ACHIEVING DYNAMIC CAPABILITIES WITH BUSINESS INTELLIGENCE

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Abstract

Business intelligence (BI) is one of the technology areas that have grown tremendously. BI describes a set of concepts and methods based on data for improving business decision making. BI capabilities have become one of the important business and technical capabilities. However, BI capabilities have remained largely unexamined in academic literature. Current understandings of BI capabilities are limited and lack systematic view. In this conceptual paper, we develop a framework to define BI capabilities as a multi-dimension concept. It consists of BI infrastructure maturity, data management capability, analytical capability, collaborative governance capability, and analytics-based process capability. We also examine how BI capabilities facilitate and support sense and respond strategies in current dynamic business environment.

Keywords: business intelligence, dynamic capabilities, sense-and-respond
1 INTRODUCTION

Business intelligence is one of the technology areas that have grown tremendously in the past few years. It is considered as one of the four major technology trends in the 2010s (IBM Systems and Technology Group 2011). The goals of business intelligence are to obtain unique business intelligence and knowledge from data, and use them to guide business improvement and transformation (Popović et al. 2012). With growing popularity and high expectation of BI, it is crucial to know how to use BI in order to survive and prosper in a turbulent environment.

Though BI capabilities have started drawing academic attention, BI capabilities have remained largely unexamined in academic literature. BI is defined as “a system comprised of both technical and organizational elements that presents its users with historical information for analysis to enable effective decision making and management support, with the overall purpose of increasing organizational performance” (Isik et al. 2013) [p.13]. Selected feature of BI systems have been studied such as data quality, data access, and data infrastructure (Isik et al. 2013; Popović et al. 2012). However, current understanding of BI capabilities is very limited and lacks systematic view. Similar to IT capabilities, BI capabilities should be a multi-dimension concept. Only little effort has attempted to investigate it and develop a comprehensive framework to define it. In this study, we aim to fill this gap.

In this study, we will also examine BI capabilities in the context of dynamic capabilities. Dynamic capabilities have been developed to investigate how organizations can manage their resources in an ever-changing environment (Davenport 2006, 2013; Nichols 2013; Techlogix 2014). Recent IS studies have adopted the dynamic capability perspective as a framework to explore how IT can help organizations overcome market challenges and improve their competitiveness (Daniel & Wilson 2003; Harvard Business Review Analytic Services 2013; Mathiassen & Vainio 2007; Sher & Lee 2004). Despite the potential of BI, few studies have explored BI-enabled dynamic capabilities. In this study, we aim to develop a framework to examine how BI capabilities help achieve dynamic capabilities.

Our paper is organized as follows: We first present current studies on BI and IT capabilities. We then present the framework that defines BI capabilities within an organization, followed by a research model that explains how BI capabilities can enhance dynamic capabilities. Finally, we present our discussions and conclusions.

2 LITERATURE REVIEW

We conducted literature search on BI and IT capabilities in premiere IS journals. The goal of reviewing BI literature is to identify the gap in the definition of BI capabilities. The goal of reviewing IT capabilities is to identify dimensions of IT capabilities that can be used in defining BI capabilities.

2.1 BI Systems and Capabilities

Business intelligence and analytic systems are comprised of both technical and managerial elements (Isik et al. 2013). Therefore, BI capabilities can be examined from both managerial and technological perspectives. The current studies on BI in premiere IS journals are summarized in Table 1.

There are also studies trying to study BI maturity models (Chuah 2010; Lahrmann et al. 2011) and critical factors for BI implementation (Yeoh & Koronios 2010). However, current studies have not explicitly and systematically developed a framework that can define BI capabilities. Isik et al. (2013) study five technological and organizational BI capabilities, i.e., data quality, integration of BI with other systems, user access, the flexibility of the BI, and risk support. However, no further details are offered to explain why only five capabilities are selected and whether BI capabilities also include other capabilities.
Table 1. Dimensions of Business Intelligence Capabilities

<table>
<thead>
<tr>
<th>Dimension of BI capabilities</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Quality</td>
<td>data consistency and comprehensiveness</td>
<td>(Isik et al. 2013; Popović et al. 2012)</td>
</tr>
<tr>
<td>Data Infrastructure</td>
<td>Data integration &amp; accessibility</td>
<td>(Isik et al. 2013; Popović et al. 2012)</td>
</tr>
<tr>
<td>User access</td>
<td>The capability of matching BI tools with user types</td>
<td>(Isik et al. 2013)</td>
</tr>
<tr>
<td>Data collection</td>
<td>Two data collection strategies: comprehensive and problem driven</td>
<td>(Ramakrishnana et al. 2012)</td>
</tr>
<tr>
<td>Analytical capability</td>
<td>The capability to query &amp; analyze data.</td>
<td>(Popović et al. 2012)</td>
</tr>
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</table>

By reviewing literature, we conclude that there is a lack of systematic effort to develop a comprehensive framework that defines BI capabilities. Research is needed to better understand BI capabilities.

2.2 IT Capabilities

To understand and define BI capabilities, we turn to IT capabilities. Though BI capabilities are different from IT capabilities, they do share some similarities such as IT infrastructure and human skills. IS researchers have done extensive studies on IT capabilities. Two streams of studies exist in IT capabilities literature (Fink 2011). The first stream defines IT capabilities as a set of sub-capabilities such as IT human capabilities and IT infrastructure capabilities, IT planning capability, system development capability, and IS operation capability (Fink 2011; Ravichandran & Lertwongsatien 2005). The second stream defines IT capability as an overarching construct that manages IT resources such as IT infrastructure, human IT resources, IT operations, IT objects and IT knowledge, IT infrastructure quality, IT business expertise, and relationship infrastructure between IT and business (Bharadwaj 2000; Tippins & Sohi 2003). In addition, there are also studies that focus on a specific IT capability such as information management capability (Mithas et al. 2011).

Despite the difference in defining IT capabilities, generally IT capabilities include technology infrastructure capability, knowledge and skill capability, execution capability, and relationship capability. In this study, we take a similar approach to the first approach in IT capabilities and define BI capabilities as the combination of a set of sub-capabilities. Derived from IT capabilities, we define BI capabilities from the perspectives of infrastructures, skills, execution, and relationship.

3 ORGANIZATIONAL BUSINESS INTELLIGENCE CAPABILITIES

In this section, we develop BI definitions based on literature review. We categorize BI capabilities into the combination of technical BI capabilities and managerial BI capabilities. Technical dimension of BI capabilities includes infrastructure maturity, data management capabilities, and analytical capabilities, while managerial BI capabilities include collaborative governance capabilities and analytic-based business process capabilities. Each of them also comprises of a set of sub-capabilities.
3.1 BI Infrastructure Maturity

In this study, we define BI infrastructure maturity as the ability of an organization to build and maintain data infrastructure, analytical application platform, BI cloud computing environment, and modularized BI systems. BI infrastructure maturity consists of data infrastructure maturity, analytical platform readiness, BI cloud computing capability, and BI system modularity. Data infrastructure maturity refers to the degree to which IT facilities such as data integration, data storage, data sharing platform and network connectivity can meet data and analytical needs. Data infrastructure serves as the foundation of BI capabilities because without a well-managed data infrastructure, data and information cannot be effectively captured, stored, sorted, and shared (Thomas 2009).

Analytical platform readiness is the availability of a set of well-connected analytical applications within an organization that can meet the organization’s analytical needs. Business intelligence and analytics have evolved from DBMS-based BI 1.0, to web-based BI 2.0, to mobile and sensor-based BI 3.0 (Chen et al. 2012). To maximize the benefits of these technologies, it is critical to build integrated, compatible analytical environments where appropriate BI tools and applications can be shared, managed by multiple stakeholders (Isik et al. 2013).

BI cloud computing capability refers to the ability of an organization to integrate various BI clouding computing services with internal BI platform and fully manage and use cloud resources for BI projects. Cloud computing, a new computing model that assigns computing requests to a great number of distributed computers, has become a viable alternative for many organizations to access IT resources when needed (Zhang et al. 2010). Because the need for processing data and intelligence varies every day in dynamic environment, cloud computing can offer scalable, affordable, and agile BI services (Reyes 2010).

The last BI infrastructure dimension is BI system modularity. BI system modularity refers to the degree to which internal and external BI infrastructures are constructed following modular design principle and can be easily re-configured. Modular design provides flexibility because components/services can be easily added or removed without interrupting the overall systems (Xue et al. 2013). Such open architecture provide agility and extensibility for new BI initiatives (GoodData 2013; IBM Systems and Technology Group 2011).

3.2 Data Management Capability

Data management capability addresses skills required for managing data. Data management capability includes data collection capability, data quality assurance capability, and data policies compliance capability. Data collection capability is the capability of an organization to develop effective strategies to define data requirements, identify the source of data, and obtain data efficiently to achieve business goals. Organizations face challenges of choosing appropriate data collection strategies such as problem-driven data collection or comprehensive data collection (Ramakrishnan et al. 2012). The effectiveness of data collection strategies relies on factors such as competitive pressure, internal resources, and business goals. The ability to plan and execute data collection is a necessary step for business analytics.

Data quality assurance capability is the ability to provide clean, high quality data with fine granularity that meets data standards (Isik et al. 2013). Data quality in BI is concerned with data completeness, consistency, recency, and relevance. Many BI projects failed due to data quality issues (Isik et al. 2013). Data quality is a critical success factor for BI (Yeoh & Koronios 2010). Data policies compliance capability refers to the ability to specify data policies regarding accessibility, security, privacy, and responsibility, and to enforce adherence to policies (Loshin 2013). Data policies on how data is used, shared, and copied are needed to protect data assets and mitigate risks associated with suspicious activities. Compliance capability is to make sure the implementation of data policies.
3.3 Analytical Capability

In this study, we define analytical capability as the ability to discover useful intelligence and incorporate it in decision-making and daily operations. Drawing on IT capability literature, we identify two sets of analytical human capabilities: data analytical capability and business insight. Data analytical capability refers to knowledge and skills possessed by data specialists and users to build predictive models, discover patterns, conduct queries, create reports, etc. It is worth emphasizing that business users should also have a certain degree of analytics knowledge. It helps them to create their own intelligence when needed. Such technical knowledge can also help them appreciate and interpret analytics results.

Business insight refers to the ability of data analysts to understand the overall business environment and specific organizational context. Such business insight can help data analysts identify business opportunities from data and make relevant suggestions to current business problems. Business insight will help data analysts better understand the expectation of business users, frame the business question to be answered by BI, assess the results in terms of business objectives, and prepare relevant recommendations (IBM 2010).

3.4 Collaborative Governance Capability

Efficient processing of information and intelligence requires tight integration and coordination of the different functional units (IBM 2010). BI initiatives involve multiple stakeholders such as data governance bodies who define data standard and policy, IT support staff to manage data storage, data scientists who analyze data to build models, business intelligence specialists who provide reporting support, and users who consume data and intelligence. Collaboration among multiple stakeholders is inevitable. Collaboration with so many different stakeholders can be challenging.

In this study, we propose collaborative governance capability as one of organizational BI capabilities. We define collaborative governance capability as the ability to define and oversee responsibility and accountability, and to facilitate problem coordination. BI requires two types of collaborative capabilities: explicit coordination capability and dynamic coordination capability. Explicit coordination refers to articulated, written policy and governance frameworks among business functions. As Haeckel points out that any organization must have its governance framework within which people act (Haeckel 1995). Explicit coordination capability is the ability to plan, specify, and oversee the governance framework regarding business intelligence and analytics initiatives. It sets boundaries in collaboration and provides a well-articulated governance framework that can guide such interactions and communication. Governance framework within which people act should be outlined, but it must be relaxed (Haeckel 1995). Explicit coordination capability needs to be complemented by dynamic coordination capability, which is defined as the ability to organically coordinate among various parties. A BI initiative is an iterative process, not a waterfall process (Larose 2005). When unexpected changes are needed, dynamic coordination capability enables involved parties to negotiate and re-negotiate coordination details to respond quickly.

3.5 Analytics-Based Process Capability

Organizational BI capabilities are not just limited to building models and creating visual presentations. They also include the organization’s capability to incorporate BI findings in their decision-making, planning, and execution. Thus, organizations need analytics-based process capability, the ability to incorporate new business intelligence in business decision-making and operation, to monitor performance, and to continually improve and build analytical knowledge. It consists of two sub-capabilities: data-driven business exploitation capability and data-driven business exploration capability. Data-driven business exploitation capability is defined as the ability to use business intelligence to incrementally improve current business processes and products. Its focus is on serving existing market and business models (Hoang & Rothaermel 2010; Sarkees et al. 2014; Voss & Voss 2013). The investment is typically moderate; the length of time is short; risks are low; and impact is
limited. While data-driven business exploitation capability focuses on current resources and business model, data-driven business exploration capability is aimed to transform current business process and plan for new products and market using BI. Contrary to data driven business exploitation capability, changes in the exploration process are company-wide with high risks and long-term goals. Exploration and exploitation involve different levels of decision making and impact. Exploitation is usually within a function area such as marketing and sales. Decision-making and execution of exploration are usually involved C-level managers and enterprise-wide efforts. These two are complementary.

4 HOW BI CAPABILITIES ENHANCE DYNAMIC CAPABILITIES

Dynamic capabilities are the capabilities to achieve new forms of competitive advantage, and to create, deploy, and protect the intangible assets that support superior long-run business performance” (Davenport 2013; Nichols 2013). Drawing from sense and respond model proposed by (Haeckel 1995), we develop our research framework to elaborate how organizations using BI can achieve dynamic capabilities via four sense and respond strategies, dynamic commitment of resources, modular process, learning processes, and context-specific governance mechanisms. Figure 1 shows the framework we have developed.

![BI-Enabled Dynamic Capabilities](image)

Figure 1. BI-Enabled Dynamic Capabilities

We believe that BI capabilities can enable dynamic capabilities by facilitating sense and respond strategies. The application of the sense and respond strategies can lead to the improvement of organizational performance in terms of effectiveness (e.g., quality, satisfaction) and efficiency (e.g., time, cost). Organizations monitor and interpret how their actions affect the market. In the following, we describe the details of our research model by focusing on BI capabilities and sense and respond strategies.

4.1 Dynamic Commitment of Resources

In dynamic environments, a business should specify the organization’s process outcome but allow individuals to have flexibility in performing their jobs. Hence, accountabilities should manifest as dynamic commitments between people, and are negotiated through protocols that allow processes to be adapted and coordinated in response to specific events and needs (Singh et al. 2011).
BI capabilities can help organizations commit their resources dynamically in several ways. First, analytic capabilities supported by BI infrastructures, data management, and collaborative governance capability provide future trends and emerging opportunities to set the vision for an organization. Such vision can guide on how current resources should be re-composed and re-allocated, help reshaping responsibilities and personal accountabilities. Second, analytics-based process capability helps dynamic commitment of resources by providing opportunities of trial new combination of resources. Data-driven exploitation and exploration processes involve reconfiguration of resources and accountabilities over the period of time. Such processes help both managers and employees negotiate and re-shape their new roles and responsibilities.

4.2 Modular Process

Designing modular process is an approach to quickly tailor current offerings to meet new market demands with low cost (Haeckel 1995). Modular process allow business quickly “snap together” new offerings from current products and processes. BI capability supports modular processes in several ways. First, BI infrastructure maturity, specifically, BI system modularity and BI cloud computing infrastructure, can provide modularized BI components to BI users (IBM Systems and Technology Group 2011). Because business processes are embedded and/or supported by information systems, the modularity at the system level certainly helps modularity at the level of business processes. Modularized BI systems and applications can be easily “snap together” to support new analytical demands. In addition, BI cloud computing infrastructure expedites modulation of BI by delivering BI services clients need and reducing complexity (Mircea et al. 2011).

The purpose of modular process design is to combine different business modules to address emerging business requirements. Analytical capability, together with data management capability, and collaborative governance capability help designing and integrating modular process by providing quantitative details on what to “snap together” and how to “snap together” new offerings from current product and processes. In addition, analytics-based process capability provides a chance for organizations to experiment new combinations of various modular processes. BI needs analytics-based process capability to implement changes. Such changes may involve reconfiguring current modular pieces and/or creating new modular process units.

4.3 Learning Process

Haeckel (1995) proposes adaptive loop design to facilitate learning at all levels, individually, collectively, and institutionally. The adaptive loop includes sensing what’s going on out there, followed by interpreting information, decision-making, and actions. The outcome of actions feeds back to sensing activity to continue the cycle.

BI infrastructure maturity helps learning process by providing a platform where data, intelligence can be collected, created, stored and shared (Isik et al. 2013). Data management capabilities can help learning by identifying sources of relevant information, and obtaining such information in usable format and with high quality (Ramakrishnana et al. 2012). Analytical capability facilitates learning by generating new business insights. This capability helps organizations learn new opportunities. Collaborative governance capability enables the learning process to co-create of new knowledge between BI teams and business teams. Analytics-based process capability provides a chance to implement new findings from analytics and provide feedback to the BI-enabled learning process. It completes the adaptive loop to facilitate learning at all levels, individually, collectively, and institutionally.

4.4 Context Specific Governance Mechanisms

Governance mechanisms include governance principles, a model, and a process. Principles define general rules of doing business, while the governance model defines a hierarchy of key accountabilities in the organization (Haeckel 1995). The governance process sketches how
governance principles can be implemented. Business governance involves establishing decision rights and accountability to ensure that investments return business value.

Dynamic capabilities require adaptive organization design and context specific coordination to respond effectively (Haeckel 1995). Organizations with dynamic capabilities should specify accountabilities instead of defining detailed procedures. The context refers to the emerging opportunities and threats that need immediate actions. Following detailed procedures would constrain the responding speed and effectiveness. Latitude needs to be given so that empowered employees or teams can act on new challenges.

One challenge in context specific coordination is that how to ensure coherent corporate behaviour emerge from the individual behaviour of empowered team (Haeckel 1995). Enterprise intelligence, generated by capable analytical expertise and distributed by BI infrastructure, can facilitate context specific governance by providing one universal quantitative truth. In pre-BI age, data and intelligence are not available. Decision-making and business implementations are usually based on intuition. In this case, the contexts faced by different teams are different. Therefore, the interpretations of current business challenges or opportunities vary. Without explicitly specified processes and procedures, it requires much more time and efforts to negotiate and re-negotiate among different stakeholders in order to take coherent actions across organizations. Fragmented BI efforts without the support of enterprise BI infrastructure also pose similar challenges.

Analytical capabilities, supported by data management capabilities and BI infrastructure, create one universal quantitative truth about the business in a timely manner. BI infrastructures deliver the truth to relevant stakeholders. The one version of truth shared within the organization provides the same context on which empowered individuals can act on. Equipped with the same information, it is easier for empowered teams and individuals to collaborate and be creative when addressing the challenges.

5 CONTRIBUTIONS AND DISCUSSIONS

This conceptual paper makes several contributions. First, it develops a comprehensive framework to define BI capabilities. Currently, BI has been used as an umbrella term referring to a variety of business and technical concepts (Deng & Chi 2012). The BI is defined as “a system comprised of both technical and organizational elements that presents its users with historical information for analysis to enable effective decision making and management support, with the overall purpose of increasing organizational performance” (Isik et al. 2013) [p.13], and as “the ability of an organization or business to reason, plan, predict, solve problems, think abstractly, comprehend, innovate and learn in ways that increase organizational knowledge, inform decision processes, enable effective actions, and help to establish and achieve business goals.” (Popović et al. 2012) [p.729]. These definitions lack the details that are needed to help further understand what BI is, how BI capabilities can be built over time, and how BI capabilities support business operations and strategies. To our best knowledge, our framework is one of the first efforts to explicitly define BI capabilities as a multi-dimensional concept from four dimensions. Such framework contributes to BI literature by providing better understanding BI capabilities from multiple perspectives. Second, our conceptual paper also attempts to explain the impact of BI capabilities on dynamic capabilities. Our study extends sensing and responding strategies (Haeckel 1995; Singh et al. 2011) by demonstrating how various BI capabilities can support dynamic capabilities by facilitating these strategies in current business environment. It contributes to literature of dynamic capability by adding BI to the picture. By providing details of what makes up BI capabilities, it provides a roadmap for managers to build and nurture various BI capabilities over time. Our study can be extended by empirically investigating and demonstrating our framework through quantitative or qualitative research methodologies in the future. The direction of future research may include the maturity levels of organizations using BI in terms of dynamic capabilities and how to achieve high level of maturity.
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