ACHIEVING DYNAMIC CAPABILITIES WITH BUSINESS INTELLIGENCE

Abstract

Business intelligence (BI) is one of the technology areas that have grown tremendously. It 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

Businesses have long realized the importance of data in a dynamic business environment. Efforts have been made to collect more data and utilize them. Data management to simply improve the operational efficiency of business processes is not sufficient to operate in ever-changing environment anymore. Business intelligence (BI) supported by big data as an emerging new IT paradigm has been recognized as a solution.

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). Most of large organizations with revenues exceeding $100 million are using some form of BI applications according to Bloomberg Businessweek (2011). The term “business intelligence” (BI) describes a set of concepts and methods based on data for improving business decision making (Deng & Chi, 2012). It is used as an umbrella term referring to a variety of software applications analyzing an organization’s raw data. 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, Hackney, Coelho, & Jakliča, 2012). BI systems provide effective means of generating new insights to aid strategic and managerial decision making in organizations. BI technologies have been increasingly adopted by organizational users ranging from senior executives to business analysts (Deng & Chi, 2012). BI is expected to help organizations move from transaction-oriented model of computing to an analysis-oriented one thereby obtaining business insights and utilizing the results for business (Popović, et al., 2012; Ramakrishnana, Jonesb, & Sidorovab, 2012). Organizations are increasingly exploring the use of BI in the development and delivery of products and services (Anderson-Lehman, Watson, Wixom, & Hoffer, 2004). With growing popularity and high expectation of BI, organizations realize that 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. In addition, with growing popularity and high expectation of BI, organizations realize that it is crucial for organizations to know how to use BI in order to survive and compete in a turbulent environment. The concept of BI capabilities has not been fully explored, especially in today’s dynamic environment. 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, Jones, & Sidorova, 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 and propose a framework that defines BI capabilities.

In this study, we will also examine BI capabilities in the context of dynamic capabilities. The prior studies on the strategic management have developed dynamic capability perspective to investigate how organizations can manage their resources in an ever-changing environment (Eisenhardt & Martin, 2000; Helfat et al., 2009; Teece, 2007; Teece, Pisano, & Shuen, 1997). The perspective describes how organizations develop new value creation strategies in response to emerging requirements from market. 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; Mathiassen & Vainio, 2007; Pavlou & El Sawy, 2011; Sher & Lee, 2004). Despite the potential of BI on organizations, few studies have explored BI-enabled dynamic capabilities. In this study, we aim to develop a framework to examine how BI capabilities help to achieve dynamic capabilities.

Our paper is organized as follows: We first present our literature review of BI and IT capabilities. We then develop 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 is defined 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” (Popovič, et al., 2012, p. 729).

Business intelligence and analytic system is comprised of both technical and organizational elements (Isik, et al., 2013). Therefore, BI capabilities can be examined from both organizational and technological perspectives. The technical dimension of BI capabilities that have been examined are information quality (Isik, et al., 2013; Popovič, et al., 2012), data collection (Ramakrishnana, et al., 2012), analytical capability (Popovič, et al., 2012), data integration and accessibility (Isik, et al., 2013; Popovič, et al., 2012), while organizational BI capabilities include management support (Isik, et al., 2013), and risk support for uncertainty (Isik, et al., 2013).

<table>
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<tr>
<th>Dimension of BI capabilities</th>
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<tr>
<td>Data Quality</td>
<td>data consistency and comprehensiveness</td>
<td>(Isik, et al., 2013; Popovič, et al., 2012)</td>
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<td>Data Infrastructure</td>
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<td>User access</td>
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<td>Analytical capability</td>
<td>The capability to query &amp; analyze data.</td>
<td>(Popovič, et al., 2012)</td>
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<td>Flexibility</td>
<td>The capability to provide decision support when variations exist in business processes</td>
<td>(Isik, et al., 2013)</td>
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<tr>
<td>Risk management support</td>
<td>The capability to support decisions under conditions of uncertainty</td>
<td>(Isik, et al., 2013)</td>
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Table 1 Dimensions of Business Intelligence Capabilities

These studies have been trying to study how different factors such as data quality, data infrastructure, data collection, analytical capability and accessibility affect BI capabilities, information use, maturity of BI systems, and BI success (Chuah, 2010; Lahrmann, Marx, Winter, & Wortmann, 2011). In addition, there is also effort to study critical factors for BI implementation (Yeoh & Koronios, 2010). However, they have not explicitly defined BI capability in their study. Isik et al. (2013) differentiate technological BI capabilities from organizational BI capabilities. They define technical capabilities as sharable technical platforms and databases, and define organizational BI capabilities as assets that support the effective application of BI in the organization. They 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.
By reviewing literature, we can conclude that there is 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. The resource-based view (RBV) has been adopted by many researchers to develop IT capabilities (Barney 1986, 1991). RBV argues that IT per se cannot generate a sustainable advantage, because it can be easily acquired and copied. However, IT capabilities that manage IT assets and resources are difficult to acquire, thus are the sources of sustainable advantages (Tippins & Sohi, 2003). Such IT capabilities are embedded in business process and organizational routines (Bhatt & Grover, 2005).

IT capabilities are IT-based assets and routines that support business conduct in value-adding ways (Fink, 2011). It is defined here as its ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities (Bharadwaj, 2000).

Two streams of studies exist in IT capabilities literature (Fink, 2011). The first stream define IT capabilities as a set of sub-capabilities such 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 define IT capability as an overarching construct that manage 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. Such capability is defined as the ability to provide high quality data in a timely manner, to provide universal connectivity and access with adequate reach and range (Mithas, Ramasubbu, & Sambamurthy, 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, adopting resource-based view, we aim to define BI capabilities. Though BI involves many IT elements, it also includes effective use of BI systems in decision-making and business operation (Deng & Chi, 2012). We take 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

We develop BI definitions based on our literature review. We categorize BI capabilities into the combination of infrastructure maturity, data management capabilities, analytical capabilities, collaborative governance capabilities, and analytic-based business process capabilities, each of which also comprise of a set of sub-capabilities.

Organizational BI capabilities are comprised of both technical and organizational elements (Isik, et al., 2013). Technological dimension such as infrastructure maturity provide data and analytical platform for BI applications. Data management capabilities and analytical capabilities deal with two sets of technical skills required for any BI implementation.

Technical capabilities alone cannot maximize the benefits of BI. BI capabilities should be “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]. The success of business intelligence and analytics depends on collaboration between business users and analysts (Larose, 2005). Its value, like IT value, emanates from robust collaborative relationships within firms (Kohli & Grover, 2008). Thus we believe that collaboration and business processes that facilitate, support and leverage analytical results are crucial to organizational BI capabilities. Collaborative governance capabilities address relation dimension, while analytic-based business process capabilities are concerned about execution dimension.

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. IT infrastructures are crucial support for BI capabilities.

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. Infrastructure inadequacies can keep users from linking, sorting, or filtering information (Thomas, 2009). A mature data infrastructure should support two levels of integration, system integration and data integration. System-level integration ensures that internal data can be easily reached, while data integration ensures that data from different sources can be preserved and transformed to useful formats.

Analytical platform readiness is the availability of a set of well-connected analytical applications within an organization that can meets organization’s analytical needs. Business intelligence and analytics has evolved from DBMS-based BI 1.0, to web-based BI 2.0, to mobile and sensor-based BI 3.0 (Chen, Chiang, & Storey, 2012). Many business intelligence and analytical tools are available such as visual analytics, data mining tools, forecasting application, querying application, model management and monitoring tools, text analytics, etc. 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. These tools and applications should also connect with enterprise systems so that new intelligence and knowledge discovered are stored in common format and are accessible within the organizations (Isik, et al., 2013).

BI cloud computing capability refers to the ability an organization has 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 assign the computing requests to a great number of distributed computers, has become a viable alternatives for many organizations to access IT resources when needed (Zhang, Zhang, Chen, & Huo, 2010). Though cloud computing faces challenges, it has become an integral part of enterprise systems. As a new paradigm, cloud computing can offer scalable, affordable, and agile BI services (Reyes, 2010). The need for processing data and intelligence varies every day. With cloud computing, BI services can be easily scale in and scale out. Organizations do not need to maintain extra hardware and software. Data warehousing capability can be easily expanded without interrupting daily business (Reyes, 2010). It can also offer a variety of BI platform that give flexibility to data analyst to quick set up and disband new projects (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 has long been recognized as an effective way to accommodate changes (Hoetker, 2006). Subsystems in modular systems are loosely coupled; and interactions between subsystems are through standardized Interfaces (Xue, Zhang, Ling, & Zhao, 2013). The advantage is flexibility because components/services can be easily added or removed without interrupting the overall systems. Such modular design principles are also embraced by some cloud computing services (GoodData, 2013). Given the increasing and changing needs for BI, modular architecture allows organizations to customize the solution and add analytics functions over
time. Such open architecture provide agility and extensibility (GoodData, 2013; IBM Systems and Technology Group, 2011).

3.2 Data Management Capability

Data management capability addresses skills required for managing data. In this study, data management capability includes data collection capability, data quality assurance capability, and data policies compliance capability. Data management capability is the foundation of organizational BI capability. How to manage data has drawn much attention in relevant context such as database management (Wang & Strong, 1996), information quality (Fisher, Chengalur-Smith, & Ballou, 2003), and business communication (Swanson, 1987). In the context of business intelligence and analytics, studies have recognized the importance of data quality (Isik, et al., 2013; Popović, et al., 2012), data integration (Isik, et al., 2013; Popović, et al., 2012), data collection strategies (Ramakrishnana, et al., 2012), and data accessibility (Isik, et al., 2013). In this study, we define data management capability as the ability to collect relevant data, ensure high data quality, define data policy and comply with data policy. Data collection capability is the ability to collect relevant data, ensure high data quality, define data policy and comply with data policy. 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 (Ramakrishnana, et al., 2012). The former one aims to collect data to address a specific business problem, while the latter one tries to collect data from all possible sources enterprise-wide. The effectiveness of two 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. Choosing wrong data collection strategies will lead to either lack of data or wasting resources on irrelevant data.

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. Nowadays, in addition to structured data, more and more unstructured data is available and become a valuable source of the intelligence. Though big data provides opportunities for businesses to obtain more insights, it also poses challenge to data quality. 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). BI is only as good as its data quality.

Data policies compliance capability refers to the ability to specify data policies regarding accessibility, security, privacy, and responsibility, and to oversight adherence to policies (Loshin). Data is valuable assets. Data policies on how data is used, shared, and copied are needed to protect such assets and mitigate risks associated with suspicious activities. Compliance capability is to make sure the implementation of data policies.

3.3 Analytical Capability

The successful application of analytics in business depends on analytical capability of an organization. In this study, we define analytical capability is the ability to discover useful intelligence and incorporate it in decision-making and daily operations. It relies on data analytical skills and business insight.

In the context of information technology, IT human capability has to do with technical capability that relates to IT personnel’s knowledge in specific technical areas and business capability that covers IT personnel’s overall understanding of business (Fink, 2011). At the same time, IS research has also emphasized the importance of business users having greater technical knowledge. IT unit’s business domain knowledge and business users’ technical knowledge are called “peripheral knowledge”

because such knowledge outside the domain of their own specialized activities (Tiwana, 2012). Peripheral knowledge is critical in creative process and/or product.

Similarly, we believe that peripheral knowledge also plays important role in BI. Thus, 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 query, create reports, etc. It is worth emphasizing that business users should also have 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 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. The success of a BI project depends on business understanding. As an iterative process of consensus building between the client and data analysts, BI projects need to understand business background, objective, success criteria, contingency, and constraints (IBM, 2010). The models need to reflect business relationships. 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

A typical analytical project, starting from business understanding, to data understanding, to data preparation, to modelling, to evaluation, and to deployment, can become very complicated with complex business problems, multiple data sources, varying data quality, a wide selection of techniques, and different ways of measuring performance (IBM, 2010). Efficient processing of information and intelligence requires tight integration and coordination of the different functional units. It involves multiple stakeholders such as data governance body who defines 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. Different stakeholders are involved at different steps of an analytical project to different degrees. 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 capability to define and oversight 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 framework 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 oversight the governance framework regarding business intelligence and analytics initiatives. It specifies the roles played by different employees and the procedures that various business units need to follow to request data, build models, distribute intelligence, generate reports, make changes, and measure success. It sets boundaries in collaboration and provides a well-articulated governance framework that can guide such interactions and communication.

Though explicitly specified governance framework set parameters, it does not and should not outline all the details (Haeckel, 1995). Though 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. Explicitly specified responsibility and accountability guide analytical initiatives, but a lot of details need to be decided based on the context during any BI project. A BI initiative is an iterative process, not a waterfall process (Larose, 2005). Experiment and feedback are the integral part of it. 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

BI is 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). Organizational BI capabilities are not just limited to building models and create visual presentation. It also includes the organization’s capability to incorporate BI findings in their decision-making, planning, and executions. Business intelligence and analytics provide new quantitative, actionable knowledge that can guide business improvement and innovation. The efforts of evaluating BI results and acting on BI findings inevitably involve trial-measure-improve cycles. 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 process and products. Its focus is on serving existing market and business models (Hoang & Rothaermel, 2010; Sarkees, Hulland, & Chatterjee, 2014; Voss & Voss, 2013). The investment is typically moderate; the length of time is short; risks are low; and impact is limited. It requires the ability to conduct experiment, develop focused measurement matric, collect feedback, and continue to improve models. It is typically event-driven. For example, organization can launch a series of new advertising campaigns to translate more quickly into increased sales based on a predictive model.

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 leadership. 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

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. The subsections include four strategies to respond turbulent environment and develop dynamic capabilities in the context of BI capabilities.

Figure 1 shows the framework we have developed based on the literature review. Dynamic capabilities are the ability to achieve new forms of competitive advantage, and to create, deploy, and protect the intangible assets that support superior long-run business performance” (Teece, 2007; Teece, et al., 1997). It helps businesses to adapt to environment and to shape them through innovation. Dynamic capabilities can be disaggregated into the ability to sense opportunities, to seize opportunities, and to respond to maintain competitiveness (Teece, 2007). Sense and respond model is proposed to build dynamic capabilities for adaptive enterprise design (Haeckel, 1995).

Organizations in a turbulent environment have to respond to dynamic nature of products and services their customers require. With the development of dynamic capabilities, organizations can effectively respond to such an environment. 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.

**Figure 1 BI-Enabled Dynamic Capabilities**

### 4.1 Dynamic commitment of resources

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 they are negotiated through protocols that allow processes to be adapted and coordinated in response to specific events and needs (Singh, Mathiassen, Stachura, & Astapova, 2011).

Organizational resource allocation should be adaptive to what environment demands and assigned to where it needs most. For example, though a case manager has a designated geographical location, she would dynamically change her focus among assigned clients based on individual needs. Another example is ad hoc teams or councils that can undertake strategic initiatives. Dynamic commitment of resources is considered a prerequisite for effective adaptation.

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; where business attention should be focused; and what actions should be taken. It helps initiate new strategic and operation planning processes and provides quantitative suggestions on new focuses. The vision can be shared and achieved by reshaping responsibilities and personal accountability.

Second, analytics-based process capability helps dynamic commitment of resources by providing opportunities of trial new combination of resources. Data driven business exploitation capability and data driven business exploration capability both require organizations to conduct experiments and change current operation routines to explore new initiatives guided by analytical results. Such exploitation and exploration processes involve reconfiguration of resources and accountabilities over
the period of time. Such exploitation and exploration processes help both managers and employees negotiate and re-shape their new roles and responsibility.

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. Lego building block is a good metaphor to describe the essence of this idea. Today’s business preaches customization and personalization. Customization and personalization require detailed knowledge of fine-grained customer segmentations. Business need to understand unique and diverse requests of each segment or even each account and be able to deliver what they want in short time. Modular process design is more important than before.

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. BI users can choose and combine specific BI functions needed for their tasks. In addition, BI cloud computing infrastructure expedites modulation of BI by delivering BI services clients need and reducing complexity (Mircea, Ghilic-Micu, & Stoica, 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. Many analytical efforts have been focused on predicting market trends and customer preferences (Larose, 2005). Business analytics can help diagnose weaknesses of current products and processes, identify new demands, and deliver superior service to customers. It helps gain insight into market demands, and thus helps tailor current offerings to meet new market demands.

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. The exploitation and exploration capabilities can help organizations design and re-design new processes that may lead to new offerings of services and products.

4.3 Learning Process

In any changing environment, continued learning is inevitable for organizations’ survival and success. Haeckel (1995) proposes adaptive loop design to facilitate learning at all levels, individually, collectively, and institutionally. The adaptive loop includes sense 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. Singh, et al. (2011) extends this framework and elaborate how such loop would work in a home health business at both transactional and transformational levels.

BI infrastructure maturity helps learning process by providing a platform where data, intelligence can be collected, created, stored and shared (Isik, et al., 2013). It ensures distribution of data and intelligence to desired location where further analysis can be done and learning can begin. It is the IT infrastructure for the learning process. Data management capabilities can help learning in the following ways. First, Data collection capability provides basis for sensing. It enables an organization to identify sources of relevant information and obtain such information in usable format (Ramakrishnana, et al., 2012). Second, data management capability assurs data quality which provides basis for interpretation and analytic results. 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 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 (Haackel, 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 (Haackel, 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. Planned procedures cannot anticipate everything. 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. By explicitly specifying accountabilities, organizations can ensure that responsibilities are assigned and key activities can happen. By leaving the details of processes open, organizations can ensure process agility. In today’s dynamic environment, even accountabilities need to be adaptive when new strategies are forming. For example, when a business change from market share driven strategies to customer retention driven strategies, employees’ accountabilities need to embrace new processes and measurements.

One challenge in context specific coordination is that how to ensure coherent corporate behaviour emerge from the individual behaviour of empowered team (Haackel, 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. When negotiations fail, it could lead to conflicted decisions and actions that, instead of support each other, would cancel out others’ efforts. Fragmented BI efforts without the support of enterprise BI infrastructure also pose similar changes. Without enterprise BI capabilities, isolated system and outdated data create multiple versions of truth, which presents multiple versions of contexts to different stakeholders. It also leads to confusions and conflicted decisions across organizations.

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. It reduces confusions and random interpretations. Equipped with the same information, it is easier for empowered teams and individuals to collaborate and be creative when addressing the challenges. By providing one version of truth, BI capabilities provide the same context that can facilitate coherent corporate behaviours from individuals.
In this paper, we develop a framework to define BI capabilities and how such capabilities affect sensing and responding capabilities in current dynamic business environment. Derived from IT capabilities, we define BI capabilities from four dimensions, infrastructure, skills, collaboration, and execution. For the infrastructure dimension, we define BI infrastructure maturity as the combinations of data infrastructure, analytical platform, cloud computing, and modularity. Skill dimension consists of data management capabilities and analytical capabilities. Data management capability is comprised of data collection capability, data quality assurance capability, and data policies compliance capability, while analytical capability consists of data analytical capability and business insight. Collaboration dimension includes collaborative governance capability, which includes explicit coordination capability and dynamic coordination capability. The benefits of BI can only be materialized if BI findings are incorporated in business planning and processes. Therefore, the last dimension, execution, is analytics-based process capability that includes both data-driven business exploitation capability and data-driven business exploration capability. Our research also propose a framework that details how BI capabilities support dynamic capabilities by facilitating dynamic commitment of resources, modular processes, learning processes, and context specific governance mechanisms.

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. It provides a foundation for further study on BI’s impact on business. Second, our conceptual paper also attempts to explain the impact of BI capabilities on dynamic capabilities. Dynamic capabilities are deemed as the key business capabilities in today’s ever-changing environment (Singh, et al., 2011; Teece, 2007; Teece, et al.,, 1997). The call has been made to expand IS research to include more intangible value created by IT such as agility and flexibility (Kohli & Grover, 2008). IT has been recognized to play a central role in it (Bhatt & Grover, 2005; Singh, et al., 2011). With the rise of BI and big data, BI will also play an important role in enabling dynamic capability. Four sense and respond strategies, i.e., dynamic commitment of resources, modular processes, learning processes, and context specific governance mechanisms, are proposed to address business adaptation (Haeckel, 1995; Singh, et al., 2011). Our study extends it 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. This study also contributes to IS practice. By providing details of what makes up BI capabilities, it provides a roadmap for managers to build and nurture various BI capabilities over time. By providing the links between BI capabilities and four sense-and-respond strategies, it can help managers use BI to transform their businesses. Our study can be extended by empirically investigating and demonstrating our framework through quantitative or qualitative research methodologies. 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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