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Business intelligence systems use in performance measurement capabilities: Implications for enhanced competitive advantage

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ABSTRACT

The purpose of this study is to better understand how the quality of a Business Intelligence (BI) system improves the diagnostic and interactive dimensions of management control systems (MCS), thereby enhancing performance measurement capabilities, which in turn are positively associated with competitive advantage. Integrating theory from performance measurement, organizational learning and the knowledge-based view of the firm, a theoretical model is developed that considers three concepts of BI quality (infrastructure integration, functionality, and self-service) and the roles they play in enhancing diagnostic and interactive performance measurement capabilities. Data collected via survey from 324 CEOs and CFOs provides support for the theorized effects of BI quality on performance measurement capabilities. These capabilities in turn are positively associated with competitive advantage.

1. Introduction

Business intelligence (BI) systems provide broad measurement and analysis capability, including the foundations for implementing integrated and comprehensive management control systems (MCS) (Elbashir et al., 2011, 2013). This broad MCS-enabling capability is derived from the hundreds of pre-designed scorecards and key performance indicators available through contemporary BI software (Howard, 2003). Prior research shows that effective assimilation of BI at the business process level can lead to enhanced organizational learning and organizational performance (Elbashir et al., 2008, 2013; Lee and Widener, 2016). These benefits arise from top management's support and knowledge of BI (Lee et al., 2014) along with a knowledge culture that promotes operational managers to use the BI and to effectively interact with IT managers to develop the BI infrastructure (Elbashir et al., 2011).

The focus of the prior research has been on top management, operational management and IT management, and their effectiveness in assimilating BI into business processes. The BI systems themselves have generally been viewed as a given, with the focus being on the human capability to adapt such systems. However, there is an absence of research focusing on how this BI capability is harnessed through effective planning and reporting to support the desired interactive and diagnostic capabilities of effective MCS.

The purpose of this study is to enhance our understanding of how BI quality enhances performance measurement practices and competitive advantage. We establish BI quality as a combination of BI infrastructure, BI functionality and BI (managerial) self-service. We apply Alavi and Leidner's (2001) three dimensions of *data*, *information* and *knowledge*, to relate BI quality to

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support of the planning and reporting activities that underlie performance measurement information. The effects of BI quality are examined for their ability to lead to better performance measurement capability combining diagnostic and interactive dimensions (Simons, 1995). Diagnostic and interactive performance measurement capabilities are considered necessary to effectively support the knowledge capability of a firm (Lee and Widener, 2016) and for the pursuit of competitive advantage (Simons, 1995).

We develop a theoretical model of the relationships between BI quality, performance measurement system effectiveness, and the associated enhancement to competitive advantage, based on a combination of theory on performance measurement, organizational learning, and the knowledge-based view of the firm. The theoretical model is tested through data collected via survey from 324 CEOS/CFOs (or equivalent). The results of the Structural Equation Modeling-Partial Least Squares (SEM-PLS) analysis support the theorized relationships, including the three dimensions of BI quality, BI quality's positive relationship with enhanced performance measurement capability, and resulting competitive advantage.

The results of this study contribute to the overall understanding of how use of BI systems impacts organizational performance by focusing on how BI quality affects performance measurement capability. The research demonstrates how the manner in which BI is implemented, and the resulting facilitation of planning and reporting activities, impacts performance measurement capability.

This research has implications for both practice and research. First, we develop a multi-dimensional set of constructs for assessing BI quality, through the concepts of infrastructure, functionality and self-service. Second, we explain how BI quality improves MCS effectiveness through both the diagnostic and interactive dimensions of performance measurement capability. Third, we find support for relationships whereby: BI infrastructure enhances BI functionality; functionality in turn enhances performance measurement capability (including indirectly through BI self-service); and performance measurement capability ultimately enhances competitive advantage.

The remainder of this paper is presented in four sections. The first section overviews the background of the research and establishes the theoretical basis for the hypothesized relationships in the model. The second section provides an overview of the research method, while the third presents the results of the analysis. The final section provides a summary of the results from the research along with limitations that should be considered and implications for future research.

2. Theoretical model

BI systems[1] (and strategic information systems as a whole) are considered to be most effective at the business unit level and it is through business unit-level enhancements that overall organizational performance is enhanced (Elbashir et al., 2008). This study therefore examines BI quality and performance measurement at the business unit level. Accordingly, our theorizations draw from Simons' (1995, 89) concepts of performance measurement and from Huber's (1991) theory of advanced information systems and organizational learning. Simons (1990) concepts of interactive and diagnostic uses are the dominant performance measurement framework in recent literature (Grafton et al., 2010). As will be demonstrated, Huber's (1991) organizational learning theory aptly applies to the cybernetic learning that underlies performance measurement systems and capabilities.

Following Alavi and Leidner (2001), the BI and performance measurement concepts in the theoretical model are differentiated in terms of data, information, and knowledge. BI infrastructure integration refers to data qualities. BI functionality refers to the quality of the applications that process data into information. BI self-service and performance measurement capabilities are the extent to which such information is mediated cognitively by the knowledge bases of individual managers. A knowledge base is an individual manager's repository of learning (Thomas et al., 2001; Clark et al., 2007). Organizational learning occurs when the knowledge base of more than one manager is affected by their cognitive processing of information (Huber, 1991). Further, there is evidence that diagnostic and interactive BI uses will improve managers' knowledge bases (Lee and Widener, 2016).

Ultimately, the interest is in competitive advantage, which refers to superior business unit financial performance relative to rival firms (Grafton et al., 2010). The hypothesized relationships with competitive advantage draw on knowledge-based theory (Grant, 1996), which extends resource-based theory (Barney, 1991) to include resources that are knowledge-based, such as the knowledge embedded in and carried through organizational culture, routines, policies, systems, documents, and the minds of individual employees (Alavi and Leidner, 2001). These two theories conceptualize a firm as a bundle of assets and resources that are deployed in routines/capabilities (Barney, 1991). An “asset”, such as a generic IT application, could be procured from external suppliers by any firm, and so any value it can contribute in organizational capabilities can only be a source of temporary competitive advantage — because eventually all firms could procure it such that there will be a situation of competitive parity (Barney, 1991). In contrast, a “resource” such as social complexity or managerial talent can be a source of persistent competitive advantage, at least to the extent that it is heterogeneously distributed across rival firms and immobile.

It is important to recognize that BI functionality, BI infrastructure integration, and BI self-service are each conceptualized as two-dimensional emergent (i.e., second-order formative) in the theoretical model. BI planning and BI reporting are the two dimensions that together constitute a performance measurement BI system. BI planning is for producing performance plans, for example, annual budgets and monthly forecasts. BI reporting is for management reporting and analysis of performance measurement outcomes and feedback variances. Both BI dimensions typically contain profit-planning data (i.e., traditional accounting

[1] BI is a term that broadly refers to management support systems for gathering, storing, and accessing data for decision making (Clark et al., 2007; Fedorowicz and Konsynski, 1992). BI systems are distinct from executive information systems, knowledge management systems, and decision support systems (Clark et al., 2007). Herein, we use the term BI in reference only to the category that is specific to business unit performance measurement (Chaudhuri et al., 2011). Other types of BI — such as data mining and analytics, predictive analytics, and text analytic engines (Chaudhuri et al., 2011) — are outside the scope of this research project.