dynamic business analytics capabilities on competitive actions (number, novelty and complexity).

H6b: Social capital (of organizations and organizational sub-units) will moderate the effect of competitive actions (number, novelty and complexity) on organizational performance.

Entrepreneurial actions require a high degree of coordination across organizational boundaries. Such actions are likely to be more effective in organizational contexts characterized by a well-developed transactive memory system, i.e., a knowledge of “who knows what” and “who does what” [26-31]. Successful implementation of information systems is argued to be facilitated by training programs that contribute to the creation of a well-developed transactive memory system [32]. Formally,

H7a: An effective transactive memory system will moderate the effect of dynamic business-analytics capabilities on competitive actions (number, novelty and complexity of actions).

H7b: An effective transactive memory system will moderate the effect of competitive actions (number, novelty and complexity of actions) on organizational performance.

H8a: Cross-functional training of managers in business analytics will moderate the effect of dynamic business-analytics capabilities on competitive actions (number, novelty and complexity of actions).

H8b: Cross-functional training of managers in business analytics will moderate the effect of competitive actions (number, novelty and complexity of actions) on organizational performance.
3. Discussion

This paper has developed a theoretical framework relating business analytics to organizational performance gains and competitive advantage. Drawing on the literature on dynamic capabilities and organizational routines, the paper has developed a model identifying organizational factors necessary for achieving organizational performance gains from business analytics.

The approach to modeling the effects of business analytics employed here is consistent with Kohavi et al.’s [15, p. 48] conclusion that “analytic solutions have to produce results that are actionable.” However, Kohavi et al. did not discuss either the organizational antecedents or the entrepreneurial processes that result in competitive actions and performance gains. The theoretical framework and propositions developed here address this limitation in the current literature.

In addition, this paper makes a theoretical contribution by extending Sambamurthy et al.’s [24] framework of the relationship between IT capabilities and firm performance. It identifies dynamic organizational capabilities that influence an organization’s ability to obtain performance gains from its IT investments.

Finally, the framework developed here identifies key factors necessary to achieve performance gains from business analytics. These include the capabilities to identify and allocate resources, to implement value creating competitive actions, a high level of social capital, a well-developed transactive memory system and cross-functional training. Success with business analytics requires a high level of autonomy and dispersed capabilities for identifying, resourcing and implementing competitive actions. This is in contrast to the requirements of success with enterprise systems, which require a high level of centralization to create integrated cross-functional processes to obtain performance gains. The starkly different implications underscore the need to develop a theoretically-grounded framework for understanding the role of business analytics in delivering performance gains and competitive advantage.

The theoretical framework developed here needs to be tested in future research. However, empirical testing of the framework is likely to face a number of challenges. First, our field research finds that a majority of organizations who have implemented a business analytics infrastructure are employing it mainly as a reporting tool that replaces existing technologies for creating and distributing reports. We found few instances where business analytics was being routinely employed to support competitive actions. We also found few instances where organizations had well-developed dynamic capabilities to develop, resource and implement value-creating strategies. Despite well-publicized anecdotes of use of business analytics to support value-creating strategies, for instance, Harrah’s Winner’s Network to create individualized offerings for its customers [1], we found few instances of such sophisticated use of business analytics. Our findings underscore the challenge involved in finding instances of practice on which to test and build generalizable theory.

Second, since dynamic capabilities-driven use of business analytics is an emerging phenomenon, theory in this area is not well-developed. Further, theoretical models developed in the context of similar technologies, for instance, enterprise systems, may not be valid for business analytics. Indeed, the theory developed here suggests that the structures and processes required to exploit enterprise systems are very different from those required to exploit business analytics. Given the early state of theory development in this area, in-depth case studies need to be carried out to understand causal relationships and identify the mechanisms driving the causal relationships.
Indeed, the transformation of organizations to develop dynamic business analytics capabilities is likely to occur over an extended period of time and may be evident only in longitudinal case studies. The willingness of organizations to provide the access required for conducting such in-depth case studies is another challenge that researchers will need to overcome.

Another challenge to testing the DBAC model developed here (Figure 1) is to identify common metrics for measuring the performance of diverse organizational units, for instance, product development, human resources and supply chain management. The DBAC model explains both inter-organizational as well as intra-organizational variations in performance. While financial performance serves as a common metric for measuring organizational performance, researchers face the challenge of creating appropriate metrics for measuring the performance of intra-organizational units.

4. Conclusion

This paper has developed a dynamic capabilities-based framework for obtaining performance gains and competitive advantage from business analytics. Extending prior theories, the framework stresses the joint role of dynamic capabilities and organizational structures and processes in extracting performance gains from business analytics. Challenges facing the empirical testing of the framework are discussed.

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